Green Apparatus: Ecology of the American House According to Building Codes

HARVARD UNIVERSITY
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Green Apparatus: Ecology of the American House According to Building Codes

Presented by

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candidate for the Doctor of Design degree and hereby certify that it is worthy of acceptance.

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Green Apparatus

Ecology of the American House According to Building Codes

A dissertation presented by

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ABSTRACT

In 2008, California introduced the first-in-the-nation *Green Building Standards Code* to encourage sustainable construction practices. While the adoption of the *CALGreen Code* marked a significant moment in the process of the *greening* of building regulations, it represents only one moment in the nation's history of code-making, and that of environmental action. Two parallel narratives, and their eventual mergence are the subject of this study. The first one is a story of the agendas that shaped the American house, and the regulations that govern it; the second an account of the rise of environmental awareness as gradually standardized by law-makers and normalized by economists. The goal is to evaluate the wide-ranging consequences of their convergence – not just the isolated green building standards. Essentially, while environmentalists criticize the devastating global effects of consumerism, free trade, and fossil fuels; governments and local authorities focus on fine-tuning of individual standards, and diffusion of efficient technologies at the scale of households. It remains to be seen whether these measures will minimize the environmental impact of American houses, or simply perpetuate the market-driven image of sustainability, and further complicate the multi-layered building code that they try to mend. This research is ultimately concerned with an *apparatus* which uses the house, and green technologies as a vehicle for economic growth. For this reason, it would remain incomplete if it exclusively focused on ecological ideas and legislative programs, disregarding economic forces, market instruments, and technology. The first part of this study provides an account of ecological ideas, economic agendas, and regulatory programs as they emerged, influenced each other, and informed the character of environmental action and American households, specifically those built in California, and the City of Los Angeles. The second part investigates the mechanics of the regulations used to standardize building practices, and financial incentives used to promote green technologies. As Bateson observed, ideas and programs interact and survive in circuits. It would then be a fallacy to assume that by changing ideas and programs, and updating standards and recipes, we can change our environmental awareness. Ideas and standards must be questioned, but the matrix from which they originate needs to be occasionally *re-circuited* as well.

THESIS COMMITTEE

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To my parents, who taught me

how to live well without calling it *wellness*,

how to stay fit without calling it *fitness*,

how to sustain life, without calling it *sustainability*

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CHAPTER 1 – Introduction.

Any normality open to possible future correction is authentic normativity, or health. Any normality limited to maintaining itself, hostile to any variation in the themes that express it, and incapable of adapting to new situations is a normality devoid of normative intentions. When confronted with any apparently normal situation, it is therefore important to ask whether the norms that it embodies are creative norms, norms with a forward thrust, or, on the contrary, conservative norms, whose thrust is towards the past.

- Georges Canguilhem, 1994

1.1. Parallel Narratives: The American House According to Building Codes and Environmental Awareness.

Two parallel, initially unrelated narratives, and the consequences of their eventual mergence are the subject of this study. The first one is a story of the American house; the second an account of the rise of environmental awareness. Rather than a comprehensive overview, each is a journey along a particular path; the former as thought by domestic engineers, merchant builders, and realtors; the latter as inspired by naturalists, informed by scientists, and put into action by environmental activists; both as gradually normalized by politicians and economists, and eventually standardized in the circuits of code-makers throughout the twentieth century. The ultimate concern is to understand how these two narratives merged and evaluate the outcome of this mergence – the green building standards. In order to understand why the American house (especially as regulated by building codes) assimilated the ecological imperative in this particular way, it is necessary to answer a series of questions. One must ask: 1) what forces affected building standards before they *turned green*; 2) what forces shaped the ecological imperative; and 3) what forces captured the ecological imperative and redefined it as *green building standards.* The answer to these questions would remain incomplete if the study was only concerned with the development of ideas and legislative programs. Inevitably, it has to also involve an investigation of economic forces, and the role played by the market instruments and technology. As a consequence, this

research is ultimately concerned with the mechanics of an apparatus which uses standards propagated across the circuits of code-makers together with economic incentives which promote technologies, to ultimately propel the economy. This is a story of an old apparatus, only that this time round, the apparatus is green.[1]

The American house has served its purpose well, and reasons to use it as a channel have never lacked. Today, the reason is to make the house resilient; in 2016, the Obama Administration launched a public-private initiative meant to "increase Community Resilience through Building Codes and Standards."[2] The palpable consequences of climate change put life safety and protection of property again in the center of attention. Hardly a decade after the state of California adopted the first in the U.S. *Green Building Standards Code* meant to reduce environmental impact of construction; mitigation of risk rather than prevention of impact is again the main concern of code-makers. Undoubtedly, the term 'resilience' will serve the market as well as the green building standards did. When the housing bubble burst in the late 2000s (Immergluck 2009), architects responded to the unsustainability of the housing market by symptomatically embracing technological innovation rather than simple restraint; they adopted the *green prefab*. This reflected the fact that, while in part effect of a genuine concern for the environment, green building standards emerged in the 1990s as part of the green economy. They expressed the pragmatic idea of sustainable development, and the belief that it is possible to decouple economy from environmental impact. They did not attempt to *correct* the increasingly deregulated real-estate market which considered financial rather than material obsolescence a reason for building more and bigger houses. This tendency was already visible in the 1980s when, with the excuse of renewing the aging housing stock, houses were built bigger rather than affordable, and the 'vernacular' was embraced as a style rather than an ecological stance. Similarly, in the previous decade, the passive solar design methods failed to compete with off-the-shelf energy-conserving mechanical appliances promoted as a means to improve energy security after the 1973 oil crisis. This was quite inevitable considering that in the 1960s merchant builders focused on delivering quickly and cheaply built, rather than custom-designed and site-specific houses (Eichler 1982). During the same time, although passive climate-control strategies attracted unparalleled interest, more market-friendly, climate-control solutions were already being defined by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). While the first

[1] For a discussion of the Foucauldian concept of *apparatus* see: "What is an Apparatus?" (Agamben 2009), and *What an Apparatus is not?* (Pasquinelli 2015).

[2] When not provided, the sources used in the introduction can be found in the following chapters where the mentioned events are discussed in more detail.

energy-conservation standards were introduced in the 1970s, similar measures were already contained in the 1950s editions of the *Minimum Property Standards for Properties of One or Two Living Units* published by the Federal Housing Administration. Adopted before the rise of environmental awareness, the reasons were clearly economy-related (Weiss 1987, Easterling 1999). In fact, these standards embodied almost 25 years of efforts to standardize the American house, normalize its cost, and minimize financial risks while promoting economic growth (Massey 2012). Even back then, the agenda was not new. In 1922, Hoover's Department of Commerce started to promote uniform and cheap construction methods to increase homeownership among middle-class families, ultimately to reduce workforce instability and secure steady economic activity (Weiss 1987). Although the purpose was novel, this too was a declination of an earlier project, the one undertaken by the first code-makers in the early 20th century. Their main concern was the basic safety, health, and welfare in tenements occupied by poor (and highly instable) workforce (Ben-Joseph 2005). The preoccupations embedded in this century-old triad of terms – 'health', 'safety', and 'welfare' – still resonate in the current use of the term 'resilience'. The difference is that back then the threat came from industrialization and excessive urban growth, today it comes from climate change and environmental disasters (Fig. 1. 1). It is deeply engrained in the regulatory landscape for the code-makers to be concerned with human safety and property protection (Fig. 1. 2), rather than to be driven by a genuine care for the environment. The ultimate goals remain unchanged: ensure community stability and economic growth; or, in modern terms: increase community resilience and economic development. It is deeply engrained in the American culture to consider the housing industry as a vehicle for economic growth.

It is also deeply engrained in the cultural landscape to think about the environment in economic terms. In the early period when the American house was being made safe and healthy, environmental awareness manifested itself in the creation of urban parks, garden cities, and wildlife reserves (Daniels 2009, Easterling 1999). These initiatives were inspired by early environmental preservationists, such as John Muir, but they were equally influenced by utilitarian attitudes, such as the conservationism advocated by Gifford Pinchot whose main concern was the efficient use of resources (Worster [1977] 1996). At this determinative stage, the environmental dynamics were still poorly understood, and hence it was impossible to apply scientific management methods to them. Anyway, nature was still abundant. Even when regional planning emerged in the 1920s, ecology was still defining its key concepts,[3] and the first

[3] Both Charles Elton, and Alfred J. Lotka were active in the 1920s.

Fig. 1. 1 Rapid urban growth: a row of tenements in Elizabeth Street, New York, NY. 1912 (left). Environmental disasters: homes destroyed by Superstorm Sandy in Seaside Heights, N.J. 2012 (right).

In the belief that good construction should be recognized as of the utmost importance in every city and town, this Building Code, as prepared and recommended, has been based upon broad principles, hoping to impress upon municipal authorities everywhere their grave responsibility in enacting and enforcing laws for the protection of life and property. 1905

The Code is necessarily somewhat voluminous owing to the efforts of the Committee to provide for conditions existing in towns as well as cities.

2016

1.1.2 Purpose. *The purpose of this code is to establish the minimum requirements to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, stability, access to persons with disabilities, sanitation, adequate lighting and ventilation, and energy conservation; safety to life and property from fire and other hazards attributed to the built environment; and to provide safety to fire fighters and emergency responders during emergency operations.*

Fig. 1. 2 An excerpt from: the 1905 National Building Code Recommended by the National Board of Fire Underwriters (top); and the 2016 California Residential Code (bottom).

impact assessment methods would not be developed until the 1960s.[4] It wasn't until the 1970s, and in reaction to a devastating impact of chemical industries as famously exposed by many scientists and activists in the 1960s, among them Rachel Carson in *Silent Spring* (1962), that the U.S citizens witnessed the creation of the first comprehensive federal environmental protection framework (e.g. National Environmental Policy Act of 1970, *Clean Air Act of 1970*, *Clean Water* Act of 1972). It became evident that it was no longer possible to simply set aside green reserves to offset the impact of industrial development, and that a more systemic action was required. Various events, conferences, and reports, among them the First Earth Day (1970), the Stockholm Conference on the Human Environment (1972), and *The Limits to Growth (*Meadows et al 1972) rose alarm about the state of the planet (Grober 2012), but the second wave of environmental legislation was in large part also triggered by the 1973 oil crisis, and the threat of energy scarcity (e.g. *Energy Policy and Conservation Act of 1975*). Unfortunately, the voice of Herman Daly who criticized the excessive focus on relative efficiency and advocated for setting absolute limits for the economy (1977), remained largely ignored (Caradonna 2014). The Reagan administration brought a drastic revision of the U.S. legislation favoring economic growth over environmental protection. Similar attitudes marked the 1980s across the entire Western world, slowly deregulating most of the existing control mechanisms in favor of free market and private property. The negative effects of this backlash, together with a growing scientific evidence of the impact of global economy on climate change and a series of major environmental disasters (e.g. Chernobyl) triggered the first wave of inter-governmental actions. The 1987 *Brundtland Report* introduced the concept of sustainable development into global politics, and the issue of emissions reduction was first discussed at the World Conference on the Changing Atmosphere held in Toronto in 1988. The collapse of the Communist block yet again diverted international attention towards issues of economic growth and triggered a new wave of expansion of capitalist markets. Although major climate summits took place during the 1990s, it was the free trade agreements, such as NAFTA, and the entry of China into the WTO that determined the course of the global dynamics in the next two decades (Klein 2015). The climate action heavily suffered from the increasing deregulation of global markets, and attention hypocritically shifted from the impact of global trade onto the efficiency of products, and sustainability of daily practices. Both the American house and environmental action were eventually canalized to serve the market.

[4] In the 1960s McHarg developed his system of land classification and established criteria for land development assessment. Environmental impact review became a legal tool as part of NEPA in 1970.

1.2. Alternative Ideas: Ecological Thought and Sustainable Morality.

Almost 20 years after the Kyoto Protocol, environmentalists continue to denounce the devastating impact of free trade and fossil fuels on communities and landscapes. In the meantime, governments fine-tune green standards, concentrating on incentives for eco-technologies to guarantee demand among potential consumers. Canguilhem said: "Certainly, the logic of normalization can be pushed as far as the normalization of needs by means of the persuasion of advertising" (1994, 373). While entire ecosystems disappear, and communities suffer from processes of deterritorialization, we advertise sustainability in terms of net-zero technologies, and smart cities. In fact, the vision of sustainability that underlines most of today's voluntary and mandatory green building standards selectively isolates certain quantifiable aspects of ecological dynamics. Simultaneously, it fails to address the open and interconnected character of ecological systems. Decades of delay in response to global warming legitimize what Agamben calls a state of exception (2005). Now extremely urgent, climate bills justifiably focus on energy efficiency and renewable sources of energy.

Green building standards and regulations are, of course, based on principles developed by ecologists and environmental scientists. For example, due to their systemic and quantitative nature, the methods developed by the ecologist H.T. Odum strongly influenced studies in urban metabolism which continue to inform urban planning. His major contribution (1971, [1983] 1994), a system-based analysis of metabolic processes in natural and urban systems in terms of energy flow, has influenced urban environmental *book-keeping* (e.g. Los Angeles Sustainable City pLAn), and indirectly green building standards. Likewise, the criteria developed by environmental planners in the 1920s, by Ian McHarg in the 1960s, and later by landscape and urban ecologists, such as Richard T. T. Forman, have informed land-use planning. However, the latter ideas have met with more resistance due to their insistence on spatial patterns, and importance of vegetation; issues that cannot be easily quantified and standardized, and in consequence are less compatible with the market-driven approach to sustainability.

Alternative visions of ecology, such as Guattari's *ecosophy*, which combine multiple ecological registers – the environment, social relations, and human subjectivity – struggle to shape the notion of sustainability, especially when translated into mandatory standards. Guattari's ethico-political and at times aesthetic position remains in stark contrast with the prevailing technocratic attitudes, as he advocates against standardization, normalization and commodification of social relations and subjectivities. Guattari's project also expands Gregory Bateson's cybernetic vision of ecology. In fact, he opens his *Three Ecologies*

Fig. 1. 3 Nature: Yosemite National Park (left). Hyperobject: "Red Ice – White Ice" by Chris Wainwright. Disko Bay, Greenland. 2008-09 (right).

by restating after Bateson that "There is an ecology of bad ideas, just as there is an ecology of weeds" ([1972] 2000, 492). It is the ideas and programs generated by interconnected minds that shape ecology, and it is these same ideas and programs that shape our notions of sustainability and propagate them in a standardized form across the circuits of code-making. Both Guattari's and Bateson's projects resonate strongly with Von Uexküll's theory of Umwelt ([1934] 2010), a proto-cybernetic account of the multiple worlds that result from systemic interactions between species and their environments. Von Uexküll's vision of ecology unfolds bursting with unique subjectivities which thrive on heterogeneous relations, and propagation of ideas across interconnected minds, with not one common standard, and not one single environment. As Timothy Morton says: "This is indeed an environment, yet when we examine it, we find it is made of strange strangers" (2010, 58). Inevitably, as he says, it is the awareness of these *strange strangers* that constitutes the true, even if at times *uncanny*, environmental awareness. And it is the recognition of being part of this heterogeneous mesh that is the only way that will allow us to face the "hyperobject" of our times – the climate change (Morton 2014), and – as Naomi Klein would have it – capitalism. Unfortunately, such expanded environmental awareness will continue to be globally *over-*

encoded[5] by the same notions of sustainability if we insist to think about the environment in terms of Nature (and the Other) as the outside from which to extract, and from which to isolate ourselves. As Negri and Hardt state in *Empire*, capital depends on its outside, it thrives on it (2001). It is the constant regeneration (and artificial generation) of this outside in the concept of Nature, powered by a techno-scientific rationality and an old set of ethical values that define the way in which we continue to think about the environment (Fig. 1. 3).

The protestant ethic that Weber identified as one of the major forces behind the spirit of capitalism, can now be perceived in the contemporary attitudes towards nature ([1905] 1993). The abstract machine which coupled the protestant ethic with the capitalist ethos of accumulation of wealth, has also aligned environmental ethics with the spirit of consumerism. The puritan ethos of the daily duty, and the utilitarian attitude towards virtues, resonate in the contemporary pursuit of environmental efficiency, and transform environmental awareness into a sustainable morality. Cities adopt *book-keeping* of environmental conduct, tracking good deeds against ecological sins. Unfortunately, like the puritan ethic which from a calling turned into an "iron cage", we increasingly find ourselves in a *green cage* of sustainable capitalism that imposes a rigid conduct while successfully neutralizing the underlying desire for a joyful and contemplative communion with nature.[6] In fact, like the protestant ethic, sustainable morality prefers the individual daily discipline from collective expression. It transforms the oppressiveness of scientific management into a daily environmental heroism. Sustainable morality requires a similar form of discipline; "a regulation of the whole of conduct" (Weber [1905] 1993, 4); a Panoptical *dispositif* of control of all aspects of life (Foucault 1975, Deleuze 1988). Once again, as Hardt and Negri point out, capitalism manages to transform the desire to resist into a useful mechanism,[7] it absorbs, celebrates, and manages resistances and differences, it couples the global warming imperative with the micro-politics of sustainability.

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[5] Guattari defines the process of over-encoding in the Glossary to the English edition of Molecular Revolution: "The idea of code is used in a very wide meaning. It could apply to semiotic systems as well as to social fluxes and material fluxes. (…) the term of over-encoding corresponds to a coding at the second degree. For example: primitive territorialized agrarian societies functioning according to their own system of coding are over-encoded by a relatively de-territorialized imperial system imposing on them its military, religious, fiscal hegemony etc." (1984, 288).

[6] Occasionally turning to emotionally-charged methods, which echo those identified by Weber in the Methodist church ([1905] 1993), to convert the others by propagating the spectacle of melting icebergs, and dying wild animals, those that Morton refers to as the *cute animals*, not the *strange strangers* (2010, 38).

[7] "Each imperial action is a rebound of the resistance of the multitude that poses a new obstacle for the multitude to overcome" (Hardt and Negri 2001, 360). See also page 198.

1.3. Coinciding Programs: Green Economy, Environmental NGOs, and Mandatory Standards.

Once adopted as a "calling", sustainability can be easily hijacked by suppliers of products and services to generate new niche markets. This mechanism is now so widely diffused that many free-market economists claim that we can only be sustainable in ways that generate profit (Caradonna 2014). The only economy that counts is that which generates a monetary profit. On the global scale, the argument that "the way to reduce pollution is to create a market for it" (Chang 2010), resulted in the cap-and-trade mechanisms which triggered a wave of lucrative speculation, replacing previous policies based on simple limitations on individual polluters (Klein 2014). On a more tangible scale, it created a market for low-energy bulbs, eco cars and solar panels, all important issues if part of a more comprehensive environmental strategy. Unfortunately, as Naomi Klein says, "Policies based on encouraging people to consume less are far more difficult for our current political class to embrace than policies that are about encouraging people to consume green" (79). Also, many environmental issues can simply not be evaluated in terms of an immediate financial profit, and short-sighted utilitarian attitudes fail when potential risks are not immediate, or when benefits are to be discounted in a poorly defined future (Pearce 1992).

Market-driven logics diffused by the media and reflected in green building standards make an average owner of a McMansion believe that their home is sustainable since its daily operations are powered with solar panels, and water comes out of an efficient faucet.[8] Unfortunately, it is not just a lack of knowledge or hypocrisy. A house which actually consumes less energy due to spatial or material solutions will not receive a tax write-off while one that promises to cover a predicted consumption with an array of solar panels will. In this context, there is no motivation to adopt environmentally-friendly solutions that do not require a purchase, although these solutions would ultimately reduce the global use of energy (Knowles 1974). Also, our commodity-driven culture and long working hours mean that most people do not have time to participate in environmental action or even do some gardening, which could potentially provide many environmental benefits. Economic incentives coupled with mandatory green standards address a bounded sustainability of individual households but detract attention from other and bigger

[8] The goal expressed in the California ZNE Residential Action Plan is that "all new residential construction in California will be zero net energy by 2020." Although very progressive, even California climate action expresses the same market-driven emphasis on operational efficiency. See the website. Accessed December 28, 2017. http://www.californiaznehomes.com/#!about/cdtl Also, as a recent article published by Greentech Media reports, while the homes become more efficient, the average household consumption has been increasing due to the size and equipment of homes. Accessed December 28, 2017. http://www.greentechmedia.com/articles/read/The-Growing-Size-of-New-US-Homes-is-Offsetting-Residential-Efficiency-Gains

environmental issues (Crist 2007), which cannot be resolved by curbing domestic operations to a net zero with solar panels. Transforming economic incentives into mandatory regulations also carries the risk of social exclusion as homes become less affordable.[9] Alternative solutions are either not advertised, or do not easily comply with official standards (e.g. straw bale construction, aerobic wastewater treatment). In fact, producers compete to set standards which will be adopted as regulations to reduce competition and increase their market share (e.g. standards for composting toilets). Setting green standards and providing eco-solutions also helps improve the image and works as a shield against environmental criticism. And if criticism arrives, companies join forces with professionals and citizens to form standard-setting NGOs, to indirectly bend the norms towards their own needs. As Hardt and Negri acutely point out: "NGOs extend far and wide in the humus of biopower; they are the capillary ends of the contemporary networks of power (…)" (2001, 313).

In the absence of governmental measures, many green non-profit organizations, such as the U.S. Green Building Council (USGBC), emerged over the last two decades to promote sustainability among architects and builders, gradually developing voluntary green guidelines for the construction industry (e.g. LEED Green Building 2000, and Neighborhood Design 2009). The broad spectrum of social groups which support the USGBC offers unique opportunities. Neither directly representing industries and suppliers, nor the state, NGOs are a perfect structure to exert indirect influence, to use Guattari's expression, they are "best fitted to capture desire and harness it to the profit economy" (1984, 229). Industries support NGOs to promote their products, real-estate developers comply with their standards to green their public image, and environmentalists, concerned citizens, teachers and students turn them into a trustworthy, third-party authority. Grassroots alternatives not aligned with the prevailing economic logics struggle to compete. In fact, those organizations which pursue more ambitious environmental and social goals, such as Living Future Institute (LFI), eventually adopt the same formula based on credentials and certifications to compete for members among architects and developers. What could be a set of flexible guidelines becomes a form of self-inflicted "microfascism" *(*Guattari 1984, Deleuze and Guattari [1980) 1987)*,* in which different organizations compete to impose certified sustainable norms, and peer support becomes a form of diffused and mediated discipline.

Eventually, when the most successful voluntary code was adopted as an extension of building regulations,

[9] Los Angeles Housing and Community Investment Department identifies the introduction of the green standards as a potential barrier to affordable housing in a recently published *Housing Market Analysis Report.* See the website of the City of Los Angeles. Retrieved July 19, 2015. http://cdd.lacity.org/pdfs/conplan39/5yearCP-39py_Section4-HousingMarketAnalysis.pdf

a norm became the *imperative* (Canguilhem 1994). Many U.S. states and cities have made LEED standards a requirement for certain types of construction.[10] By adopting the criteria developed by USGBC, governments legitimized them as a national green building standard monopoly, despite (but in reality, precisely because of) the fact that it represents a compromise between the interests of sustainable advocates, construction industry, and real estate developers. However, since obtaining LEED certificates posed a financial challenge and brought few advantages to smaller commercial and residential developers, these groups opposed resistance, and were initially excluded from the mandatory compliance with LEED standards. Despite the initial resentment, in 2008 California was the first U.S. state to develop and apply its own minimum mandatory green building standards (the *CALGreen Code*) to almost all new constructions. It is noteworthy that the USGBC whose interest is to maintain LEED certifications on the market, responded by recognizing the *CALGreen Code* requirements towards LEED points, to both maintain its position, and mark a clear distinction between the California baseline, and the USGBC's ambition to set the highest standards. Ultimately, in 2012 the International Code Council (ICC), another powerful non-governmental association, introduced a new model code, *International Green Construction Code* (IgCC), to provide baseline green building requirements. With this latest addition, ICC recognized the work done by, among others, the USGBC, and the state of California, as sufficient to prepare policy-makers, the market, and general public to accept an additional layer of restrictions in all types of construction. The greening of the building code is under way. The green apparatus is in place.

Green building standards apparently limit the freedom of the housing industry in response to a growing environmental awareness. Unfortunately, the complicated nature of the restrictions means that they often promote a misleading feeling of safety, and a distorted notion of welfare, while still supporting specific economic interests (*Fig. 1. 4*). Even if, as Ha-Joon Chang claims, "some markets look free, it is only because we so totally accept the regulations that are propping them up that they become invisible" (2010). Indeed, it seems that some restrictions rather than limiting the market, do prop it up. In the process of defining the constraints, the control apparatuses capture and channel desires to transform them into ideologies, at times empowering grassroots movements, at other times disarming them; and at times limiting the market, and at other times empowering it. In case of green building standards, the question is whether these standards really promote the right to a healthy environment (or better, the right of the

[10] For a comprehensive list of cities that adopted LEED as a mandatory measure, see: "How Often Do Cities Mandate Smart Growth or Green Building?" (Lewyn and Jackson 2014). Retrieved July 21, 2015. http://mercatus.org/publication/how-often-do-cities-mandate-smart-growth

Fig. 1. 4 Green Building Standards: The first edition of the CALGreen Code (top left). Free Market: Cleanout Foreclosures Pricing Guidelines (bottom left), and a house in San Antonio, Texas, facing foreclosure in 2009 (right).

environment to be healthy), or just perpetuate the market-driven image of sustainability using mechanisms of state power.[11] Surely the norms meant to restrict the market support it at least in one specific way. The mandatory nature of the norms ensures that environmental solutions can be easily assessed in terms of their monetary value and compared in terms of financing risk. This mechanism was put in place when the American house became a standardized real-estate product financed with a FHA-insured mortgage, and it naturally continues as the housing construction industry evolves under the pressure of sustainable imperatives. The first part of this study, **Part 1 – Agendas**, explores the co-evolution of these two phenomena, and the ideas and programs that continue to persist in the code-making circuit.

With the introduction of the mandatory green building standards, the spirit of sustainable morality has finally conquered the last uncharted territory: *oikos*. And if, as Christopher Hight says, "Ecology is the

[11] In *Questioning Architectural Judgment*, Moore and Wilson (2014) discuss two important instances of market limitation achieved through code-making: Disability Act and Affordable Housing Act introduced in Austin, TX.

central administrative knowledge for the ordering of things within an age of biopower" (2014, 94), the household is the smallest arena for "miniaturized instruments of coercion" (Guattari 1984, 263). It remains to be seen if mandatory green building standards bring the households, and their economy closer to natural and social life processes, or whether they will further complicate the already multi-layered building code system that, to use Ben-Joseph's expression, they try to "Band-Aid" (2005). The risk is that the new standards will simply expand the project of "self-regulation built into norms of 'home'" (Hyde and Aggregate Group 2014, viii) onto its relationship with the environment, and extend the biopolitical governability beyond the human onto the realm of natural living processes themselves. All of the above by using architecture, its sites, and its processes as a conductive channel.

1.4. Beneath the Green Surface: Financial Incentives and the Structure of Regulations.

When environmental awareness started to influence regulations in the 1970s, the building code was already a crystalized system of rigid prescriptions of often forgotten origin, criticized for excessive complexity (Ben-Joseph 2005, 104). Environmental regulations (such as the *Energy Code* first introduced in the U.S. by the state of California in 1978) were simply added to the existing codes. *Band-Aiding* rather than a systemic revision of the underlying notions and previous regulations continues to characterize code-making as the new green building standards are being introduced in response to the emerging sustainable imperatives. Clearly, it is easier to analyze an issue as a two-variable problem of simplicity, and speculate about few potential solutions, rather than approach it in terms of organized complexity and control interconnected effects. It is also easier to explain a well-defined issue to residents, and ultimately convince them that the solution lies in a *green* product, rather than revise the entire system of codes, and impose a dramatic change in mindsets and habits. The tendency to adopt isolated regulations is also driven by the fact that complex issues are administered across a maze of independent governmental agencies, both issue discussed more than half a century ago by Jane Jacobs ([1961] 1992). These attitudes also support specific modalities of control. While discussing different ways of expressing norms, William Baer pointed out that prescriptive standards impose blueprints for artefact-driven solutions, while performance-based criteria impose a result (2011, 277). They consequently require a capacity to develop new receipts and think in terms of, to use Herbert Simon's distinction, process, not state descriptions ([1969] 1996, 479). Clearly isolated problems can be resolved by adopting a product-based solution, while systemic issues are wicked problems (Rittel and Webber 1973) which can rarely be resolved by simply developing a new technology. They must be acted upon by adopting complex process-based solutions

with no clearly predicted outcomes.

Herbert Simon observed: “As creatures of bounded rationality, incapable of dealing with the world in all of its complexity, we form a simplified picture of the world, viewing it from our particular organizational vantage point and our organization's interests and goals” ([1969] 1996, 44). The “bounded rationality” which favors highly prescriptive standards is a double edge sword. While it protects from unpredictable effects of unverified solutions, it also limits our capacity to innovate in response to new priorities. Georges Canguilhem said: “No fact termed normal, because expressed as such, can usurp the prestige of the norm of which it is the expression, starting from the moment when the conditions in which it has been referred to the norm are no longer given” (1994, 353-4). Cultural norms, and informal normative practices are bound to specific cultures, both in terms of time and space. While providing local communities with ready-made rules for safety, prescriptive standards promote generic solutions which *overcode* these informal norms. Regulatory mechanisms which transform fluid systems of norms into rigid, legal structures will always struggle to keep pace with changing conditions, and often fail to reassess norms to respond to emerging needs. They will also inevitably limit heterogeneous expressions of ecological awareness to bounded forms of sustainability.

In the recent years, the codes (e.g. the *California Energy Code*) have become more flexible, gradually evolving into a complex mix of prescriptive and performance-based standards and criteria, which theoretically encourages technological innovation. Yet, non-standard solutions require a team of well-prepared designers and consultants capable of developing and defending them, which inevitably increases soft costs, and entails additional legal risks. Many potentially beneficial passive design strategies which take advantage of the local climate are rarely adopted either because they create conflicts with pre-existing regulations or require expensive performance tests (Moore and Wilson 2014, 131-36). Passive solutions (e.g. natural ventilation), and organic systems (e.g. vegetative shade) are penalized by prescriptive standards which prefer products with a manufacturer’s warranty and guaranteed performance, over custom-designed spatial configurations, and over use of vegetation which has not been

fully standardized,[12] and escapes full control as it evolves with seasons. Meanwhile, the fact that mechanical systems can be easily made unreliable by people's irrational behaviors, and irregular weather patterns is not perceived as a problem in the culture that prefers passive consumption over an active involvement and relies on product datasheets which guarantee fixed performance even, if not corresponding to the actual results.

Although many authors have acknowledged the harmful side effects of many existing standards (Ben-Joseph 2005, 43), and recognized the need for a systemic reassessment of the entire code, most dissertations[13] and dedicated reports concentrate on environmental benefits of recently adopted green building standards and investigate their impact in isolation from the existing codes. For example, in *Green Buildings and the Law* (Adshead 2011), McCuen and Fithian analyze some of the contradictions that exist between green building standards and the rest of the current code, and briefly point out that: "legislation is typically passed for a particular component or a problem in the system, rather than addressing the entire system" (38), but they then concentrate on potential harmful environmental impact of specific green building standards. Meanwhile, four interconnected problems seem to characterize the current regulatory mechanisms: 1) excessive reliance on prescriptive standards, which impose either rigid dimensional restriction or product-based solutions;[14] 2) lack of revision of old, and by now fully assimilated regulations; 3) little attention payed to the combined effects of the entire regulatory system which produces unforeseen outcomes due to its internal complexity, flexibility meant to facilitate interpretation and application, and by consequence its vulnerability to political pressures and economic

[12] Or hasn't been yet standardized enough in terms of performance. Meanwhile, turf grasses and most agricultural products have been engineered for decades. As an example, see the story of the engineered potato, in Michael Pollan's *The Botany of Desire* (2001). Possibly, organic systems will be accepted by the building industry only when it becomes possible to represent them as CAD blocks and therefore integrate them into the BIM system which provides "a means of organizing and classifying electronic object data and thereby [fosters] streamlined communication among owners, designers, material suppliers, constructors, facility managers, and all stakeholders associated with the built environment." (National Institute of Building Sciences 2014) They will be integral to the project once the process of their scientific management has been completed all the way through to representation.

[13] For example: *The Role of CalGreen Codes and Sustainable Rating Systems in Practicing Sustainability* (Rezvan 2013).

[14] For example, in 2014 the city of Lancaster in California was planning to introduce a Net Zero Water law. The plan to impose a reduction on consumption was immediately coupled with the promotion of a specific start-up which would most likely also influence the imposed standards. See a 2014 article by Catherine Tweed "Next Step in Sustainability: Requiring Homes to Recycle Water," Accessed December 28, 2017. https://www.greentechmedia.com/articles/read/next-step-in-sustainability-requiring-homes-to-recycle-water

interests;[15] and 4) the impact of economic incentives used in combination with mandatory regulations to promote environmentally-friendly appliances and construction methods, and support economic growth. These issues are explored in the second part of this study, Part 2 – Mechanics.

1.5. Pre-Design: Organization of the Research.

Since most homes are financed with mortgages which are issued under strict conditions imposed by lenders and insurers to minimize risk, in residential projects solutions which comply with prescriptive standards imposed by the code prevail over spatial and ecological innovation. Most of the time, the codes are the mechanism responsible for the environmental impact of their construction. For these reasons, this study focuses on residential construction. As mentioned previously, California has always been at the forefront of environmental legislation and was the first state to expand its code of regulations with a set of mandatory green building standards. At the same time, the city of Los Angeles provides a fascinating case study. Its vast, and apparently uniform fabric regulated by one set of rules extends over a vast territory characterized by many different ecologies, to use Banham's *geography*: Surfurbia, Foothills, and the Plains of Id. Because of its thriving economy, and now also due to climate change, the Los Angeles basin suffers from excessive heat waves, extreme air pollution, and almost constant water shortage. Simultaneously, it resembles a tropical garden. For these reasons, the study focuses on the city of Los Angeles, and uses the *California Building Standards Code,* specifically those parts that apply to residential construction, as a case study. The choice to concentrate on a single typology and one jurisdiction will hopefully help understand how one set of regulations responds to a variety of specific environmental, urban, and social contingencies.

The research is organized in two parts. The first one traces the co-evolution of the two parallel narratives, the American house and environmental awareness, and the process of formation of the code-making circuit in which these ideas eventually merged. The second one investigates the mechanics, importance of economic incentives used to promote technological artifacts, and the meta-rules that drive the form of regulations. Following this introduction, Chapter 2 – *From Welfare and Safety, to Ecology*: before the 1970s focuses on the ideas and programs that shaped the American house and residential building regulations

[15] An example of this phenomenon is given by Mike Davis in *City of Quartz* when he explains how Los Angeles homeowner associations used environmental protection laws to their advantage: "The 'greening' of the Santa Monicas, (…), was widely seen as a hypocritical attempt by the rich to use ecology to detour Vietnam-era growth around their luxury enclaves." (1990, 173).

before the environmental movement started to affect the federal legislation, and prior to the oil embargos of the 1970s. Chapter 3 – *Environmental Protection and Sustainable Development*: 1970s-1980s focuses on the period in which both environmental action and building regulations were shaped by the energy crisis, and eventually transformed by the agendas encapsulated in the term 'sustainability'. In Chapter 4 – *Green Economy and Green Building Standards*: 1990s- present the focus is on the period in which the present-day green building standards were developed, and eventually adopted as part of the mandatory building regulations. The historical overview is followed by two chapters that form the second part of this research and scrutinize the mechanics of the technics used to disseminate green building standards – the impact of market forces, and the importance of their own internal grammar. Chapter 5 - *Quid pro Quo* focuses on the economic incentives used to promote green technological artifacts, while stimulating economic growth. The closing Chapter 6 - *Meta-Code* addresses the core of the apparatus; it examines the internal structure and forms of the building code to understand how its meta-architecture and the internal syntax affect the agency of involved actors, and ultimately influence the outcomes.

The intention of this research is to expose some of the spatial, and socio-cultural implications of the increasingly-standardized design procedures and reveal some of the micro-politics hidden in the building regulations. The ambition is to better understand the ways in which the building code regiments the environment and affects social attitudes towards ecology. The study will hopefully be of interest to a range of readers: 1) architects, students of architecture, and developers whose work directly alters environments; 2) code-makers who predetermine potential futures by writing regulations; and 3) us, the urban dwellers who affect the environment by our domestic activities on daily basis. Although this research examines a specific jurisdiction and its regulations, the issue transcends borders, and boundaries. While grounded in a specific context, it will hopefully contribute to a general discussion about the standards that predetermine our relationship with the environment, shape our notions of ecology, and practically represent the *pre-design* stage of architectural praxis.

PART 1 – AGENDAS

Ecology, in the widest sense, turns out to be the study of the interaction and survival of ideas and programs in circuits.

- Gregory Bateson, 1972

Introduction

The events and agendas which shaped building regulations throughout their history, indirectly also shaped the contemporary definition of ecological thinking, practice of sustainability, and the standards of green construction embedded in the current codes. The scope of the chapters that make the first part of this study is to examine how regulatory measures applied to the American house, and those meant to legitimize environmental awareness, evolved in relation to each other, and with respect to other socio-political and cultural events that affected domestic architecture in the United States in the twentieth century. The ambition is twofold. The first objective is to analyze the regulatory activity that occurred both before, and after the first environmental acts targeted residential construction, and to trace the different agendas that gradually became influential, and continue to coexist today, either supporting or obstructing one another. The second ambition is to emphasize how late the environmentally-driven building regulations addressed environmental protection as opposed to human environmental comfort (considered as part of health and welfare), or environmental resource management. The general ambition is to understand when the *circuits* of code-making formed, and what ideas affected their present shape. If ecology – as Bateson postulated – has to do with understanding "ideas and programs in circuits;" then an ecology of the American house will remain an incomplete study without addressing the code-making circuits. As this research will try to demonstrate, these circuits are an intrinsic part of ecological dynamics.

The legislative acts, regulations, and events discussed in the first part of this research can be found in the appendix which provides a comprehensive (although obviously not exhaustive) timeline. The timelines included in this brief introduction are meant to highlight the key regulatory events and anticipate the agendas that shaped them. The first one of them focuses on key regulations related to residential construction, regardless the underlying motivation (Fig.P1.1). The second one lists acts that pursued environmental agendas, yet targeted a larger, territorial, scale (Fig.P1.2). The last timeline is comparative, it illustrates the emergence of new motivations as linked to specific legislative events and emphasizes the gradual accumulation of different agendas (Fig.P1.3). These motivations can be divided into two groups, and this is reflected in the way the abridged timelines are structured. The agendas related to ecology (both its social and natural aspects) are listed on the left side of the central spine which indicates the scale that is targeted by regulations. They are: 1) health, safety, and welfare; 2) environmental resource management; 3) environmental protection; and 4) civil rights. The agendas that are purely economically-driven are listed on the right side of the spine, and they are: 1) real-estate market; and 2) economic growth in general. The central spine is divided in three to indicate the targeted scale: 1) building; 2) urban; and 3) territorial. The aim of these three chapters, as illustrated in the comparative timeline, is to demonstrate as clearly as possible the impact of the many different motivations that shaped regulations before the advent of green building standards. This is because those long-forgotten reasons still actively shape the present-day codes, and their way of regulating the environmental impact of domestic architecture.

The chapter that opens this part, Chapter 2 – *From Welfare and Safety, to Ecology*: before the 1970s, concentrates on the events and ideas that shaped building regulations before the rise of environmentalism, demonstrating in five sections the gradual accumulation of regulatory measures before the first environmental acts were enacted in the 1960s and early 1970s. The first section focuses on the period before the 1920s, highlighting how scientific management affected the early health, safety, and welfare-driven regulations, and emphasizing the distance between health-driven climate control and the early environmental protection movement. The objective in the second section is to emphasize the market-driven motivations in a period of intense economic growth, the Roaring Twenties, and contrast it with the agendas embraced by regional planners and first ecologists. The Great Depression is subject of the third section. The objective here is to highlight the crucial impact of the New Deal programs on the future of the building regulations, and to simultaneously emphasize the distance between the agendas of code-makers, and the environmental emergencies that defined the Dirty Thirties. In the fourth section,

the focus is on the growing importance of the Federal Housing Administration and its standards after World War II, specifically on their role in promoting suburban expansion as a means towards economic prosperity, and despite the early signs of an impending environmental crisis. The last section in this chapter focuses on the environmental action and legislation which, while still disconnected from building regulations, addressed the impact of environmental degradation on human health and welfare in the 1960s. The overall aim of this chapter is to highlight the distance between American residential architecture, and environmental protection movement in a period when both the science of ecology and building regulations were being defined. The objective is to clearly identify the driving agendas in those formative decades.

The next chapter, Chapter 3 – *Environmental Protection and Sustainable Development*: 1970s-1980s, continues the analysis of key events that shaped the environmental protection movement and residential regulations as the two coincided in the energy-driven 1970s, and then parted again in the 1980s. The first section focuses on the regulatory measures that connected the environment with the house through the standards that defined energy conservation in the 1970s. The second section concentrates on the 1980s, a decade of accelerated economic growth and speculation, in which the international community intensified the efforts to protect the environment under the banner of sustainable development. The objective in this chapter is twofold. In the first section, the aim is to explain the actual reasons for the adoption of the first environmental resource management measures that targeted residential construction and highlight how these reasons shaped the specific character of the adopted measures. The objective in the second section is to highlight the many conflicting interests that defined the 1980s, the disconnection between the agendas that drove residential construction and those that shaped the environmental movement, or the gap between the international environmental protection efforts and the expanding global markets. The aim of the chapter is to explain the context in which first energy-conservations measures were adopted, and then to analyze how they were absorbed by the 1980s, a decade that saw a backlash against environmental regulations but transformed the construction industry that would set them in the 1990s.

The chapter that closes this part, Chapter 4 – *Green Economy and Green Building Standards*: 1990s – present, focuses on the period in which green architecture and green building standards as we know them today were born. The first section discusses the context from which green construction standards emerged, and the character of the non-governmental initiatives in the 1990s. The main issues discussed here are the international environmental action and U.S. regulations in the context of globalization of

markets, and green economy as a pragmatic response to the sustainable development imperative. The second section of this chapter, and the last in this historical overview, concentrates on the period defined by the subprime mortgage crisis, which coincided with the culmination of the green building standards efforts. The aim in the first section is to understand the multiple agendas (health and welfare, environmental resource management, environmental protection) that shaped the green architecture, as expressed in the third-party rating systems that preceded the adoption of the first state green building standards codes in 2008. The objective in the second section is to highlight the contrast between the agendas that drove the adoption of green building standards, and the environmental impact of residential construction caused by the deregulated real-estate speculation. While the environmentally-related strengths and weaknesses of the building code will be explored in detail in the chapters that make the second part of this study, this section will hopefully demonstrate the general limitations of the premises behind the green construction standards in face of the challenges posed by the growth-driven economy.

FIG. P1.1 - TIMELINE of SELECTED LEGISLATION: CHANGING AGENDAS

focus: residential construction

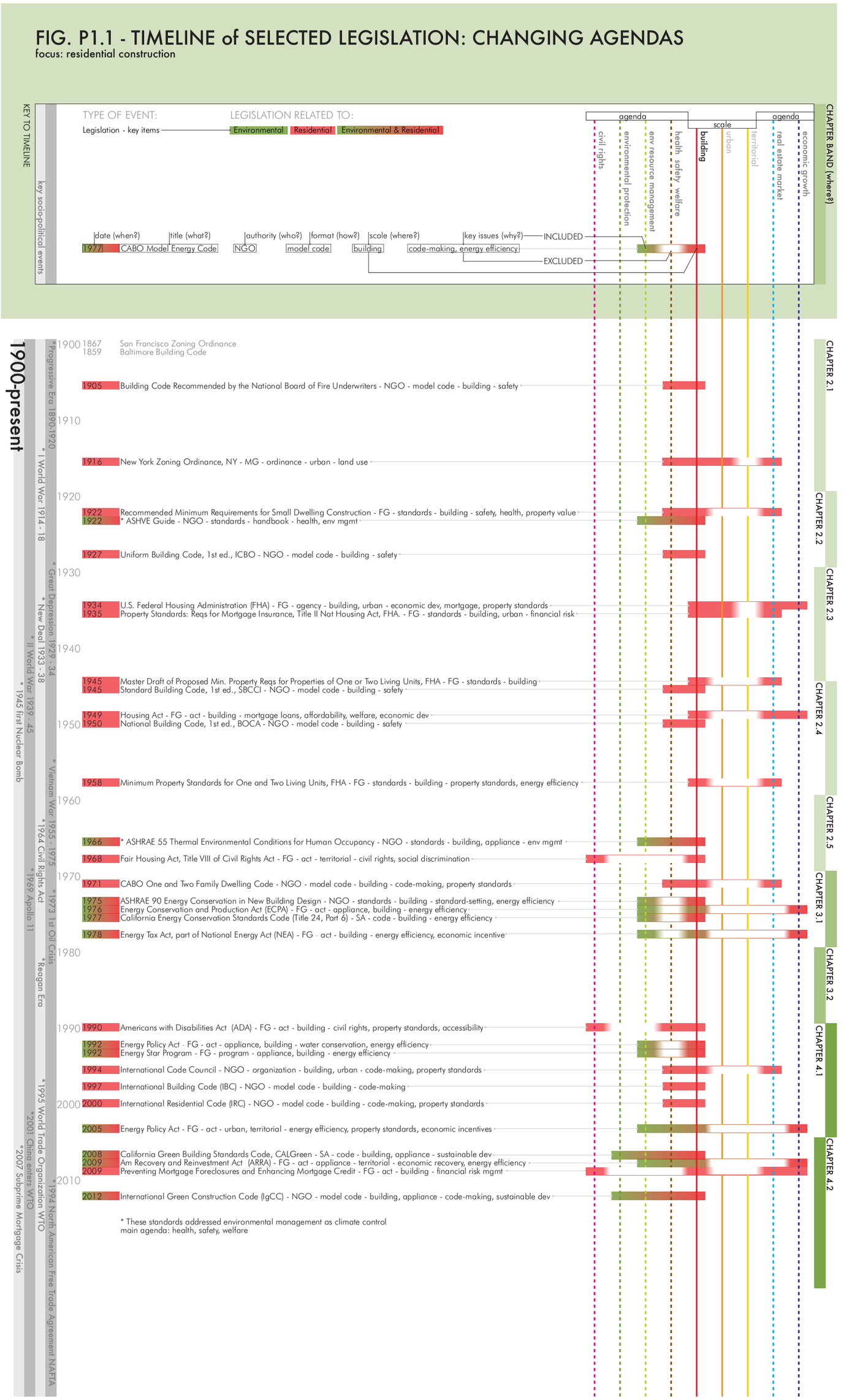
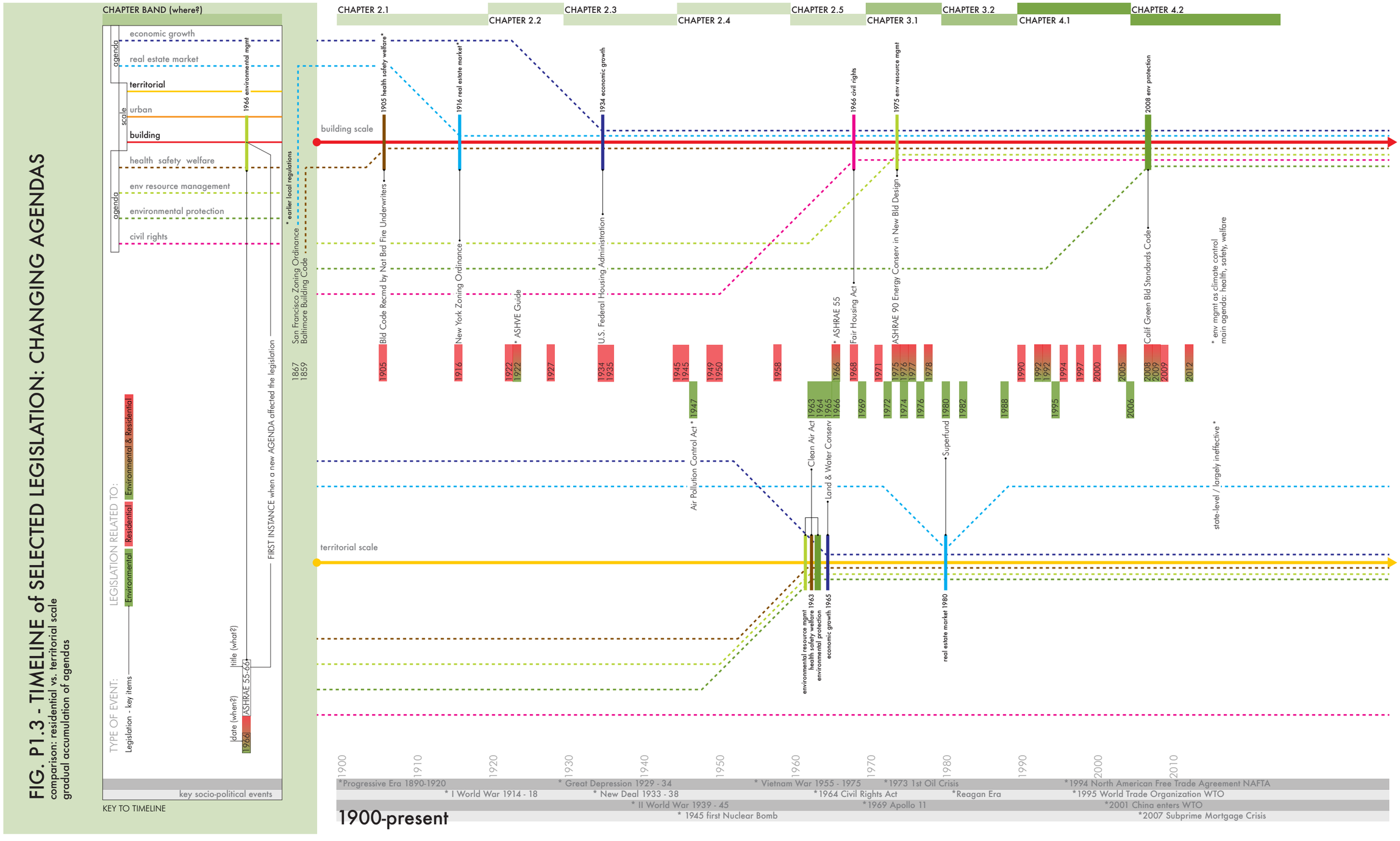


FIG. P1.2 - TIMELINE of SELECTED LEGISLATION: CHANGING AGENDAS

focus: evironmental protection

FIG. P1.3 - TIMELINE of SELECTED LEGISLATION: CHANGING AGENDAS

comparison: residential vs. territorial scale
gradual accumulation of agendas



CHAPTER 2 – From Welfare and Safety, to Ecology: before the 1970s.

2.1. Before the 1920s: New York Tenement House Acts & National Building Code Recommended by National Board of Fire Underwriters (1905).

While the general focus of this chapter is to understand the importance of events that paved the way for the Age of Ecology and the environmental legislation enacted in the 1970s, the first of the five sections concentrates on the dynamics that shaped environmental thought, residential construction, and building regulations in the U.S. before the 1920s. The section addresses the socio-economic context, to then concentrate on early urban planning and building regulations. It eventually examines the agendas promoted by the first household reformers and positions these concerns against the early environmental management efforts undertaken at a territorial scale. The overall aim is to highlight the agendas that shaped building regulations in its early stages, and to emphasize their distance from the nascent environmental discourse.

It was in the context of intense industrial development, and as a result of an accelerated growth of worker communities, that the United States passed the first pieces of legislation meant to regulate housing construction. Next to the first zoning ordinances, and urban planning efforts inspired by the City Beautiful movement, the ***New York Tenement House Acts*** established statewide provisions meant to improve the living conditions of the poorest urban dwellers. Learning from the codes adopted locally in the 19th century, and using knowledge developed by fire safety standard-setting organizations, the precursor to the present model building code, the ***National Building Code Recommended by National Board of Fire Underwriters*** was developed in 1905. In parallel to the rule-making efforts, household efficiency was promoted by reformers and educators, and eventually by the advocates of scientific management. Environmental management was first addressed in the context of residential construction as part of the efforts to improve human health and comfort. It was climate control. In this early period, protection of natural environment was exclusively perceived as a large-scale issue, with landmark events such as the creation of the National Wildlife

Reserve System clearly demonstrating early signs of the future conflict between preservation of nature and conservation of natural resources, or environmental resource management.

***

The late 19th and early 20th century was an intense period of standardization. Improvements in manufacturing methods, and changes in workflow management transformed industrial production, increasing safety and efficiency of industrial processes, and improving quality and uniformity of materials, products and services. Initially concerned with uniformity of the currency, weights and measures, standards laboratories gradually evolved into research bodies charged with the task of improving (and later certifying) the safety, quality, and uniformity of materials, products, services, and eventually standards themselves.[1] Some of the oldest standard setting organizations were created just before the turn of the century: Underwriters Laboratories (initially concerned with electrical and fire safety standards) was founded in 1894, and the American Society of the International Association for Testing and Materials (ASTM International) started its activities in 1898. In 1901 the U.S. Department of Commerce established the National Bureau of Standards to support efforts towards uniformity, recognizing that standardization was a fundamental step towards social and economic progress.[2] One of the symbols of the Progressive Era, the first automobile affordable to an average American, Ford Model T, started being produced in 1908. It was the efficiency of the first moving assembly line introduced at Ford's Highland Park plant in 1913 that greatly contributed to its affordability, commercial success, and eventually its overall impact on the American society. Yet, next to efficiency of materials, products, and industrial processes, the success of this new method also depended on the efficiency of manual workers, both during and outside working hours.

First efforts to standardize workflow (initially manual material handling) were made by the founder of scientific, or as he initially called it shop management, Frederick Taylor. His influential ideas were eventually summarized in the 1911 book *Principles of Scientific Management*. Yet, while these efforts further improved efficiency and contributed to a rapid development of industries, they also accelerated

[1] In 1918 a group of leading engineering societies (all established in the second half of the 19th century) supported by the federal government established what is now called the American National Standards Institute (ANSI), an organization which oversees standard-setting efforts and accredits standards organizations.

[2] Standardization or, as Herbert Hoover (in role of the Secretary of Commerce in the 1920s) later referred to it, simplification. In his book *Standards: Recipes for Reality,* Lawrence Busch points out: "However, fearing that some would think that the term meant that everything would be the same, he encouraged the use of a less pejorative term: simplification. To that end, Division of Simplified Practice was established at the National Bureau of Standards in 1922. By 1927 some seventy-nine simplified practice recommendations had been completed" (2011, 117).

the growth of dense worker communities clustered around factories. This trend amplified the already existing concerns about order, safety, health and welfare of worker communities, and triggered an urgent need for scientific management of workers outside factories. Most of the urban-scale regulatory efforts during the Progressive Era addressed such issues as congestion and compatibility of land uses. Long before the famous *New York Zoning Resolution* introduced the first citywide code in 1916, zoning ordinances were enacted in California, Washington D.C. pioneered regulation of building heights, and the first subdivision regulations were introduced in New Jersey.[3] Drinking water provision was first regulated in Boston in 1895,[4] and by 1915 America produced its first sewage manual, which provided indispensable knowledge for the cities expanding their water supply infrastructures.[5]

A highly influential urban reform idea was popularized in 1883 during the Chicago World's Columbian Exhibition designed by, among others, Frederick Law Olmsted Sr. The City Beautiful movement advocated for urban renewal through beautification, and promoted the presence of nature in the city, construction of civic centers, public parks, and tree-lined boulevards. The City Beautiful movement, and Ebenezer Howard's 1902 book *Garden Cities of To-morrow* [6] greatly influenced the first National Conference on City Planning which took place in 1909, the year in which the most ambitious city beautiful plan, the Plan of Chicago, was also unveiled (Fig.2. 1).[7] Although the influential 1913 Chicago City Club Competition attracted not only garden city proponents but also urban reformers, and entries were assessed according to precise criteria in search of optimum ratios of density to cost, as Keller Easterling states in her book *Organization Space*: "most [of them] contained no new organizational protocol but were rather street pattern compositions that looked something like obsessive subdivision mandalas" (1999, 138). What was to eventually shape the American residential suburbs was the idea expressed by Raymond Unwin who claimed that smaller number of houses surrounded by open space was more economical while it also

[3] In chronological order: the 1867 San Francisco Zoning Ordinance; the 1885 Modesto, CA Zoning Ordinance; the 1899 Height of Buildings Act, Washington, D.C.; the 1908 Los Angeles Land Use Zoning Ordinance, CA; and the 1913 New Jersey Subdivision Regulation, NJ.

[4] See the *Metropolitan Water Act* of 1895.

[5] Mulholland's controversial Owens Valley Aqueduct started pumping water to Los Angeles in 1913. *American Sewerage Practice* authored by Leonard Metcalf and Harrison P. Eddy was published in 1915.

[6] First published as *To-morrow: A Peaceful Path to Real Reform* in 1898.

[7] Although few garden cities were built, Howard's ideas influenced urban design. An example can be found in: *Nothing Gained by Overcrowding! How the Garden City Type of Development May Benefit Both Owner and Occupier*, a book written in 1912 by Raymond Unwin, the author of the influential book *Town Planning in Practice* (1909).

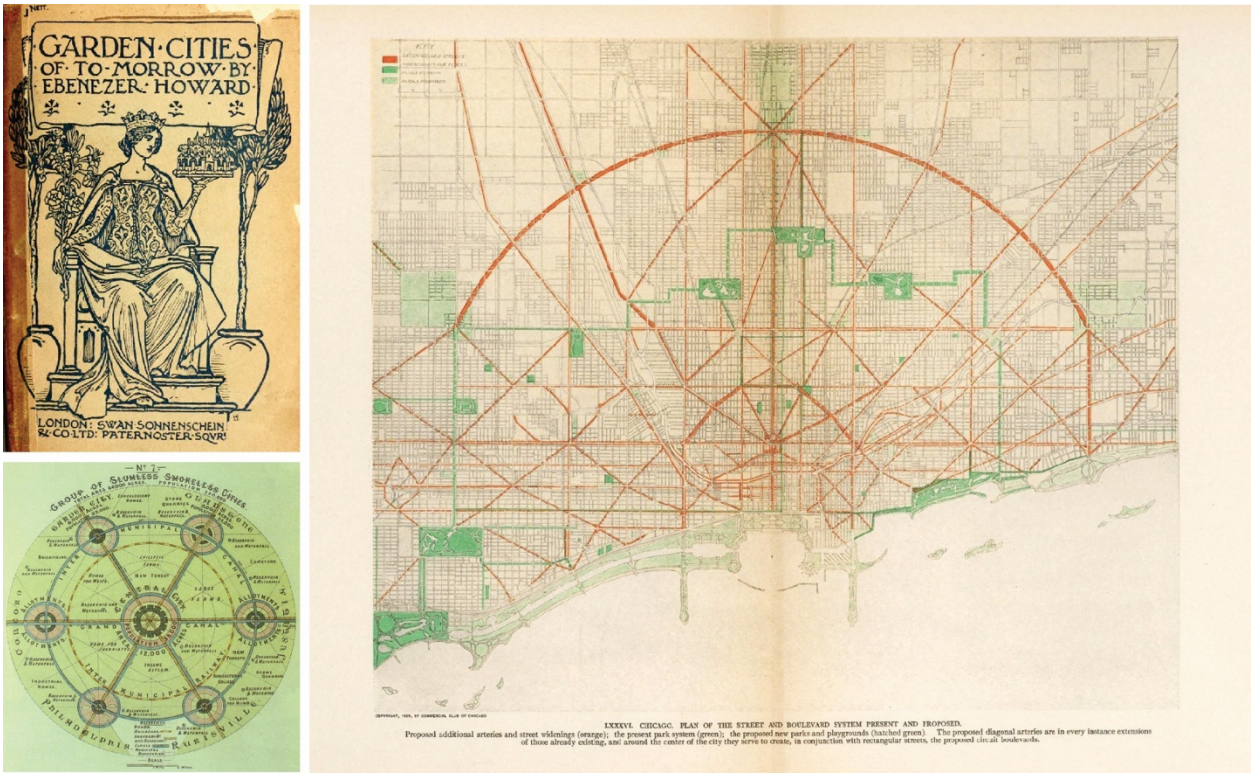


Fig.2. 1 The cover of Ebenezer Howard's Garden Cities of To-morrow, and the concentric diagram of a "slumless and smokeless cities" (left), the 1909 Plan of Chicago, also known as the Burnham Plan (right).

provided more badly needed green space.[8] Green space which was still plentiful. From its establishment in 1917, American City Planning Institute launched a dedicated program to continue to analyze and compare different urban schemes to gradually develop standards and recommendations for the new American middle classes escaping the congested tenements.[9] Industrial standardization not only indirectly triggered the need for urban planning, but it also influenced the planning methods themselves.

While American urban planners and designers were experimenting with optimal subdivision patterns for low-density green residential neighborhoods, building regulations were already quite commonly (yet unsystematically) used to curb unsafe construction practices and prevent fires. General building codes were first officially adopted by individual municipalities in the 1850s. The city of Baltimore, for example,

[8] See note 7 above, and *Organization Space* (Easterling 1999, 132).

[9] Ben-Joseph (2005) mentions one of the first publications, *Neighborhoods of Small Homes*, published in 1917 by one of the founders of the institute, Thomas Adams, which addressed the importance of economic conditions behind residential development, p. 57.

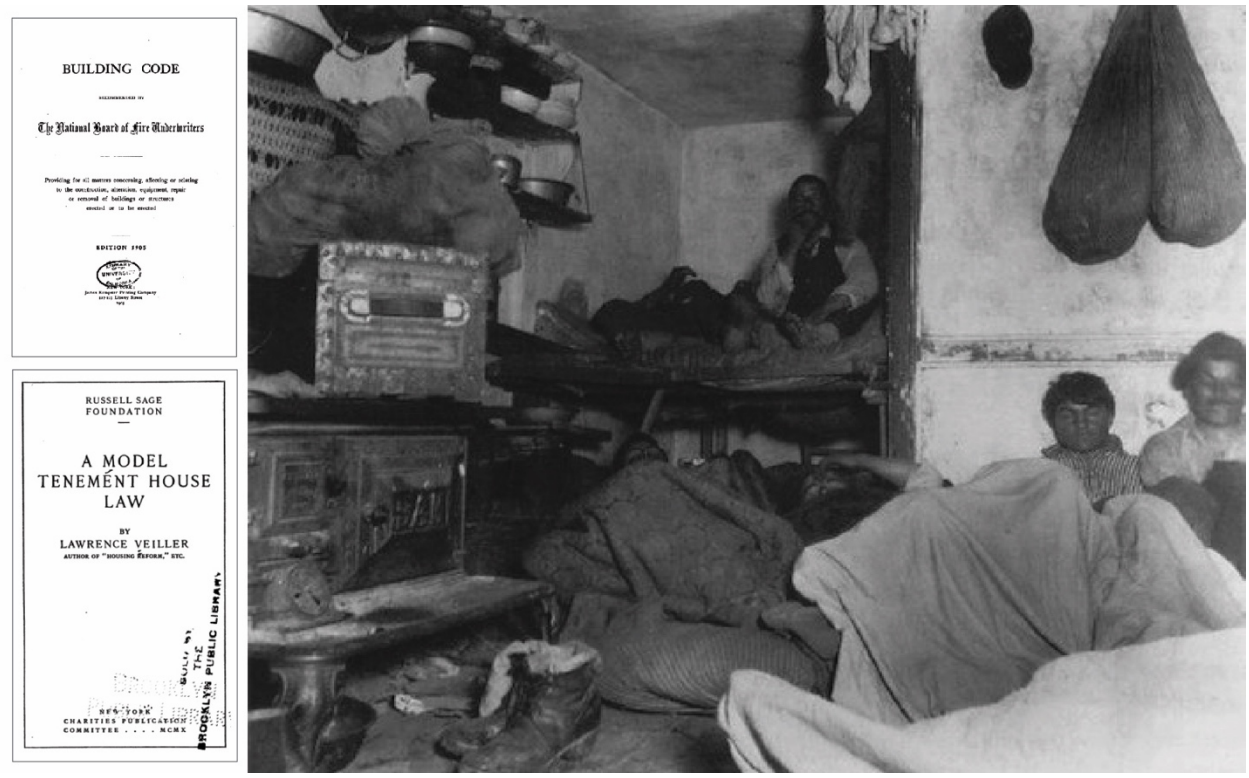


Fig.2. 2 The 1905 National Board of Fire Underwriters Recommended Building Code (top left), the 1910 Model Tenement House Law (bottom left), the interior of a 1889 tenement, from Jacob Riis' How the Other Half Lives (right).

had its first code in 1859. The first model tenement, the New York Workmen's Home, was built in 1855, and the first building act to specifically address living conditions in the tenements which housed the poorest workers was passed in 1867 as the *New York Tenement House Act*.[10] In 1901, the *New York State Tenement House Act* imposed first statewide measures: fire escapes; windows facing a source of fresh air and light in each room; privies; running water; maximum lot coverage; and eventually garbage removal; outward-facing windows; and fire safeguards. A decade later the National Housing Association (NHA) authored the 1910 *Model Tenement House Law*.

In 1905, an early form of a model building code was proposed by a non-governmental organization, the National Board of Fire Underwriters (Fig.2. 2).[11] This *Recommended Building Code* addressed a wide range of issues in relation to different building classes. It differentiated between residences (one and two-family dwellings, apartments, tenements and other temporary types of lodgings), offices, and public buildings. It

[10] It was followed by the *1879 Second New York Tenement House Act*, a 1887 amendment.

[11] This body was also the hosting organization for the previously mentioned Underwriters Laboratories originally created as the Electrical Bureau of the National Board of Fire Underwriters.

discussed basic provisions, such as minimum amount of living space, means of egress, natural light, and ventilation. It addressed aspects of building techniques, such as quality of materials, structural loads, and fire resistance of different construction systems. Details concerning heating, plumbing, and drainage systems were also included. Most of the aspects addressed by present building codes were already contained in this early code. The document consisted of 263 pages and referred to a list of more specific technical standards developed by the same National Board of Fire Underwriters since its creation in 1866. Ten years later, the first private organization dedicated to code-making, the Building Officials and Code Administrators International (BOCA), was established in 1915 to collect local knowledge and promote uniformity in building regulations, an objective in theory achieved only 80 years later, when the first International Building Code was published by the International Code Council.

While planners were modernizing cities, and early code-makers imposing minimum safety requirements on housing; philanthropists, housewives, engineers and architects were reforming the idea of the house itself. In *The Natural House* Frank Lloyd Wright asked recalling his early years: "What was the matter with a typical American house? Well, just for an honest beginning, it lied about everything" ([1954] 1982, 14). Yet, while Wright complained about the absolute reign of joinery, and lack of unity or "sense of earth", household reformers focused on efficiency. The genealogy of domestic efficiency can be traced back to Catherine Beecher, recognized to be the forerunner of studies of efficiency and comfort in housework. Her function-driven approach was first made known to the public in her 1841 book *A Treatise on Domestic Economy*, and then more fully *in The American Woman's Home*, a manual written with Harriet Beecher Stowe in 1869. Concerned with domestic economy rather than aesthetics, Beecher's dynamic vision of the household paved the way towards the pragmatic house in which most of suburban America now lives. It inspired the early 20th century studies and publications promoting efficient homes in the spirit of positivism of the Progressive Era,[12] and those influenced by scientific management methods.[13] While

[12] An important example is the 1905 study by the sanitary engineer and founder of home economics Ellen H. Richards entitled *The Cost of Shelter*. Rybczynski notes: "When Ellen Richards wrote that "the house as a home is merely outer clothing, which should fit as an overcoat should, without wrinkles and creases that show their ready-made character," she was anticipating - by twenty years - Le Corbusier's statement that "one can be proud of having a house as serviceable as a typewriter"" (1986, 190). The houses would eventually become ready-made and more like a typewriter than clothing.

[13] Such as *The New Housekeeping: Efficiency Studies in Home Management* by Christine Frederick (1914), and the *1915 Principles of Domestic Engineering: Or the What, Why, and How of a House* written by Mary Pattison, both influenced by the principles of Taylorism.

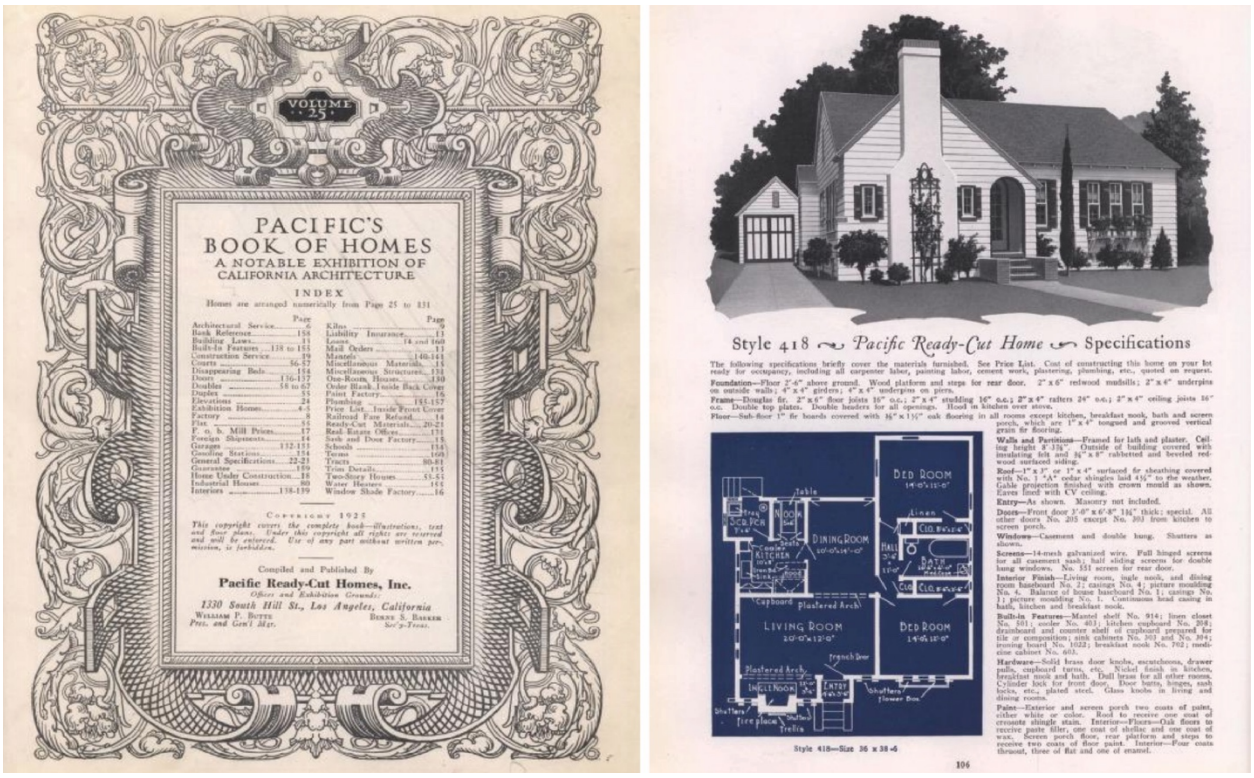


Fig.2. 3 The 1925 edition of the Pacific's Book of Homes, vol.25 (left), one of the advertised Pacific Ready-Cut Home styles (right).

America was moving in into the first *Pacific Ready-Cut* homes,[14] efforts were made to render efficient and standardized house plans available to the masses (Fig.2. 3).

In these early studies, natural processes were examined with scientific precision to provide best management of environmental comfort, climate control was perceived as an aspect of household efficiency. Galton's 1880 *Observations on the Construction of Healthy Dwellings*, and Plunkett's 1885 *Women, Plumbers, and Doctors: Or Household Sanitation*, promoted environmental technology as a means to improve levels of sanitation and health (Fig.2. 4). Above all, as Rybczynski points out, this type of research "introduced people to the idea that domestic comfort was something that could be studied, measured, and explained" (1986, 137). The opportunity to define the meaning of environmental comfort

[14] Between 1908 and the beginning of World War II, the California-based Pacific Ready-Cuts sold thousands of ready-to-assemble homes based on almost two thousand plan variations. See *California's Kit Homes: A Reprint of the 1925 Pacific Ready-Cut Homes Catalog* (Thornton and Wolicki 2004).

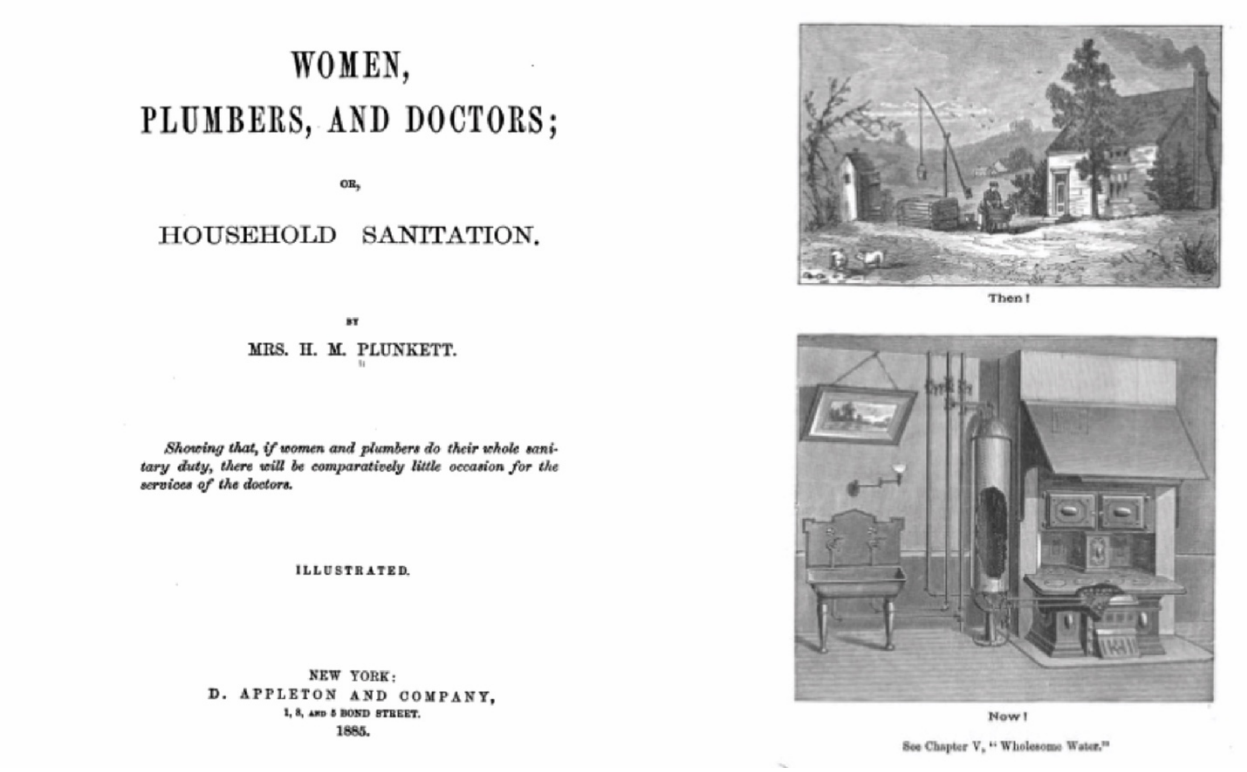


Fig.2. 4 The cover of Plunkett's book Women, Plumbers, and Doctors: Or Household Sanitation (left), and an illustration from the book which compares how water was obtained "then" with what technology offers "now" (right).

was, however, snubbed both by most architects and interior decorators,[15] and the task was ultimately left to engineers and their methods. Reyner Banham mentions William Baldwin who in his 1899 study entitled *Outline of Heating, Ventilating and Warming* insisted on abstract values unsupported by studies of human physiological response to fluctuations in thermal conditions (1969, 39-40). Moreover, environmental technology arrived in households relatively late,[16] and when it did, it was rather inserted than integrated into the design. This with the exception of few architects, such as Frank Lloyd Wright who, although hardly concerned with the minimum dimensions of efficiency (Fig.2. 5),[17] developed some of the most innovative ways to integrate environmental control with architectural design, for example in his 1908 *Baker and*

[15] An attitude openly expressed in such popular books as the 1880 *House Architecture* by the British architect John Stevenson. See *Home* (Rybczynski 1986, 147).

[16] Rybczynski (1986, 146) mentions a 1862 book by a Canadian engineer Henry Rutton, entitled *Ventilation and Warming of Buildings* in which he discussed many systems designed for railroad cars, such as double glazing, that were still waiting to be applied to house construction.

[17] His 1901 design commissioned by the *Ladies Home Journal* and published as "A Small House with Lots of Room in it'" did not prove 'small enough'.

Fig.2. 5 The cover of the 1901 issue of Ladies Home Journal (left), Frank Lloyd Wright (center), and a page from the journal where his "A Small House with Lots of Room in it'" is featured (right).

Robie Houses.[18] Whether inserted or integrated, climate management technology was to transform households forever by assuming the role of a mediator between the house and nature (or at least weather), permanently affecting the idea of domestic comfort and our daily relationship with natural elements.

First attempts to address the wellbeing of the natural environment itself concentrated on large-scale territorial dynamics, and therefore far from individual households. Early natural preservation projects, such as the creation of the National Park Service in 1916, were inspired by 19th century naturalists such as

[18] In *The Natural House,* he observed as he continued his critique of American houses: "Steam heat, plumbing, and electric lights were the only redeeming features, and these new features were hard to put to it to function in the circumstances. Bowels, circulation, and nerves were new in buildings. But they come to stay, and a building could no longer remain a mere shell in which life was somehow to make shift as might" ([1954] 1982, 15).

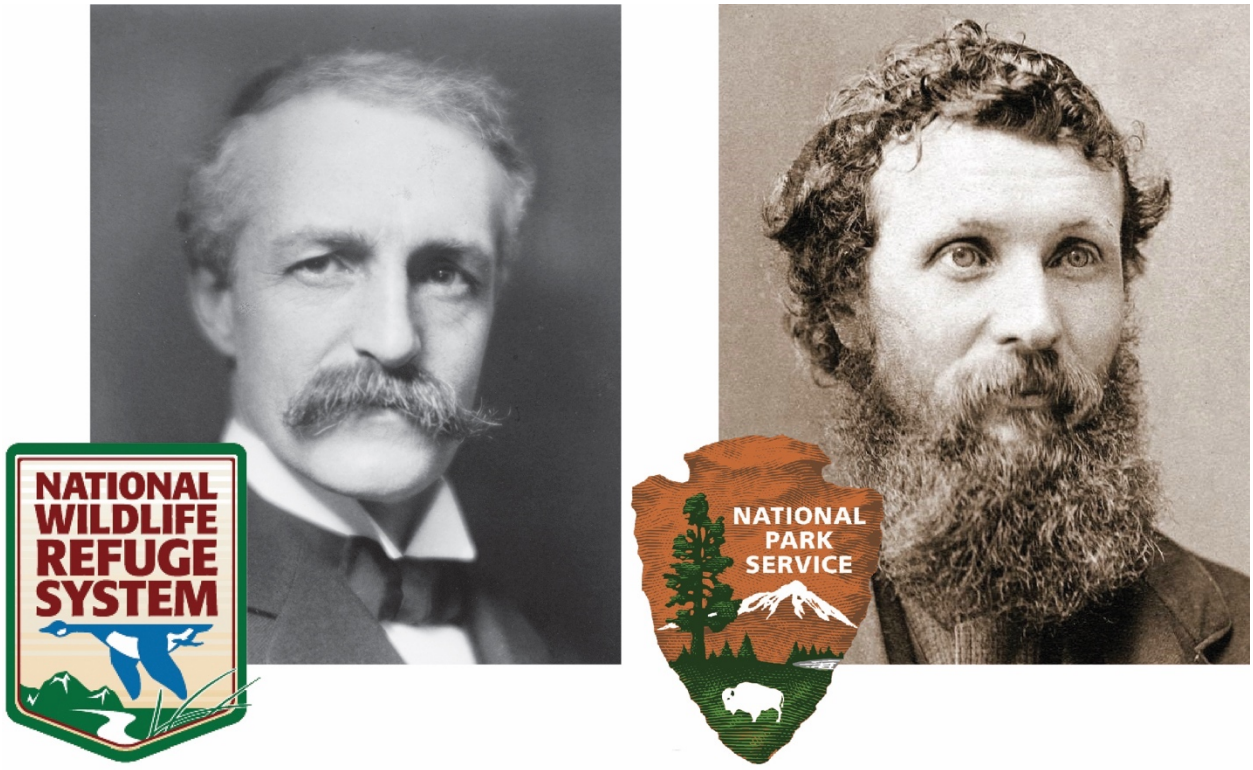


Fig.2. 6 Gifford Pinchot, and the logo of the National Wildlife Refuge System (left), John Muir and the symbol of the National Park Service (right).

Henry Thoreau,[19] and possible thanks to efforts of preservationists such as John Muir.[20] However, utilitarian attitudes of conservationists best represented by Gifford Pinchot, and mainly interested in efficient use of resources and sustainable yield, would increasingly take over.[21] This managerial attitude manifested itself in the creation of the National Wildlife Reserve System in 1903, and then the United States Forest Service, and the Bureau of the Biological Survey, both created in 1905 (Fig.2. 6). Nature was increasingly perceived as an external entity (or an internal source of resources) which could be controlled

[19] Who, embracing the interdependencies between man and nature in a holistic manner, said: "I wanted to know my neighbors," and elaborated: "get a little nearer to them." See *Nature's Economy* (Worster 1996, 60).

[20] In 1892, John Muir founded the Sierra Club, one of the first large-scale environmental preservation organizations, and prior to that successfully campaigned for the creation of the Yosemite National Park created in 1890. Through his preservationist efforts, he expressed the same holistic attitude that Thoreau encapsulated in *Walking* (1862) by saying: "in Wildness is the preservation of the world." Similarly, to Henry Salt, an early advocate of biocentrism and animal rights, he opposed the anthropocentric ethics of the conservationists.

[21] Pinchot served under Theodore Roosevelt as the Chief Forester. His attitude towards wilderness is best expressed in his own words, as quoted by Worster: "Unless the reserved lands of the public domain are made to contribute to the welfare and prosperity of the country, they should be thrown open to settlement (…)" (1996, 266). It's worth noting that the U.S. Forest Service was part of the Department of Agriculture where plants were perceived as crops.

– preserved or conserved but always managed - by man and his increasingly complex technologies.[22] Scientists, yet to be called ecologists,[23] were only starting to comprehend natural dynamics that politicians, planners and legislators were tinkering with.[24] Most of them ignored George Perkins Marsh who, in his 1864 book *Man and Nature*, extensively wrote about land management and, as one of the first, called for (ecological) caution concluding, as reported by Donald Worster in his book *Nature's Economy*: "The equation of animal and vegetable life," he warned, "is too complicated a problem for human intelligence to solve" (1996, 268-9).

***

General safety, fire prevention, health, and social welfare were the lenses through which legislators addressed urban planning and building practices in the early period of code-making. While standardization and increased productivity were among indirect reasons for urban explosion, the methods adopted by industrial managers influenced the technics used by planners, code-makers, and social reformers. This early quest for efficiency and predictability would affect both the future character of American households, and their relationships with the natural environment. From the very beginning, climate management was perceived by most designers as a problem of sanitation, a medical and technical issue left to doctors, plumbers and mechanical engineers. In this early period, protection of the natural environment (as opposed to the management of environmental, or simply speaking, weather phenomena) was solely addressed at a territorial scale. Open land was still abundant enough to serve conflicting interests of nature conservancy, industrialists, and builders. Although the future struggle to balance between protection and resource conservation was already visible in the divergences between passionate naturalists and pragmatic economists, the scale of economy was small in comparison to the vast and still unconquered natural expanses. It was small enough for politicians and technicians to disregard the early warnings about the negative impact of human actions, and to act upon nature with authority despite the insufficient understanding of its dynamics.

2.2. 1920s: Recommended Minimum Requirements for Small Dwelling Construction, Department of Commerce's Bureau of Standards (1922).

This section concentrates on the dynamics that shaped residential construction and building regulations in a period of dramatic socio-cultural changes and intense economic growth, the Roaring Twenties. It first returns to urban land use control, to then concentrate on regional planning in relation to the emerging notions of ecology. Eventually, it focuses on building regulations and household reform, and the objective here is to emphasize the impact of economy on the changing motivations behind code-

[22] An early expression of this view can be found in Lester Ward's *The Psychic Factors of Civilization* (1893) who claimed that "Nature had no economy," and needed to be scientifically organized and "redeemed, along with society, from its primitive state." See *Nature's Economy* (Worster 1996, 174-5).

[23] Although Haeckel coined the term *oecologie* in 1866, the term was not used by scientists and naturalists until the 1890s.

[24] Some of the first influential studies in ecology were: *The Oecology of Plants*, written by Eugenius Warming in 1895, revised and translated into English only in 1909, *The Development and Structure of Vegetation* published in 1904 by Frederic Clements, and the 1916 *Plant Succession: An Analysis of the Development of Vegetation* by the same author.

making, and their impact on the idea of home.

As negative effects of industrial development persisted in the cities, urban planners supported by the federal government continued to improve zoning tools. An important school of regional planning emerged in an attempt to address the problem at a larger scale. Inspired by early preservationists, garden city planners, and by organicists, the Regional Planning Association of America tried to integrate environmental and economic objectives through flexible territorial plans. While the members of RPAA celebrated the interdependent and indeterminate character of nature, the young science of ecology was increasingly turning towards precise quantitative models, and bounded phenomena. The managerial ethos that shaped New Ecology also permeated building and climate management standards. Building regulations became more uniform, and climate control more quantified. Managerial attitudes continued to affect household manuals as well, but the underlying agenda shifted from health and welfare, towards economic growth and social stability. Similarly, promotion of homeownership drove private and federal campaigns. In 1922 the first ***Recommended Minimum Requirements for Small Dwelling Construction*** were published by Hoover's Department of Commerce to streamline residential construction, and by the early 1930s the government addressed the scale of neighborhood subdivisions. Homeownership became more accessible, but critics asked whether it was still a home that middle-class Americans were encouraged to own.

***

By the 1920s, the risks posed by the unconstraint urban and industrial development were clearly perceived. The majority of urban planners continued to work on zoning regulations to internally manage growth. The decade was an important period in the history of urban codes: *Village of Euclid Zoning Ordinance* was passed in 1922, and in 1926 the constitutionality of zoning was confirmed by the Supreme Court in the landmark court case *Village of Euclid, Ohio vs. Ambler Realty Company*. The case gave name to the oldest form of land use control, Euclidean zoning, which prescribed permitted land uses, setbacks and maximum heights of buildings, and controlled means of egress and access to light.[25] Since zoning was considered an important component of the urban reform, the federal government encouraged it by publishing two sets of independent legislative guidelines, one suggesting rules relative to zoning code adoption procedures, and the other to urban planning.[26] However, since zoning and planning were not bound together, in many cities, up to present days, zoning regulations are in place although planning for

[25] For a brief description of Euclidean zoning (and other more recent forms of land use regulation), see *A Better Way to Zone* (Elliott 2008).

[26] In 1924, rev. 1926, the Advisory Committee on City Planning and Zoning appointed by Hoover (when serving as secretary of commerce) published a set of guidelines for legislators entitled *Standard State Zoning Enabling Act* (SZEA). The same committee published the *Standard City Planning Enabling Act* guidelines in 1928. Many states and cities since then adopted zoning acts and ordinances. Among the first, in 1927 *California Planning Act* was approved; and eventually the *Los Angeles Zoning Ordinance* was passed in 1930.

the future and in relation to a larger regional context is missing.[27]

Alarmed by the shrinking gap between expanding human settlements and protected wilderness, some planners did, however, focus on the larger picture. In an essay entitled *Regionalism and Irregionalism* Lewis Mumford warned: "In the very act of seizing all the habitable parts of the earth, we have systematically misused and neglected our possession" (1927, 277). Mumford was an active supporter of the Regional Planning Association of America (RPAA) which was founded in 1923, and whose members strived to combine lessons learned from garden city planners, wilderness preservationists, and resource conservationists to develop decentralized forms of networked settlements organically interacting with natural dynamics. Their projects were also inspired by Patrick Geddes who understood cities and human systems to be intrinsically related to larger regions and depended on their bio-geographies and geo-morphologies.[28] Members of RPAA contributed to the creation of state-level land-use plans,[29] yet, implementation of interstate projects proved problematic without some form of governmental coordination (which Hoover as president fiercely opposed), and many of them eventually dedicated themselves to smaller urban development projects.[30] The Tennessee Valley Authority (TVA) established in 1933 (and possible due to a changed political climate during Roosevelt's New Deal era), stands out as a unique example of a regional economic development agency which holistically considered preservation and management of natural resources as part of a successful regional planning strategy. The team included Benton MacKaye famous for his 1921 Appalachian Trail, and for his campaigns against unplanned regional sprawl (Fig.2. 7).[31] For MacKaye, the TVA project was a rare opportunity to test ideas in practice. The strategy he adopted was to develop open-ended prototypical organizations, neither aesthetically pleasing landscape patterns, nor rigidly engineered plans. His 'liquid planning' offered flexible frameworks

[27] Elliott expresses the following judgment regarding the zoning and planning guidelines published in the 1920s: "creating legal authority to regulate land before creating the authority to plan for future land uses puts the cart before the horse, at least in the minds of planners" (2008, 16).

[28] See *Cities in Evolution* (Geddes 1915).

[29] In an essay entitled "A Trail Across Time," Thomas Daniels reports that the New York State Housing and Regional Planning Commission was the first body to develop a state-level land use plan in 1925. The plan was developed under the supervision of Clarence Stein, one of the founders of RPAA (2009, 183).

[30] Stein and Wright (both founders of RPAA) worked on Sunnyside Gardens in Queens, NY, and Radburn, NJ, which although never completed due to the economic crisis of the Great Depression, became a model for planned unit developments. Stein also collaborated with the Resettlement Administration (RA) on greenbelt cities.

[31] See *The New Exploration, a Philosophy of Regional Planning* (MacKaye 1928).

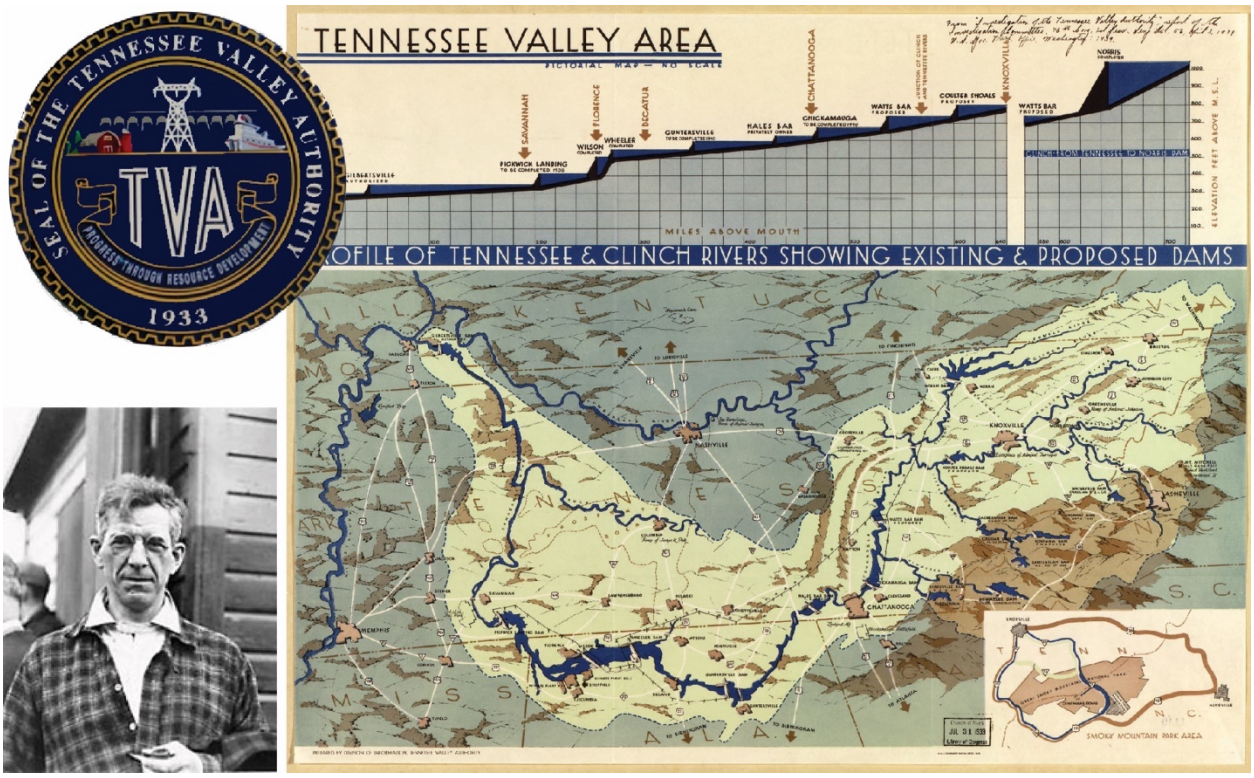


Fig.2. 7 The seal of the Tennessee Valley Authority (top left), Benton MacKaye (bottom left), Tennessee Valley Area: pictorial map (right).

for inevitably indeterminate future economic development.[32]

Members of RPAA were clearly aware of and inspired by new scientific theories and developments in ecology. Notions of emergence, aspects of evolution, and process-based organicist thinking influenced their most innovative concepts and proposals. Although Whitehead's 1925 *Science and the Modern World* remains the most precise critique of the mechanistic thought, and an astounding celebration of the interdependent and indeterminate nature of the processes that shape reality, many other thinkers and natural scientists *practiced* the organicist thought.[33] Geddes, Mumford, and MacKaye embraced the indeterminate and interdependent nature of ecological systems, and believed in the efficacy of natural

[32] For a detailed discussion of these aspects of MacKaye's work, see *Organization Space* (Easterling 1999, 54-6).

[33] See Worster's *Nature's Economy,* "Chapter 15: Declarations of Interdependence" (1996, 316-31) for an account of ecological thought and science in the 'age of organicism'. Except for Whitehead (316-20), Worster mentions many pioneering works written by natural scientists, among them: *Emergent Evolution*, a 1923 book by C. Lloyd Morgan, which introduced the concept of emergence (321), and discussed the idea of unpredictability in nature; and *Animal Aggregations: A Study of General Sociology* published by Warder C. Allee in 1931 which drew attention to the importance of mutual interdependence and cooperation in nature (327).

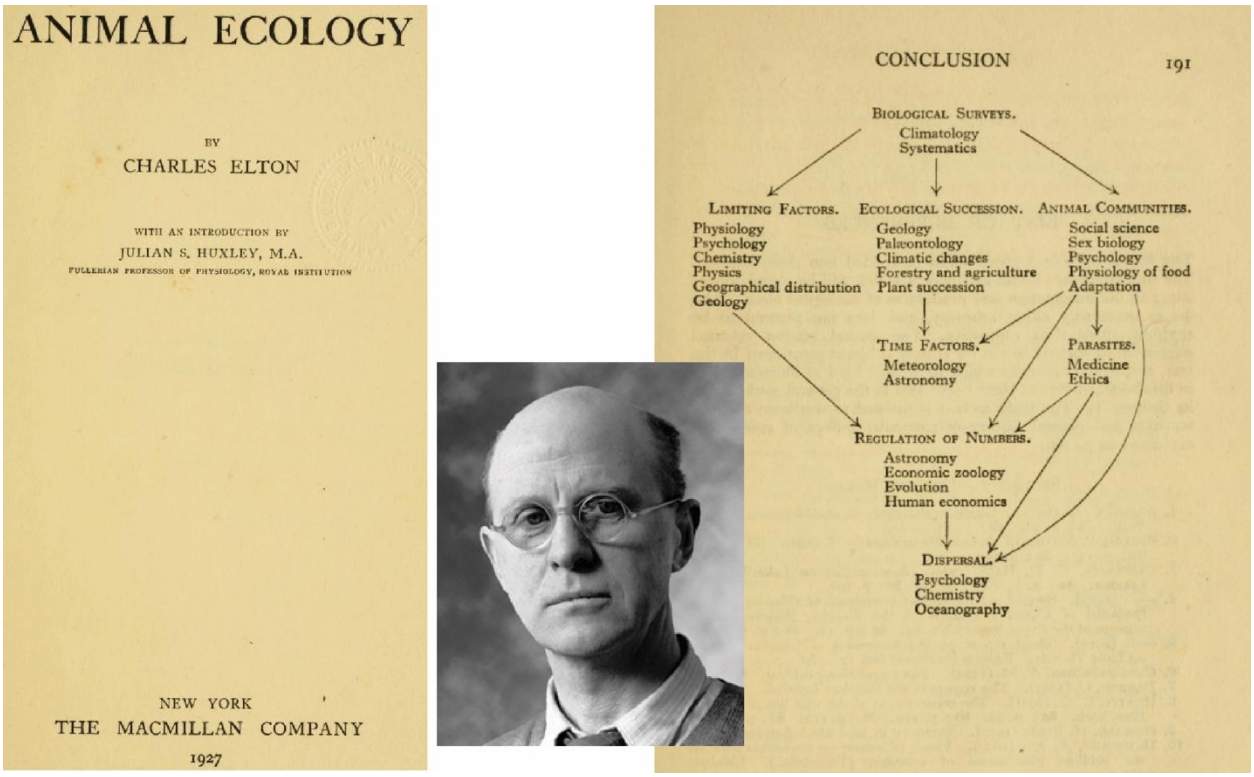


Fig.2. 8 The cover of Elton's Animal Ecology (left), Charles Elton (middle), a diagram from the book (right).

systems of checks and balances.[34] However, the future generations of planners would see more promise in the emerging New Ecology which embraced the managerial ethos of the era,[35] and was moving towards an ever greater quantitative precision of energy-based mathematical models.[36] The fascination with evolution and process was being replaced with an interest in circumscribed dynamics that could be reduced to concrete quantities, and as such modelled more precisely, and eventually managed towards a specific scope. It was the tangibility of bio-economics developed by Charles Elton in his studies of community structures that would lay the foundations for systems ecology (Fig.2. 8).[37] These ideas would eventually also shape environmental resource management and legislation in the decades to come.

[34] Similar views were promoted by C. C. Adams, a proponent of ecological pragmatism and an active critic of artificial pest control methods (Worster 1996, 275, 278) or William Morton Wheeler, an expert of social insects and natural interdependences (320).

[35] For a discussion of the impact of the managerial ethos on ecology, see *Nature's Economy* (Worster 1996, 294-5).

[36] The importance of energy flow in nature was first studied by Alfred Lotka in his 1922 *Contribution to the Energetics of Evolution*, and the 1925 *Elements of Physical Biology*.

[37] Charles Elton described his 1927 book *Animal Ecology* as "the sociology and economics of animals" (Worster 1996, 295).

While the organicist (or organic) thought found its way into architecture through the work of such masters as Frank Lloyd Wright,[38] it was the same managerial ethos which pervaded New Ecology that would shape the organization and climate management of American homes through new regulations and standards. The second of the three, principal code-making organizations, the International Conference of Building Officials (ICBO) was created in 1922. In 1927, ICBO authored the *Uniform Building Code (UBC*), which would remain in use on the West Coast and across most of the Midwest until the introduction of the *International Building Code* in 1997.[39] In 1922, the American Society of Heating and Ventilating Engineers published the first edition of its *ASHVE Guide* which contained data and instructions pertaining to design and construction of heating and ventilating installations (Fig.2. 9).[40] Although directed towards "the engineer, the architects and the contractor alike" (1922, 5), the *Guide* was written in a language that most architects must have found simply inaccessible. Two years later, in 1924, ASHVE produced the first version of the *Comfort Zone* diagram which reflected a study of physiological reaction of (unclothed) humans (in front of a fan) to temperature, humidity, and air movement. Adjusted over the years (with more and more quantitative data pertaining to, for example, metabolic rates and impact of clothing), the diagram became a fundamental component of the *ASHRAE Standard 55 Thermal Comfort Conditions* (first published in 1966). The diagram standardized the idea of comfort representing it as a well-demarcated region in a field defined by varying temperatures and humidity levels.

The quest for efficiency and standardization that was shaping codes and standards of climate

[38] "Conceive now that an entire building might grow up out of conditions as a plant grows up out of soil and yet be free to be itself, to "live its own life according to Man's Nature." Dignified as a tree in the midst of nature but a child of the spirit of man. I now propose an ideal for the architecture of the machine age, for the ideal American building. Let it grow up in that image. The tree. But I do not mean to suggest the imitation of the tree" ([1954 1982, 39). The same spirit permeated the early work of one of Wright's collaborators, Rudolph Schindler, whose West Hollywood Schindler-Chase House completed in 1922 established an organic union with the landscape while exploring novel construction technics (i.e. lift-up concrete wall system developed by Irving Gill). A similar union was intended in the Hollyhock House on which the two architects collaborated, and which Wright completed in the same period. In this monumental house, the landscape was literally meant to cross the house, water flew through it, occasionally inundating it. In his textile-block houses, on the other hand, Wright pushed this organic union to another level. As Frampton explains in his *American Masterworks*, he "introduced decomposed granite from the site into the mix so as to achieve an intrinsic, not to say mystical, union between nature and culture, (…)" (2008, 14).

[39] Other code-making bodies were created around the same time: the International Association of Plumbing and Mechanical Officials (IAPMO) was created in 1926, and two years later the Los Angeles City Plumbing Inspectors Association released its first *Uniform Plumbing Code*, 17 years before the first edition of the *IAPMO Uniform Plumbing Code*.

[40] The *Guide* also contained regulatory recommendations, and technical reports, one of which dedicated to automatic heat control. Already in 1922, for reasons of simple common sense and economy, rather than matters of national energy security or climate change, ASHVE recommended: "The installation of automatic temperature regulation, or system for prevention of excess temperature, is a justifiable investment for all heating systems inasmuch as it very positively contributes to: 1. Conservation of fuel. 2. Improvement in health. 3. Gain in personal efficiency" (1922, 34). (ASHVE was established in 1894, and became ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers in 1959.)

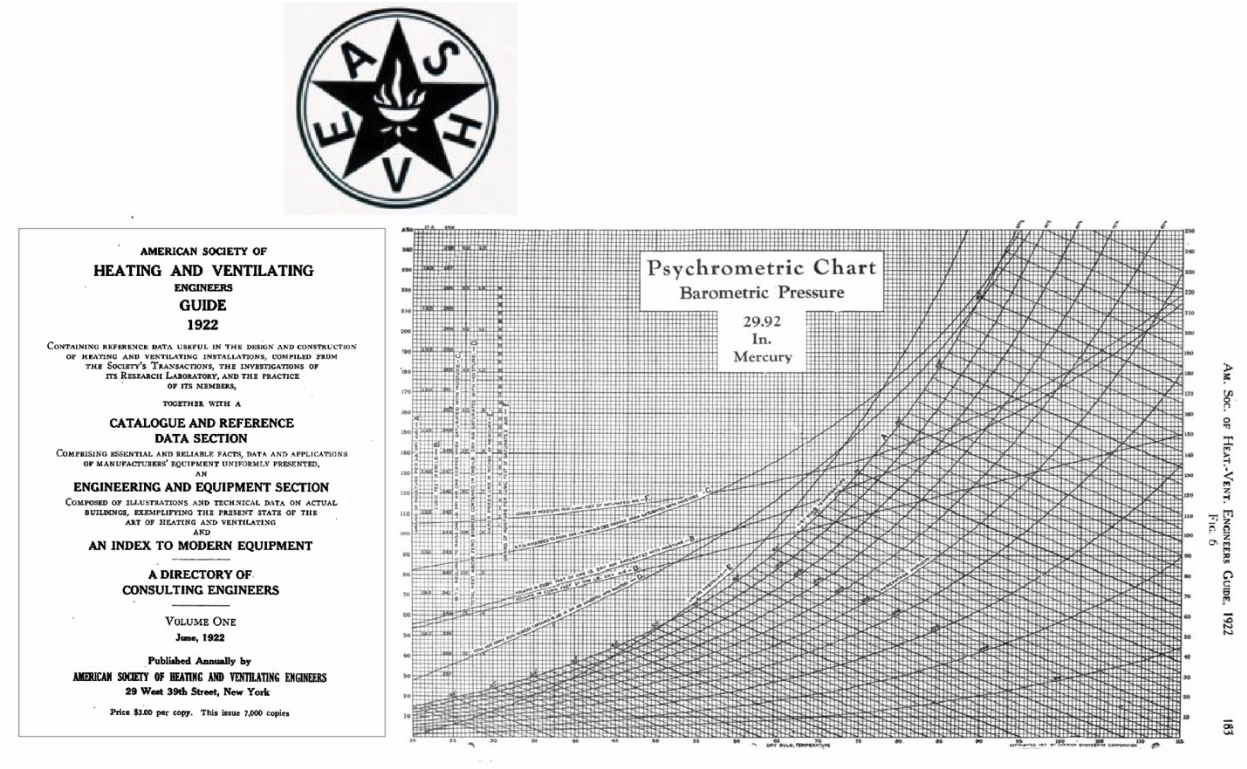


Fig.2. 9 The cover of the ASHVE Guide (left), a psychrometric chart from the guide (right).

management, continued to define the tone of household manuals as well. Yet, although healthy lifestyle determined the character of the houses that Dr. Lovell commissioned Schindler and Neutra in the Los Angeles area,[41] the general motivations were shifting from health and welfare towards a new set of underlying agendas: consumption of household appliances, and homeownership. In 1923 Christine Frederick published another manual entitled *Household Engineering: Scientific Management in the Home*. Although many of the methods such as precise inventories and schedules did not enter average households, as Rybczynski observes, domestic engineering affected the physical organization of households, especially the efficiency of kitchens and had a tremendous impact on the market of household appliances (1986, 168-71). While some women, such as Charlotte Perkins Gilman, were calling for a complete revision of domestic roles, Frederick was interested in rendering home-making more

[41] Schindler's Lovell Beach House was completed in 1926, and Neutra's Lovell Health House in 1929. In each house (although in dramatically distinct ways) integration of the natural landscape into the domestic space, and careful treatment of natural and artificial light celebrate aspect of healthy living using novel construction technics (Schindler experimented with the plasticity of cast in-situ reinforced concrete, while Neutra explored the cold precision of steel).

efficient without disrupting the traditional family structure and its importance for the economy.[42] In her 1929 book *Selling Mrs. Consumer* Frederick aligned even further with the emerging economic reality focusing on the spending power of housewives. Recognizing women (and children) as an important but previously ignored consumer type was crucial in the context of the overall economy increasingly relying on single-family households as an important source of growth and social stability. The house was becoming a commodity, and its efficiency and durability fundamental prerequisites for its marketability. The federal administration actively endorsed private initiatives that promoted home ownership,[43] and provided technical support to future homeowners.[44] In 1923 Better Homes in America (BHA) campaign initiated its Better Homes Week program which consisted in the construction of demonstration houses across the country, and in other forms of distributed information about homeownership (Fig.2. 10). BHA was to become an important privately-developed model for the federal campaigns which would promote standardization and efficiency in the housing industry during the 1930s.[45]

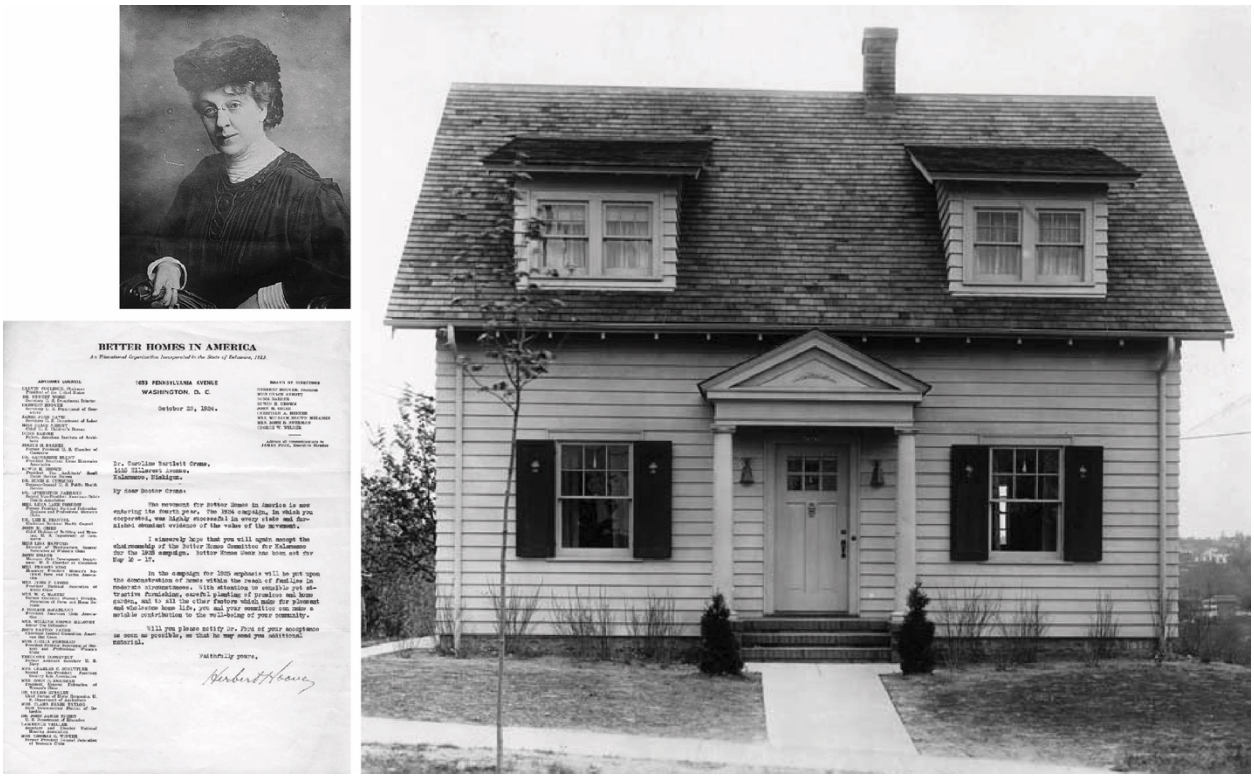
While leveraging private initiatives, the federal government was also developing its own programs to address housing shortage. In 1922 the Department of Commerce's Bureau of Standards released the first federal *Recommended Minimum Requirements for Small Dwelling Construction* (Fig.2. 11). In contrast to the 1905 *Building Code Recommended by the National Board of Fire Underwriters*, the aim of the *Recommended Minimum Requirements* was to simplify and standardize the codes in order to conserve resources in face of "high cost and inactivity in building industries" (1922, 1). While professional bodies and municipal governments were working to improve the safety of buildings in general, the intention of the federal government was to streamline construction and delivery of small privately-built and owned

[42] For a discussion of feminism in the household design, see *The Grand Domestic Revolution* (Hayden 1981).

[43] In 1918 the Department of Labor supported the *Own Your Own Home* campaign organized by the National Association of Real Estate Brokers (Massey 2012, 25), and Architects' Small House Service Bureau created in 1920 was supported by the Department of Commerce (33).

[44] In his essay *Risk and Regulation in the Financial Architecture of American Houses*, Jonathan Massey explains: "Shortly after becoming secretary of commerce in 1921, Hoover incorporated national housing policy coordination into the Commerce Department purview, and he applied to the field of housing his conviction that the proper role of the state was to promote cooperation among private entities. He founded the Division of Building and Housing to promote standardization and efficiency in the housing industry. Among the areas of standardization and simplification of practice that the division tackled, in collaboration with industry groups, were those of building codes, real estate contracts, and zoning" (2012, 25).

[45] In *Organization Space*, Keller Easterling explains: "The Hoover administration targeted the individual house as a commodity useful in stimulating the economy and home ownership as an economic tool for maintaining property values and a cultural tool for stabilizing the work force. Hoover had been honorary president of the 1929 'Better Homes Campaign in Rural Communities and Small Towns,' one of several private efforts after which the federal government would later fashion its own New Deal homeownership campaigns" (1999, 138-9).



BETTER HOMES IN AMERICA

1633 PENNSYLVANIA AVENUE
WASHINGTON, D. C.

October 23, 1924.

Dr. Caroline Bartlett Crane,
1410 Hillcrest Avenue,
Kalamazoo, Michigan.

My dear Doctor Crane:

The movement for Better Homes in America is now entering its fourth year. The 1924 campaign, in which you cooperated, was highly successful in every state and furnished abundant evidence of the value of the movement.

I sincerely hope that you will again accept the chairmanship of the Better Homes Committee for Kalamazoo for the 1925 campaign. Better Homes Week has been set for May 25 - 31.

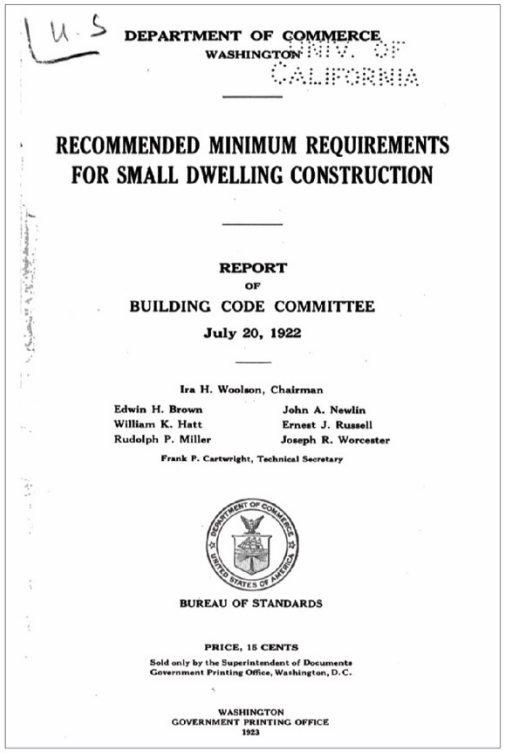
In the campaign for 1925 emphasis will be put upon the demonstration of homes within the reach of families in moderate circumstances. With attention to sensible yet attractive furnishing, careful planning of premises and home gardens, and to all the other factors which make for pleasant and wholesome home life, you and your committee can make a notable contribution to the well-being of your community.

Will you please notify Mr. Flint of your acceptance as soon as possible, so that he may send you additional material.

Faithfully yours,

Herbert Hoover

Fig.2. 10 Caroline Bartlett Crane (top left), a letter from Herbert Hoover to Crane (bottom left), Everyman's House, 1924 (right).



U.S
DEPARTMENT OF COMMERCE
WASHINGTON
UNIV. OF CALIFORNIA

RECOMMENDED MINIMUM REQUIREMENTS FOR SMALL DWELLING CONSTRUCTION

REPORT
OF
BUILDING CODE COMMITTEE
July 20, 1922

Ira H. Woolson, Chairman

Edwin H. Brown — John A. Newlin
William K. Hatt — Ernest J. Russell
Rudolph P. Miller — Joseph R. Worcester

Frank P. Cartwright, Technical Secretary

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PART I.—INTRODUCTION.

Defects of Existing Building Laws.

The United States Senate Committee on Reconstruction and Production, appointed in 1920, investigated the underlying reasons for high cost and inactivity in building industries in all parts of the country. In almost every city where hearings were held statements were made to the effect that local building laws required more material or refinements of workmanship than were justified, considering the purpose of the buildings affected. It was further disclosed that building codes and builders, either through ignorance or selfish motives, frequently failed to recognize modern methods of construction, thus denying the property owner such benefits as might accrue therefrom.

The following excerpt taken from the preliminary report of the Senate Committee on Reconstruction and Production is significant:

> The building codes of the country have not been developed upon scientific data, but rather on compromises; they are not uniform in principle and in many instances involve an additional cost of construction without assuring more useful or more durable buildings.

This subject was further expanded in the final report of that committee (S. Rept. No. 829, p. 57), from which the following extracts are taken:

> A study of these codes and experience under them would be of great service in preparing the material for the drafting of a building code which would be

1

Fig.2. 11 The cover of the 1922 Recommended Minimum Requirements for Small Dwelling Construction (left), excerpt from the Introduction (right).

dwellings. In fact, the report also expressed the need to differentiate between rules applied to complex buildings and regulations applicable to simple dwellings. By promoting a simplified set of standards for small dwellings, it indirectly determined the future shape of American housing. The aim of the report was, of course, also to reduce low-grade construction and improve the quality of housing stock, but the principal reason for these concerns was to control investment risks. It was clear that the future of American housing depended on a skillful combination of public and private endeavors and had to satisfy both government's goals and private interests of the builders and realtors.[46] The private and federal efforts of the 1920s culminated in the second edition of *Recommended Minimum Requirements for Small Dwelling Construction* published in 1932. A year earlier, in 1931 President Herbert Hoover's Conference on Home Building and Home Ownership addressed city planning and subdivision methods in the style of the 1913 Chicago City Club competition. While the *Recommended Minimums* were shaping the house itself, the outcomes of the conference would greatly influence the shape of urban developments and provide support to the community builders active in the post-crisis period.[47]

While most voices prized homeownership for its positive impact on economic growth and social stability, the dark side of the everyman's dream home (and life) was exposed by artists. While in a book describing the *Everyman's House*, a traditional cottage built by BHA in 1924, Caroline Bartlett Crane emphasized the role of homeownership as a means of control of migrating masses of workers, in his 1920 film *One Week* Buster Keaton was deriding the emerging standards of building practices and associated with them modes of life. As Iñaki Ábalos observed in *The Good Life*, in face of an apparent error, "Keaton has no alternatives to hand, no other model of thinking to oppose to that of the manual and will blindly proceed to mechanically assemble what turns out to be a cruel metaphor of the destiny of the couple and the institutional family of our times" (2000, 142-3). Definitely, a cruel metaphor of what both *home* and *house*

[46] The intricate combination of federal and private support and control mechanisms was tested during the Great War. The outbreak of the First World War triggered massive migrations towards wartime factories and shipyards, and in 1918 the Emergency Fleet Corporation and the U.S. Housing Corporation was created to provide adequate housing for workers. With more than 80 projects completed, and 170,000 people served, the program offered a testing ground for the future organization of the U.S. housing economy and influenced urban developments in America in the decades to come. See *Organization Space* (Easterling 1999, 143). See also and *House Housing: An Untimely History of Architecture and Real Estate*, Temple Hoyne Buell Center for the Study of American Architecture at Columbia University, 2013-16. Accessed October 16, 2016: http://www.house-housing.com/#1918-United-States-Housing-Corporation-Builds-Housing-for-Wartime-WorkersProgram-Abandoned-as-Role-of-Government-is-Questioned

[47] In *The Rise of the Community Builders*, Marc Weiss explains how "President Hoover's Conference on Home Building and Home Ownership expanded the public urban land planning agenda by detailing the means by which the federal government, in association with financial institutions, building products manufacturers, utilities, and trade associations from various branches of the real estate and construction industries, could help speed the transition from subdividing to housebuilding as a large-scale, standardized, modernized, and economically integrated sector of production" (1987, 67).

are. The home-making standards that even such keen domestic engineers as Mrs. Gilbreth saw as an individual choice of each family were to become recommendations, then minimum requirements, and eventually technical specifications and code.[48]

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The 1920s were an important period for land use control, Euclidean zoning became a standard control tool, yet it was rarely preceded by comprehensive urban planning. While regional planning made an important contribution to cross-scalar integrative land management, due to economic and political climate few territorial plans developed by the RPAA were implemented. Hoover's presidency favored individual entrepreneurialism over government interventionism which is unavoidable in large-scale planning. Quantitative methods developed by New Ecologists rather than MacKaye's "liquid planning" were to shape the future of environmental management. The same managerial ethos affected building scale regulations. The second uniform model code was released in an attempt to render construction uniform across the country, and thermal comfort was defined as a precise region of weather. In the same spirit, household reformers continued to promote domestic efficiency, but the main objective of private campaigns shifted form health and welfare towards economy - promotion of household appliances and homeownership. The federal programs embraced the same economic agenda, and next to support for zoning regulations, Hoover's administration developed the first *Recommended Minimum Requirements* to streamline construction of single-family dwellings. While private and federal programs supported urban planners and construction industry, and promoted homeownership, Buster Keaton ridiculed the model house kit exposing the social rigidity and spiritual impoverishment embedded in the standard home. Quest for efficiency and predictability, rather than an organic union with nature were defining the character of the American house.

2.3. 1930s-1945: The Federal Housing Administration (1934).

The events triggered by the 1929 market crash, and in general the period in which the federal government heavily invested in the construction industry to stimulate economic growth during the Great Depression, are the topic of this section. The objective here is to highlight the crucial impact of these federal programs on the future of the construction industry and building regulations, and to simultaneously emphasize the distance between the agendas of code-makers, and the environmental issues for which the decade was named the Dirty Thirties.

In 1934 the U.S. Congress established the **Federal Housing Administration** to set construction standards, define underwriting criteria, and provide insurance of mortgage loans. The FHA requirements improved the quality of construction yet by standardizing and simplifying, the FHA also limited spatial and technological innovation. Prominent architects dedicated efforts to redefine the future of American homes, yet, only those innovative solutions which streamlined wood-framed construction, and lowered the overall costs were welcomed by developers. Although Neutra won a Best Homes in America award, his light-weight steel systems failed to compete with wood framing, and while Wright dedicated the decade to the middle-income Usonians, his

[48] Lillian Gilbreth authored several books on domestic engineering, among them *The Home Maker and Her Job* (1927). As a mother of twelve children, she applied many of the ideas that she developed together with her husband (an expert in scientific management and an industrial engineer) to her own household and family.

solutions did not convince the FHA either. While architects also experimented with integrated climate management strategies, the federal agendas encouraged predictability of mass-produced appliances. Yet, although apparent also at the small scale, it was the disconnection from the environment evident in the new farming methods that first alarmed the ecologists. The Midwest dust storms triggered an important debate about rationalization of natural landscape, ecologists started to address human impact in their studies, and eventually entered territorial planning.

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The 'Roaring Twenties' culminated in a spectacular market crash and bankruptcy of thousands of banks. Yet, the efforts initiated by the Hoover administration in the 1920s laid the foundations for the New Deal programs. Launched to offset the effects of Great Depression, Roosevelt's initiatives dedicated to residential construction supported construction of affordable housing, improving mortgage financing mechanisms and promoting homeownership. The 1934 *National Housing Act, also known as the Capehart Act,* established the Federal Housing Administration, an agency authorized to insure private lending institutions that would provide low-interest, long-term loans to individual homebuyers. The authors of the 1934 *Housing Act* and the creators of the FHA were neither architects or planners, nor philanthropists. The FHA was created by representatives of real estate, financing and insurance companies, who together crafted a mixed-economy system that supported private entrepreneurship by guaranteeing low-risk investments and securing returns to the real-estate industry. Simultaneously, it provided cheap housing to low-wage workers and the emerging middle class. As Jonathan Massey observed: "Instead of socializing housing production, as Ackerman and others had advocated, the National Housing Act socialized risk." (2012, 36) Housing was to become an industry, and to function well, the product had to be made as predictable and controllable as Ford's Model T. Efficiency and comfort became selling points, and quality of construction a guarantee both for the lenders and the borrowers. Increasingly perceived as a commodity and a site of consumption, the home ultimately became a loan security, and, as explained by Keller Easterling, "the first determination about the new house involved appraisal value" (1999, 176).

It became clear that the protocols of production and delivery needed to be further standardized to reduce risks. Based on the knowledge accumulated by Hoover's Bureau of Commerce, and the successful campaigns of Better Homes in America, the FHA gradually developed and popularized its own criteria of assessment influencing not only the shape of individual homes but also that of subdivisions and

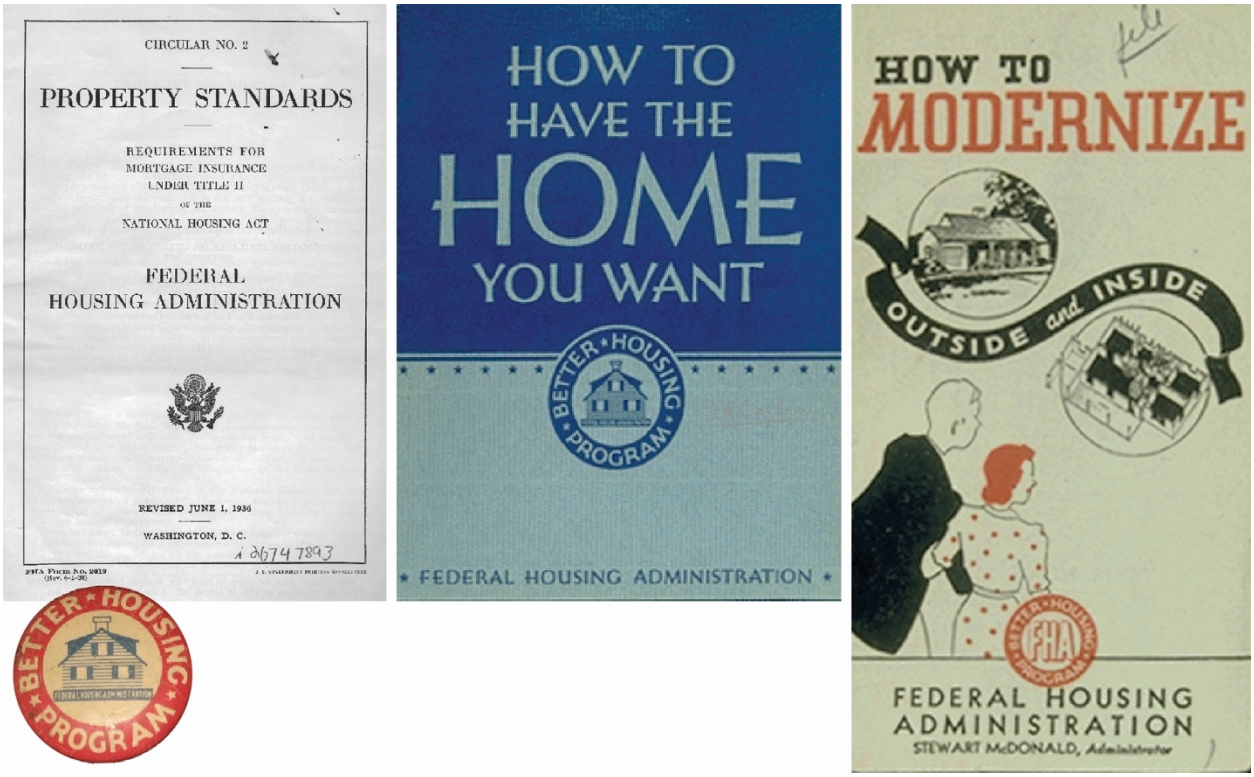

Fig.2. 12 The cover of the 1936 FHA Property Standards (top left), FHA Better Housing Program badge (bottom left), promotional FHA publications from the same period (middle and right).

neighborhoods.[49] The potential benefits were such that both lenders and borrowers were happy to adopt FHA standards.[50] As Marc Weiss points out, distrusting local politicians and planning commissions, realtors actively supported the FHA standards of construction and underwriting to defend their own interests (1987, 142). According to Keller Easterling, developers "began to streamline the process by submitting large tracts of similar houses for approval," a practice that was well received by FHA since building large subdivisions of identical houses helped reduce risks due to lack of coordination (1999, 134). In 1935, FHA

[49] Marc Weiss points out: "Officially the FHA did not assist in financing subdivision development. The mutual mortgage insurance applied only to individual properties within subdivisions. However, because FHA could refuse to insure mortgages on properties due to their location in neighborhoods that were too poorly planned or unprotected and therefore too "high-risk," it definitely behooved most reputable subdividers to conform to FHA standards." Later he specifies: "FHA published four important sets of written guidelines and graphic suggestions: *Subdivision Development* (1935), *Planning Neighborhoods for Small Houses* (1936), *Planning Profitable Neighborhoods* (1938), and *Successful Subdivisions* (1940). The entire development pattern of modern American suburbia may be quickly and easily understood by reading these four remarkable documents (1987, 149).

[50] Massey specifies: "Mortgages insured by FHA typically featured higher loan-to-value ratios that had loans in the 1920s, with longer terms (fifteen years at first, although terms rapidly lengthened until thirty years became the norm) and blended-payment amortization. The incentive of inexpensive federal insurance led lenders, borrowers, and builders to adopt FHA standards rapidly." (2012, 36).

published the first *Property Standards: Requirements for Mortgage Insurance* (Fig.2. 12), under *Title II of the National Housing Act* (focused mainly on neighborhood design and planning), and in 1937 it released the *Minimum Construction Requirements* (which addressed construction methods). In 1942 the content of both documents was combined in *Minimum Property Requirements,* but the publication was rarely used during the war. It was not until after World War II that the FHA released a significant update to its standards (1945). By the end of the war, the basis for a parallel regulatory system were in place. When it came to one or two living unit dwellings, FHA standards just about replaced local building regulations either where still missing or when less stringent.[51]

The FHA subdivision guidelines practically eliminated small-scale speculation and jerry-builders, and initially greatly improved construction standards.[52] Larger, forward-looking community builders contributed to it by testing new subdivision patters and experimenting with private deed restrictions to ensure long-term quality.[53] With time, FHA guidelines crystalized into a perfect regulatory system. However, while minimizing risks and ensuring smooth operations, they also greatly limited architects, and stopped innovation in urban design for decades. Frank Lloyd Wright deplored the situation referring to the influence exerted by the FHA in the following words: "Our government forces the homemaker into the real estate business if he wants a home at all" ([1954] 1982, 54). In 1939 his *East Lansing Usonian Houses* failed to meet the underwriting criteria and were denied the FHA-insured mortgage. The design remained on paper.[54] Wright's own *minimum* standard proved incompatible with the early FHA ideals although the principles he developed for the middle-income Americans in his 1930s Usonian houses would greatly influence the spatial organization of many suburban houses in the post-war period, defining the spirit of the contemporary ranch-type house in general.

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[51] As specified in a report prepared for HUD in 2003: "*Minimum Construction Requirements* was designed to serve as a default standard for deficiencies in local code enforcement." See *Part 1 of a Study of the HUD Minimum Property Standards for One- and Two- Family Dwellings and Technical Suitability of Products Programs* (National Institute of Building Sciences 2003, 4). Retrieved July 20, 2016: https://www.huduser.gov/Publications/pdf/mps_report.pdf

[52] See *The Rise of the Community Builders* (Weiss 1987, 142).

[53] Two important examples in the Los Angeles area were: the Westside Village built in 1939, and 'Homes at Wholesale' in Westchester, developed in 1941 - 1944, both by Marlow-Burns Developer. See *Magnetic Los Angeles* (Hise 1997, 137-149) for a discussion of construction methods and design principles applied in these massive pre-war (and pre-Lewittown) developments.

[54] See *House Housing: An Untimely History of Architecture and Real Estate*, Temple Hoyne Buell Center for the Study of American Architecture at Columbia University, 2013-16. Accessed July 20, 2016: http://house-housing.com/#1939-FHA-Denies-Insured-Mortgage-for-East-Lansing-UsoniaFrank-Lloyd-Wright-Houses-are-Declared-Bad-Investments

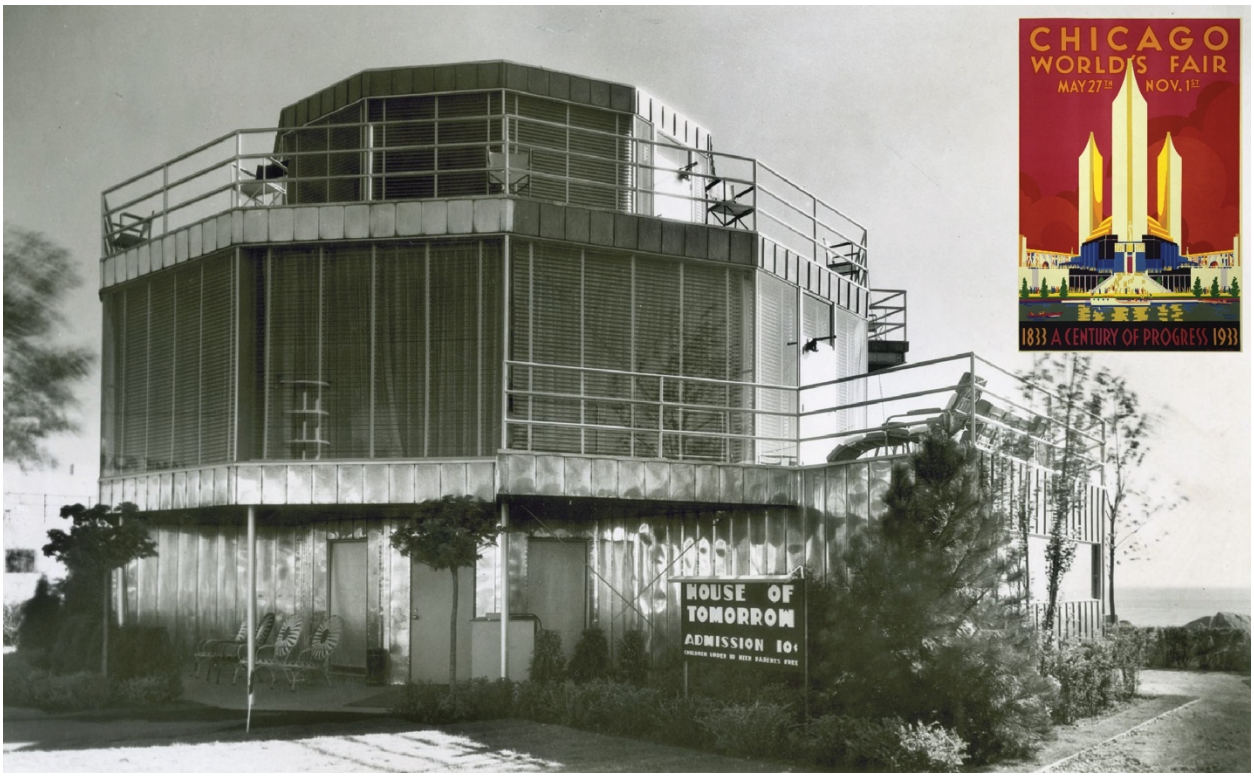

Fig.2. 13 Keck and Keck's House of Tomorrow built during the Century of Progress exhibition in Chicago, 1933 (main image), exhibition poster (top right).

Such visionaries as Buckminster Fuller, Richard Neutra, and Keck and Keck dedicated efforts to redefine the future of American households (Fig.2. 13).[55] These innovators often integrated structural experimentation with concerns related to climate management. In the 1935 Beard House, Neutra experimented with a hollow metal load-bearing paneling wall system which (in theory) also distributed conditioned air. Keck and Keck's houses built with modern materials featured various climate-control strategies and mechanisms, including movable external blinds and evaporative cooling roofs. Yet, only those inventions which helped streamline construction and lower costs influenced the shape of the average house. Eventually, even Neutra accepted that wood framing was the way America wanted to build

[55] Except for Buckminster Fuller's *Dymaxion House* designed in 1927, technological innovation clearly drove the design of such projects as Neutra's 1935 *Beard House* (which even won a Better Homes in America award), Keck & Keck's 1933 House of Tomorrow, and the 1934 Crystal House (both designed for the Chicago's Century of Progress exhibition). Many less radical prefabricated solutions such as *Motohome* by White & Co. (1935) or *Thermo-Namel House* by Higgins Incorporated of New Orleans (1946) were developed before the post-war boom. See *Organization Space* (Easterling 1999, 187). For an account of Neutra's experimentation see *Richard Neutra, Complete Works*, especially the section entitled "Technological Investigations" (Lamprecht 2000, 22-32). For a brief discussion of both Neutra's and Keck and Keck's prototypes, see *American Masterworks* (Frampton 2000, 72-3).

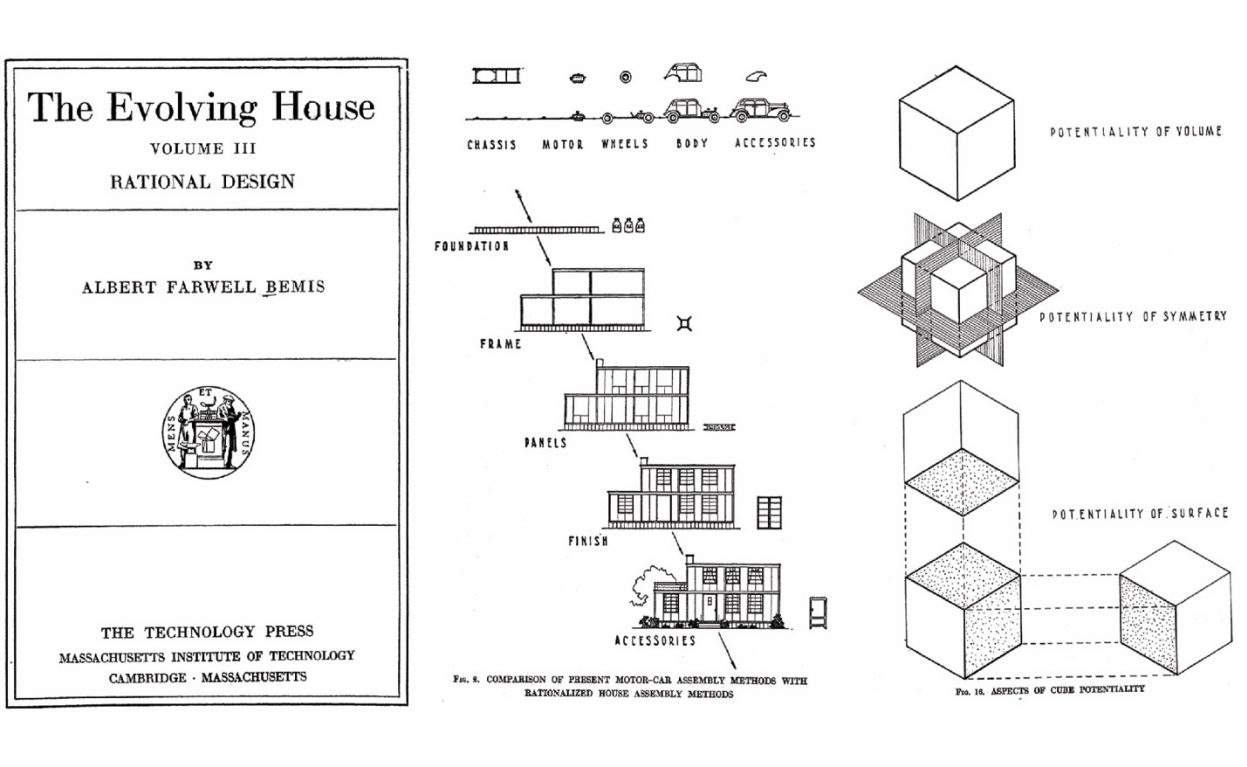

Fig.2. 14 Bemis's The Evolving House (left), diagrams of "rational design" and the "cubical module method" included in the book (middle and right).

its houses (Lamprecht 2000, 32), and Gropius too *framed* his own *modern* house near Cambridge. Such organizations as the Housing Division of the Pierce Foundation, the Bemis Industries, or the U.S. Housing Authority were to lead some of the most important experiments in modular construction technologies.[56] While in Europe Ernst Neufert was publishing his famous design norms,[57] Albert Bemis, the inventor of the Cubical Module Method of design, was summarizing his efforts to codify the construction of small affordable dwellings in the 1936 *Rational Design*, the third volume of *The Evolving House* (Fig.2. 14). Rationalization, however, quickly produced side-effects. As observes by Banham, with the emergence of modular building components, "a dimensional inertia was built up, which resists variations of the tile sizes, and constraints the dimensions of any new technologies (…). Sets of standard dimensions are thus created outside any intentional systems of preference or modular co-ordination and affect other buildings

[56] The Pierce Foundation developed such products as Microporite and Asbestos-Surfaced Plywood Panels.

[57] The first German edition of Neufert's *Architects' Data* was published in 1936 as *Bauentwurfslehre* (Building Design Guide).

(…)."[58]

Researchers also continued to study household efficiency but as Greg Hise explains in his *Magnetic Los Angeles*, in contrast to the Taylorist pursuit of specialization, the aim of these "Laboratories for Living" was to develop flexible multi-purpose spatial arrangements in order to reduce the need for many separate rooms dedicated to specialized tasks (1997, 63). Eventually, private and federal efforts towards 'de-gadgeting' of the house created new standards. Combined cooking and dining space, and absence of basements became common. Although the aim was to eliminate sub-standard housing, critics described the American Existenzminimum as "*reductio ad absurdum*" (64). The effect was far from the "interior spaciousness" that Wright achieved in his designs although he was equally critical of domestic functions translated into separate boxes.[59] Yet, a *minimum* became the *optimum*, and by the end of the Second World War, America had a dwelling norm, and a perfect product. All of this took place with little contribution from renowned architects. Not only did Wright fail to impress the readers of the Ladies' Journal, but his *East Lansing Usonian Houses* were denied mortgage.

While human existence was being condensed to a minimum, the earth, as Mumford warned in 1927, was being reduced to flat rectangles (277), and… dust. If *Fallingwater* – Wright's masterpiece of landscape integration - had little impact on the way average houses would fit in with the environment, the ecologists were more preoccupied with dust storms, insect plagues, and the alarming effects of the farming methods used in the Midwest.[60] These were the Dirty Thirties (Fig.2. 15). Unfortunately, scientists were still debating about what exactly should be protected, and even the little and imprecise existing knowledge was not applied to land-use planning. Paul Sears's influential book *Desert on the March* (1935) addressed this point. As explained by Worster, "Sears advocated the appointment of a resident ecologist to supervise land use in each county with the aim of spreading the view that "all renewable natural resources are linked into a common pattern of relationships" (1996, 233). In the meantime, the problems discussed by ecologists were the nature of these relationships and the role of man. While some scientists

[58] Banham discusses suspended ceiling kits on the example of the Acousti-Vent Ceiling System developed by Burgess Laboratories in 1936. See *The Architecture of the Well-Tempered Environment* (1969, 213-16).

[59] "Each domestic function was properly box to box. I could see little sense in this inhibition, this cellular sequestration that implied ancestors familiar with penal institutions, except for the privacy of bedrooms on the upper floor. They were perhaps all right as sleeping boxes" ([1954] 1982, 34).

[60] Worster mentions a 1936 federal report entitled *The Future of Great Plains,* which not only acknowledged the human responsibility but also stated that millions of acres "should be immediately returned to native sod ad never plowed again" (1996, 229-30).

Fig.2. 15 The cover of Deserts on the March (left), a dust storm in Stratford, Texas in 1935.

were eager to follow Clements's natural climax theories and protect the grass-bison biome, others were pointing out that modern man could no longer be isolated from ecological studies as there was little land that he left untouched. Strikingly, while some experts were simply acknowledging the devastating effects of farming and advocating for a more conservative land-use, others were pointing out that there was no ideal natural climax state and man was free to manipulate the environmental dynamics in function of his needs.[61] Although these disagreements would keep on dividing ecologists in the future, and often serve as a justification for invasive land-use policies, as pointed out by Worster, one of the important results of the

[61] It is worth pointing out that although in the 1939 book *Bio-Ecology* written with Victor Shelford, Frederic Clements "merged plant and animal communities into a broader 'biotic community'" (Worster 1996, 214), he refused to include the humans in the system. He recognized the disruptive action of white man, but he saw him as an external threat to be controlled (217-8). It was hard to accept that man was an invasive species characterized by a managerial attitude and equipped with a powerful technology. Criticism from European scientists provided an alternative perspective. According to A.G. Tansley, insisting on the idea of an ideal natural climax state, "would effectively deprive the ecologist of a subject to study, for virtually none of Clements' climaxes had existed intact on the other side of the Atlantic for several centuries." However, the consequences of these observations were not always positive. As Worster explains, "Tansley did not want to accent any climax achieved by purely natural processes as an ideal for man to respect and follow." (1996, 241) While recognizing both the complexity of nature and the profound impact of man on natural systems, ecology also validated the idea that humans could simply re-design the world in search of an ideal anthropic climax state.

dusty thirties was the fact that "the new profession of ecologists found themselves for the first time serving as land-use advisers to an entire nation" (1996, 253). Even if still timidly, ecology entered planning.

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Roosevelt's New Deal programs focused on setting construction standards and underwriting criteria, improving mortgage financing mechanisms, and promoting homeownership. The 1934 *Capehart Act* established the Federal Housing Administration which by insuring mortgages indirectly determined how Americans would live in the decades to come. In order to streamline the delivery of affordable homes, and reduce financial risk associated with lending to individual owners, the FHA gradually developed a parallel regulatory system, practically substituting building codes. The FHA *Minimum Property Requirements* initially improved the quality of construction and made homeownership accessible to more working families. At the same time, however, they determined the course of experimentation by promoting certain types of technological and spatial standards and blocking other, more risky forms of innovation. Even when accepted, many novel design strategies were reduced to absurd minimums. Although Wright's masterpiece *Fallingwater* was built during this decade, it stands out as an isolated example of organic integration with landscape in a decade that transformed the house into a standardized commodity (and loan collateral) and turned grasslands into deserts. Although devastating environmentally, economically, and socially, the Dirty Thirties saw important advances in ecology, reintroducing man and his activities into the ecological debate, and eventually bringing ecologists a step closer to planning.

2.4. 1945-1950s: The National Housing Act (1949) & Minimum Property Standards for Properties of One or Two Living Units, FHA (1958).

This section addresses the events which followed World War II. It first examines how wartime military research affected the science of ecology, both informing the early modern methods of environmental resource management, and triggering an important, ideological counter-reaction to it. The account then focuses on the construction boom and emphasizes the growing importance of the FHA standards in promoting urban expansion as a means towards economic prosperity, and despite the early signs of an impending environmental crisis.

In the 1950s New Ecology flourished in the context of systems theory and operations research developed for military purposes during the war. Precise stock and flow models were applied to study productivity of isolated natural ecosystems. In reaction to this reductionist and managerial approach, and inspired by Leopold's "Land Ethic", a new biocentric attitude emerged. Ecologists formed conservation groups, while authorities experimented with environmental legislation. In the meantime, largely unaffected by environmental debates, cities experienced an explosion. Supported by municipal governments and the FHA, merchant builders were perfectly poised to transform fields into tracts of homes. The ***National Housing Act of 1949*** supported urban redevelopment, while in 1958 the FHA consolidated its standard-setting efforts publishing the ***Minimum Property Standards for Properties of One or Two Living Units.*** Although this *de facto* building code included articles related to energy conservation, the underlying motifs were purely economic. By the 1950s the American middle-class families had their dream house, yet, regardless the mid-century explosion of design experimentation, they opted for a cottage well-equipped with modern appliances, but traditional in style.

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Following Charles Elton's bio-economic vision of nature, many ecologists were gradually switching from Whitehead's organismic holism and MacKaye's 'liquid planning' to quantifiable system models. Tansley's *ecosystem* concept suited the era of systems theory and operations research better than Clements' superorganism.[62] Following Lotka's work in the 1920s, first energy budgets appeared in 1940s. An early study, which preceded H.T. Odum's work, assessed the productivity of a natural lake.[63] Yet, as Worster explains, "One cannot help but see in such research the agronomic influence at work: the concern for crops, productivity, yield, and efficiency now being translated into a broader ecological model that could be used to measure natural as well as artificial ecosystems" (1996, 305). Although interest in the flow of energy and biomass was not always economy-driven, as Worster points out "there was at work here the still-vigorous influence of Progressive conservation philosophy" (1996, 312). The tendency to think about natural systems in managerial terms was also a reflection of research agendas promoted and funded by the federal government during the war time.[64] Ecosystem ecology emerged from that context, and such prominent scientists as Raymond Lindeman,[65] G. Evelyn Hutchinson,[66] and Eugene Odum,[67] all embraced

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[62] In 1935 A. G. Tansley published an essay entitled *The Use and Abuse of Vegetational Terms and Concepts* in which he "attempted to rid ecology of all the lingering traces of organismic philosophy, expressed most recently in Clements' description of vegetation as a single living organism." (Worster 1996, 301) He rejected such terms as community in relation to animals and plants and replaced them with the word "ecosystem" which allowed him to describe processes in terms of material and energetic flows and exchange. Although this helped bridge the gap between organic and inorganic matter, as Worster observes "in reducing the living world to ingredients that could be easily measured and graphed, the ecologist was also in danger of removing all the residual emotional impediments to unrestrained manipulation" (304).

[63] Worster mentions *The Annual energy Budget in an Inland Lake*, written by Chancey Juday in 1940 (1996, 305).

[64] The world "became a system' an intelligible and controllable system, thanks to computers developed for military needs. While Los Alamos researchers were hired to provide solutions to specific military problems (as part of such programs as the Manhattan Project), the Labs researchers' close collaboration with the ENIAC team (also funded through military funds but based in Philadelphia) contributed to the development of a general-purpose computer. Among many different disciplines, which emerged in that period one can mention Wiener's cybernetics, Shannon's information theory and von Neumann & Morgenstern's game theory, and in general the operations research methods. Although initially the ultimate goal was analytical and consisted in simulating to predict, and ultimately control the functioning of complex systems, eventually it became normative and consisted in writing 'receipts' to generate new artificial systems.

[65] Lindeman's posthumously-published 1942 paper *The Trophic-Dynamic Aspect of Ecology* was a ground-breaking study of metabolic processes in Cedar Bog Lake. The study expressed all processes in terms of energy storage and flow, providing a clear analysis of the metabolic efficiency of organisms across various trophic levels. For a more detailed discussion of Lindeman's contribution. See *Nature's Economy* (Worster 1996, 306-310).

[66] G. Evelyn Hutchinson was Lindeman's professor and he initiated the use of trophic dynamic models. His concept of the *niche* understood as an n-dimensional hypervolume provided a numerically-controlled mathematical model which described an organism as an n-dimensional system (of needs) interlinked with *n* independent dimensions of its habitat (reduced to conditions and resources).

[67] Eugene P. Odum was another pioneer in ecosystem ecology. He and Howard T. Odum wrote the popular ecology textbook *Fundamentals of Ecology*, published in 1953.

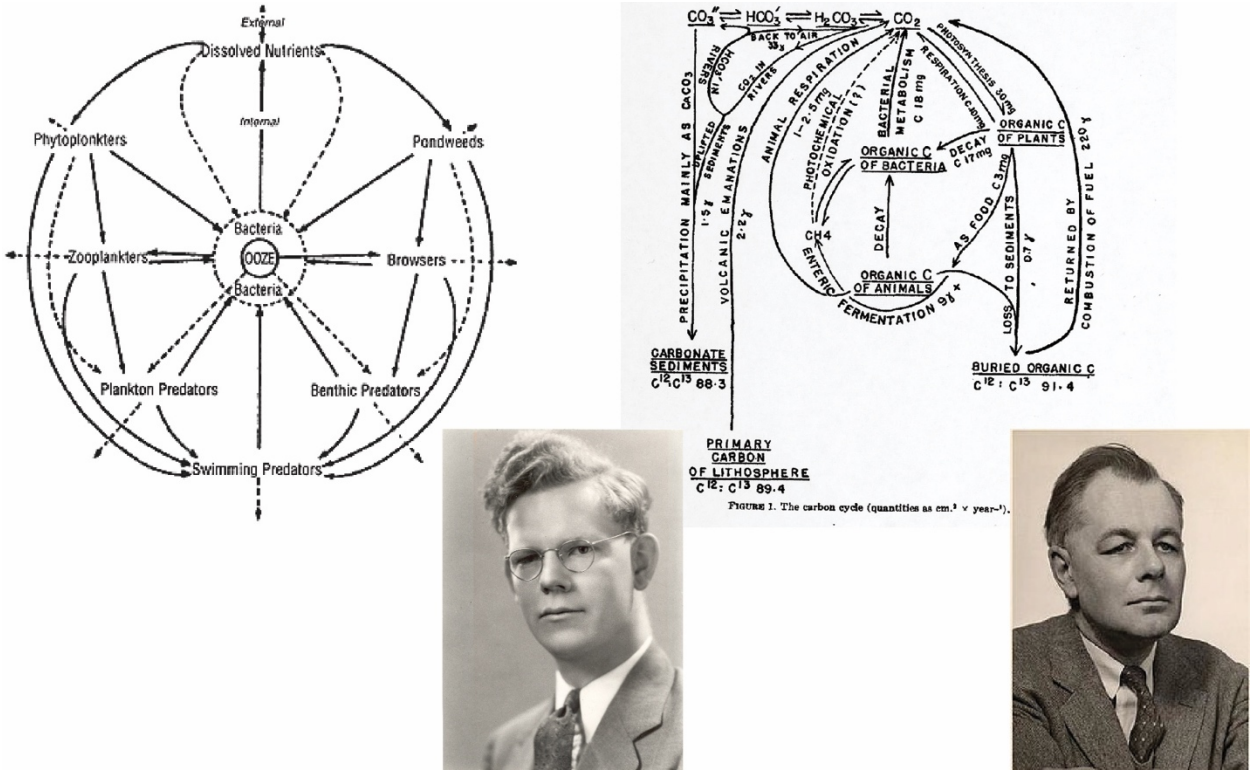

FIGURE 1. The carbon cycle (quantities as cm.³ × year⁻¹).

Fig.2. 16 Lindeman's diagram of a food cycle in Cedar Bog Lake, 1941 (left), Raymond Lindeman (bottom left), Hutchinson's diagram of carbon cycle, 1948 (right), G. Evelyn Hutchinson (bottom right).

December 23, 1949, Vol. 110 SCIENCE 675

The United Nations Scientific Conference for the Conservation and Utilization of Resources

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WHEN MORE THAN 600 scientists, economists, private businessmen, and government officials from 50-odd countries of the world met at Lake Success from August 17 to September 6 for the United Nations Scientific Conference for the Conservation and Utilization of Resources, it was thought that anything could happen. What did happen was not startling. There were almost no sharp clashes that created ready-made newspaper headlines, for those who took part were not concerned in this meeting with political ideologies. The organization of the conference must be considered a great tribute to the work of the Economic and Social Council of the United Nations, and to its Secretariat.

In opening the conference, Trygve Lie, United Nations Secretary-General, stated:

Modern science has developed a wide range of new techniques for wresting more wealth from the earth's resources. Their effective application is basic to achieving a world of abundance—a world where the specters of hunger and wastelands will be things of the past.

In particular, the underdeveloped areas of the world can reap the benefits of learning new methods to use their untapped resources and to build up their economies. The conference represents one of the first and most important steps in the program of technical assistance to underdeveloped countries, which the United Nations is undertaking.

What these world authorities talked about had to do with the material things necessary for the survival of man and his attainment of higher levels of living. What was said about the availability of resources was generally reassuring. There are a few materials which are now considered essential but which are believed to be insufficient to meet the world population's increasing demands. The possibility of new discoveries, the availability of substitutes of more plentiful materials, and the possibilities of conservation in use tended to alleviate the worries of those who were inclined to view the situation in great alarm.

The basis for this general optimism was founded upon the ingenuity, resourcefulness, and knowledge with which modern man is developing techniques for the conservation and use of the resources of the world. Reports of the tremendous advances that are being made in the techniques of production, processing, use, and conservation of resources of the world, as documented in the hundreds of scientific papers presented, proved that necessity was creating invention.

Colin Clark of Australia pointed out the race between the increasing world population and the world's food supply:

While man has proved himself capable of the most appalling misuse of natural resources under certain circumstances, he has also shown himself capable of scientific improvement of agricultural technique capable of raising the product per man-year at the rate of 1½ percent per annum. Even in some of the crowded areas of Europe and Asia great increases in agricultural production have been achieved. The world's population is increasing at the rate of 1 percent per annum and our problem is clearly soluble if we go about it the right way.

A. I. Levorsen of the United States, summarized the outlook for petroleum reserves:

Petroleum occurs in sedimentary rocks. The volume of sedimentary rocks found both on the land and under the shallow waters of the continental shelf areas bordering the continents may reasonably be expected to contain an amount of petroleum per unit volume comparable to what has been found in the sediments of the explored regions. The present estimates of the amount of the undiscovered reserve are on the order of 500 times the current annual world consumption. Such estimates merely reflect the state of technical development and geological understanding at the time of the estimate. As ideas have developed, estimates have increased and may be expected to continue to increase in the future.

These reserves must be discovered, to be of any use. Their discovery is determined by a combination of technological, economic, and political factors.

It was brought out time and time again that research, both fundamental and applied, must be increased if the demands of the world's increasing population are to be met. It was emphasized that research must include discovery, development, production, and use of resources if supplies of needed materials are to provide a basis for the attainment of higher levels of living. It appeared that the earth's resources and the ingenuity of man can provide an almost unlimited potential for improved living standards for the world's population.

Fig.2. 17 UN Scientific Conference on the Conservation and Utilization of Resources, New York, 1949 (left), a Science article discussing the event (right).

mathematical 'stock and flow' models to better comprehend the inner workings of natural systems (Fig.2. 16).

Paradoxically, to comprehend these systems in their complexity, ecologists had to reduce them to more and more discrete and manageable physio-chemical processes.[68] The risk was that their management would remain equally disjointed. While the analytical approach of New Ecology equipped post-war conservationists with tangible tools, many environmentalists perceived it as a threat. For those who saw nature as a community rather than a resource, the managerial ethos, as clearly expressed in the title of the first *UN Scientific Conference on the Conservation and Utilization of Resources* which took place in 1949 in New York (Fig.2. 17), was isolating humans from nature. "The Land Ethic" published in 1949 by Aldo Leopold as part of *A Sand County Almanac* expressed this disillusion with the modern approach to nature and marked an important moment of shift. As Worster explains, Leopold's well-established scientific expertise combined with a newly-acquired biocentric ethic helped launch the Age of Ecology and inspired a new generation to appreciate nature again as a community rather than a commodity.[69]

Regardless of the differences in methodological approach, many scientists actively supported conservation efforts. In 1946, the Ecologists' Union was formed by a group of scientists "to take 'direct action' to save threatened natural areas." The Union evolved into the leading environmental organization and is now called Nature Conservancy.[70] These and other similar efforts resulted in the first (although little known) environmental acts. In 1947 and in reaction to severe smog episodes, California passed the first in the nation *Air Pollution Control Act*, and in 1955 the federal government first recognized air pollution as a danger to public health and welfare.[71] Although after numerous attempts to regulate the pollution in rivers and lakes, the *Federal Water Pollution Control Act* was finally enacted in 1948, and other

[68] An important critique of the mechanistic bio-economics of the New Ecology was expressed by H. G. Wells and Julian Huxley in the 1939 book *The Science of Life*. See *Nature's Economy* (Worster 1996, 314).

[69] For an account of Leopold's personal transformation from the Progressive conservationism to a biocentric approach to nature, see *Nature's Economy* (Worster 1996, 284-8).

[70] The Union was formed by a group of ecologists who were previously part of the Ecological Society of America formed in 1915 but unlike other members believed that scientists should support conservation efforts. The Union, renamed Nature Conservancy in 1951, its mission now is "to conserve the lands and waters on which all life depends." Although criticized for its close links with businesses, it remains the leading non-confrontational environmental organization with more than one million members around the world. For a brief history and the mission of the Nature Conservancy, see their website. Accessed October 13, 2016: http://www.nature.org/about-us/vision-mission/history/index.htm?intc=nature.tnav.about

[71] This was the *Air Pollution Control Act* of 1955. For a history of air pollution acts, see the Congressional Research Service Report entitled *Clean Air Act - A Summary of the Act and Its Major Requirements* (McCarthy and Copeland 2013).

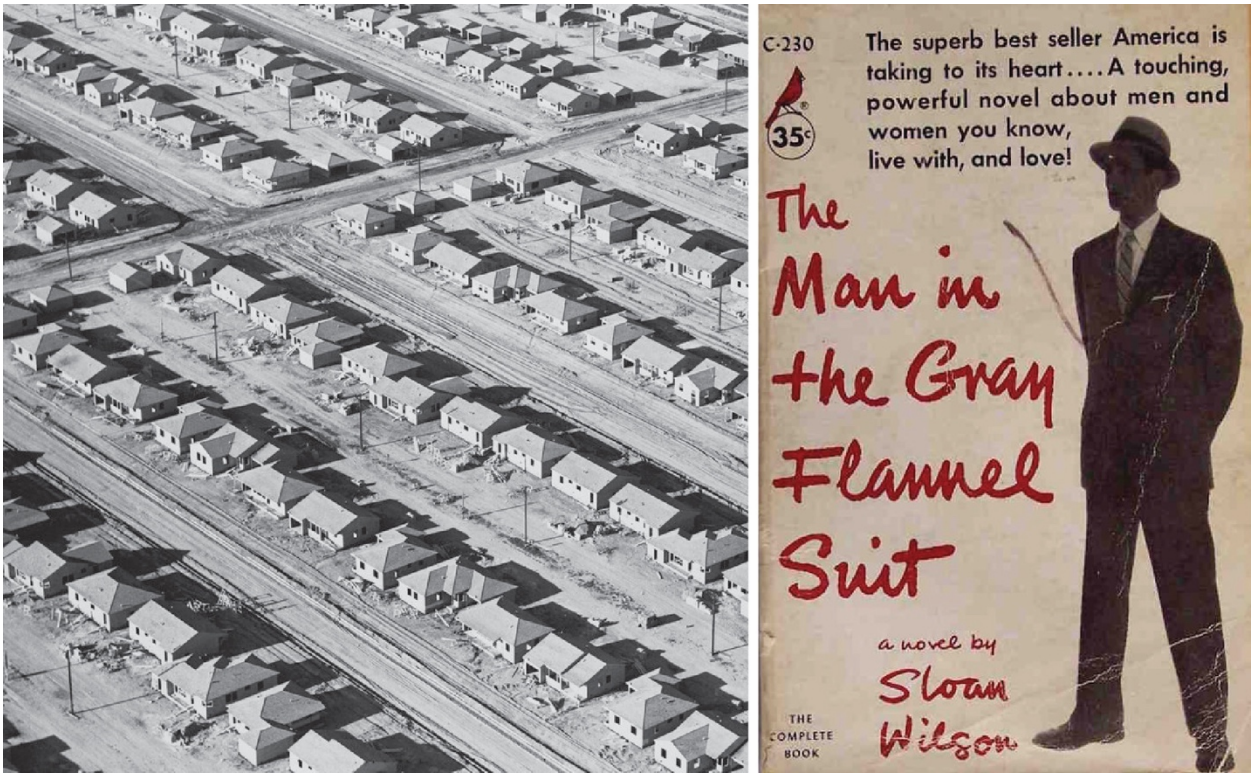

Fig.2. 18 Lakewood under construction (left), the cover of The Man in the Gray Flannel Suit by Sloan Wilson (right).

congress bills allocated funds for important research and information campaigns, federal air and water pollution control would remain practically inexistent until the 1960s.[72]

Essentially disconnected from large-scale environmental concerns, urban areas were preparing for an era of dramatic expansion. The wartime experiments in mass-produced housing prepared the ground for the era of merchant builders. As observed by Keller Easterling, "traditional development protocols were replaced by protocols for product distribution or financial structures" (1999, 134). In 1946 Los Angeles passed a new *Zoning Ordinance* which remapped most of the city and rezoned most of its agricultural land for residential use to comply with the FHA subdivision standards and satisfy the demand for large tracts of land. The times of community-oriented developers were coming to an end, and the Westcoast *Levittown - Lakewood* was hastily being sketched onto a bean field (Fig.2. 18). In *The Holy Land*, D. J. Waldie explains how *Lakewood* was designed: "Louis Boyar's wife told her husband to redesign the street plan he had

[72] For a history of clean water acts, see the CRS Report entitled *Clean Water Act - A Summary of the Law* (Copeland 2016).

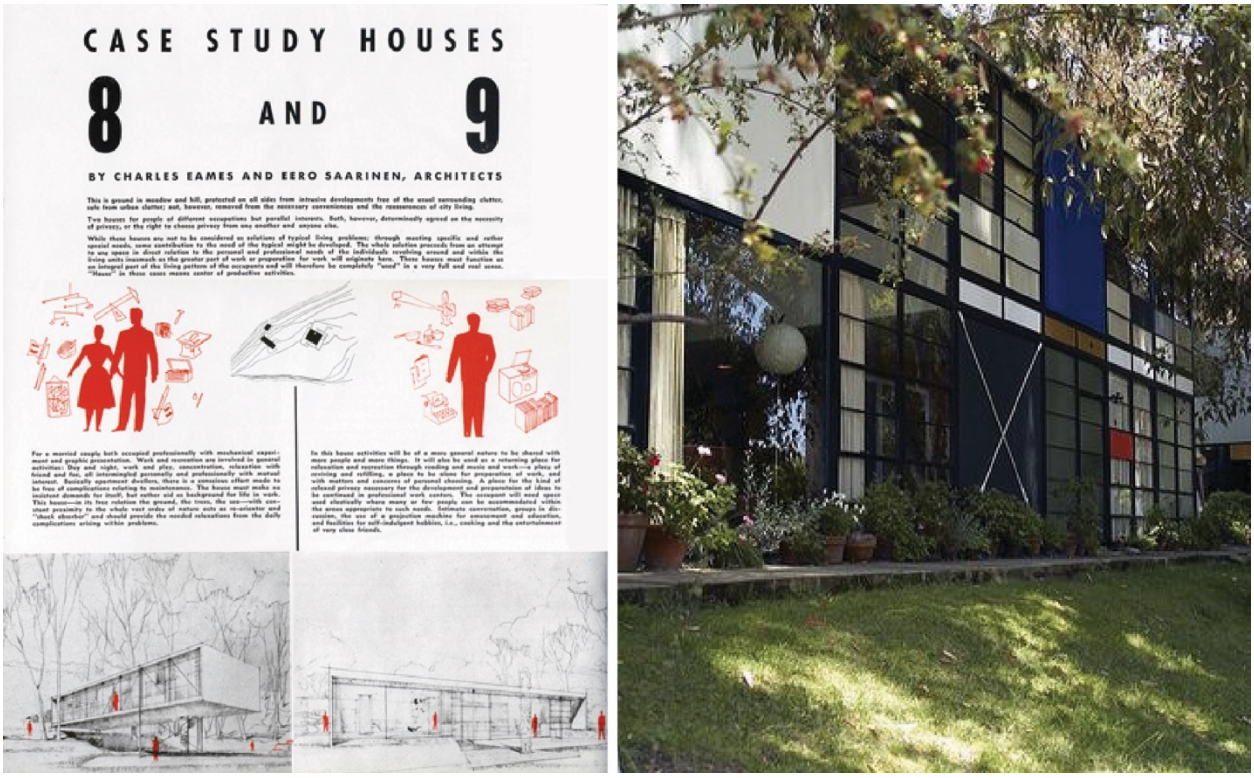

Fig.2. 19 The original design for Eames and Saarinen's Case Study Houses 8 and 9 (left), Eames's CSH # 8 today (right).

sketched. She wanted him to add parkway panels and parallel service roads to separate the residential streets from highway traffic. She told her husband that children like to play in the street, and how dangerous the streets were in Chicago where she grew up. When construction began in 1950, the *Los Angeles Daily News* said the new community was 'scientifically planned'" (2005, 100).

While the house was inarguably becoming a perfectly-standardized commodity, it was also an expression of an attainable American dream, a fact often denied by the critics of the post-war sprawl, and candidly told by Waldie in his 'suburban memoir.' Yes, to use his words again: "This pattern - of asphalt, grass, concrete, grass - is as regular as any thought of God's" (48), but to that disillusioned wartime generation what counted was precisely that – it was a thought of God's dedicated to the ex-GI's. With thousands of families ready to move in, planning and design were stripped to a minimum. "In a suburb that is not exactly middle class, the necessary illusion is predictability" (2). Predictability was more than a marketing tool, it was the key to deliverability. The merchant builders mastered the process of quickly assembling traditional cottages and ranch-style houses perfectly aligned with the FHA-standards. Although Joseph Eichler's fascination for modern design helped 'popularize' the design and lifestyle associated with the

Case Study Houses (Fig.2. 19),[73] theirs was a small niche. In *The Merchant Builders,* Eichler's son observed: "All during the decade there was much talk and even ballyhoo about presumably impending technological advances and even revolutions. (…) Hardly noticing such nonsense, merchant builders continued developing with their crude technology" (1982, 77).[74] Experiments with factory-assembled dwellings did not really affect the postwar developments. However, as Keller Easterling points out "in many ways prefabrication techniques ironically, served as a model for the regimentation of the assembly process in conventional stick construction" (1999, 188).

Innovation was selectively absorbed by the market, but the federal government made sure that the right regulatory structure was in place to support it. While the first postwar act, the *Housing Act of 1948*, continued to improve mechanisms to make credit available for low-cost housing, it also emphasized the need to standardize building codes and measurements in the building industry. The objective of Truman's landmark *Housing Act of 1949* was, on the other hand, "a decent home and a suitable living environment for every American family," and while it continued to address mortgage insurance, it also provided funding and mechanisms for slum clearance and urban redevelopment.[75] A year after the passage of this act, Building Officials Code Administrators International (BOCA) published another model code, the first edition of its *National Building Code* (1950), which remained in use on the East Coast and throughout the Midwest until the introduction of the International Building Code in 1997. In the meantime, FHA continued to define the shape of federally-insured subdivisions and homes by refining its underwriting standards. In 1945, the FHA issued a 180-page *Master Draft of Proposed Minimum Property Requirements for Properties of One or Two Living Units*. While initially individual states issued their own amended

[73] Among other modernist architects, Eichler worked with Jones and Emmons who were involved in John Entenza's Case Study House Program. However, although Eichler experimented with modern technology and realized a couple of steel-frame prefabricated houses, he quickly realized that he had to find ways to innovate without dramatically changing technology. In fact, his houses were all wooden post-and-beam structures, and few featured completely flat roofs or fully-glazed walls. In any case, his success was in the capacity to find the right balance between a market-driven compromise and an architectural quality that he wanted to offer to his clients.

[74] Ned Eichler specifies that by 1959, merchant builders "established continuity, a reasonable rate of production and well-engineered models. They had brought specialization to work crews. They had organized reliable supply, some of it precut and preassembled. They had fostered subcontractors who could mesh with their schedules. They had introduced small, but important, automatic equipment, especially in carpentry. They still used lumber, although plywood was increasingly replacing siding. They put a house together much the same as it had been done for years. (Eichler Homes' presumably modern house was one of the oldest structural types known.) They did not change anything fundamentally except the way the work was organized. Yet organizational improvements, crude though they were, had a startling result." (78)

[75] For an overview of the *Housing Act of 1948* (Public Law 80-901), and the *Housing Act of 1949* (Public Law 81-171), see *A Chronology of Housing Legislation and Selected Executive Actions, 1892-2003* (U.S. Congressional Research Service 2004). Retrieved July 24, 2016: https://www.gpo.gov/fdsys/pkg/CPRT-108HPRT92629/html/CPRT-108HPRT92629.htm

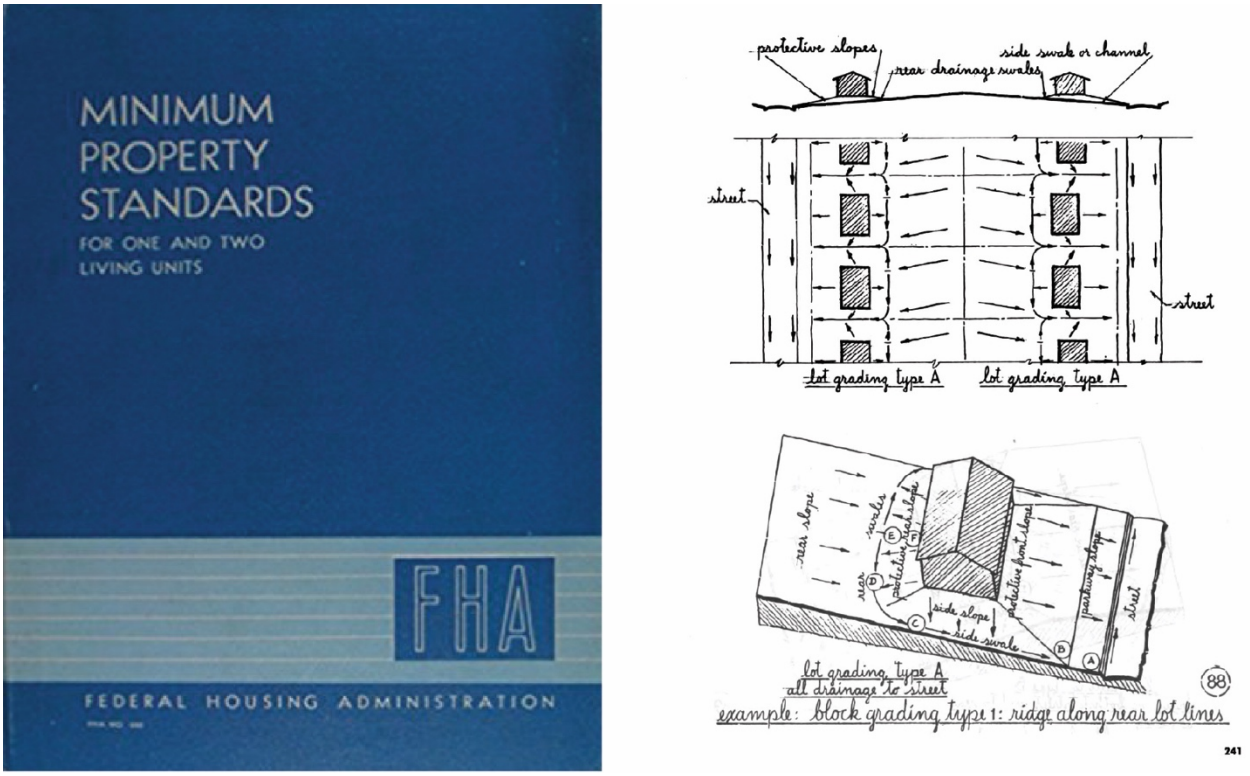

Fig.2. 20 The cover of the 1958 edition of the FHA Minimum Property Standards (left), a grading diagram from the same publication (right).

versions of the document, by the time the 1958 edition was released as *Minimum Property Standards for Properties of One or Two Living Units*, all differences were erased to achieve a complete uniformity across the country (Fig.2. 20).[76] The *Minimum Property Standards* now occupying 315 pages became "a de facto building code, a largely prescriptive document that went well beyond local codes in specifying allowable building methods, materials, components, and finishes, as well as minimum dimensions, room sizes, and the like."[77] Since desirability was paramount, safety and welfare consideration were listed next to precise

[76] The process of consolidation started shortly after the war: "In August 1947, FHA *published Significant Variations of the Minimum Property Requirements of FHA Insuring Offices*, apparently in response to post-war interest in industrialized housing. (…) within a year or two, the insuring offices were issuing *Minimum Property Requirements* on a multi-state basis. A southern version, for instance, covered the states of Georgia, Alabama, South Carolina, North Carolina, Mississippi, and Tennessee." See *Part 1 of a Study of the HUD Minimum Property Standards for One- and Two- Family Dwellings and Technical Suitability of Products Programs* (National Institute of Building Sciences 2003, 4). Retrieved July 20, 2016: https://www.huduser.gov/Publications/pdf/mps_report.pdf

[77] See the report mentioned in the previous note, page 6.

descriptions of closets.[78]

It is worth also pointing out that "residential [energy] efficiency standards were first established in the 1950s (…), in response to mortgage defaults on federally insured loans on homes with high utility bills."[79] In fact, although air-cooling was not yet regulated as the first domestic air-conditioners started to be advertised around 1948,[80] heating and insulation standards were addressed in multiple articles of the 1950s editions of the FHA *Minimum Property Standards*.[81] However, the aim was again purely economic: reduce operational costs of heating, in order to improve the desirability of the house, and ultimately minimize the financial risk for the mortgage lenders.[82] However, standardized post-war tracts equipped with energy-, and water-demanding appliances catered for the perfect Mr. and Mrs. Consumer so the energy conservation was inevitably a secondary problem. Profit and economic growth rather than environmental issues motivated both the developers and the Federal Housing Association.

The American post-war house, shaped by the positivist outlooks of domestic engineers of the progressive era and the wartime ergonomists,[83] became a perfect expression of the dream dreamt by the federal government for the 'men in the gray flannel suits.'[84] In *The Good Life*, Iñaki Ábalos dedicates a chapter to Jacques Tati's 1957 film Mon Oncle, in which he contrasts the positivists ideals embodied in the life and the house of the Arpels with alternative ways of living (of Mon Oncle – the old-fashioned uncle), and with alternative forms of, to use his words, "subjectivism or vitalism" that those models express (2001, 69). Unlike the European Arpels, the American suburbanites did not embrace the modern orthodoxy, but it

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[78] The following article from a 1952 edition of standards can serve as an example: Building Planning Requirements / Space Requirements / 302-C. Minimum Size of Spaces / 4. Closets / b. Bedroom closets: "Provide each bedroom with at least one closet having a minimum: Depth: 2 feet. Floor area: 6 square feet. Height: 6 feet above closet floor. One shelf, rod, and hooks." See *Minimum Property Requirements for Properties of One or Two Living Units Located in Northern California District 1952*, 301-L 302-C.

[79] See *The History of Energy Productivity* (Alliance Commission on National Energy Efficiency Policy 2013, 9).

[80] Banham mentions the McQuay air-conditioners advertised in 1948 and quotes a passage from Arthur Carson's 1954 book *How to Keep Cool* in which he points at 1951 as a year in which mass-produced units appeared on the market (1969, 186).

[81] The same 1952 editions of MPS for Northern California contains the following articles: Minimum Construction Requirements / Structural Requirements / 402-A. Insulation which defines the maximum allowable heat losses, and: Minimum Construction Requirements / Heating Requirements / 501 -C. Heat Loss Calculations which refers to the 1922 *ASHVE Guide* for calculations on maintaining 70° F.

[82] Similarly, to the 1922 *ASHVE Guide* which recommended automatic temperature control for reasons of common sense and economy. This time however the economic agenda was much clearer. See note 40 above.

[83] Henry Dreyfuss published the first edition of *The Measure of Man* in 1959 closing a long period of studies in efficiency and ergonomics.

[84] Sloan Wilson wrote his novel *The Man in the Gray Flannel Suit* in 1955, and in 1956 William H. Whyte theorized his heroes in *The Organization Man*.

would be an error to assume that they all inhabited the celebrated pragmatist house from Hockney's painting instead (165). The houses that the American 'men in the gray flannel suit' would live in, were, yes, in some way also modern and affordable, but they did not reflect the celebrated ideals of the Case Study Houses that Eichler tried to popularize as an alternative to the traditional cottages standardized for the masses by FHA. Unlike Jacques Tati's European Arpels engaged in a modernist spectacle, Wilson's American Raths and thousands of other nostalgic pragmatists across the continent, enjoyed the coziness of a Better Home (in America) without noticing that their cottage - maybe a guarantee of a relative wealth, surely an expression of a comfortable predictability and a longing for a bygone past – was little more than a perfectly standardized bank collateral, adorned to simulate the old ways of the American settler.

***

Although the distance between ecology and residential regulations remained vast, the post-war period brought ecology a step closer to territorial management. Yet, at the same time, it launched cities into expanding suburban territories. Wartime developments in systems theory further advanced ecosystem modelling which granted ecologists more control over circumscribed dynamics that they could now manipulate with greater precision. Critical of this managerial attitude, a more communal way of thinking about nature emerged announcing the Age of Ecology. Nature Conservancy was established by a group of ecologists convinced that it was scientists' obligation to protect rather than just study nature, and first (still largely ineffective) attempts to regulate environmental pollution were made by local and federal governments. Undisturbed by these advances, municipalities updated zoning plans, dedicating more and more agrarian land for residential development. Armed with the FHA standards and protected by its mortgage insurance, merchant builders delivered the dream home to the post-war migrants and veterans. Although the FHA standards made construction quality more predictable, reducing waste and improving minimum quality, risk of mortgage defaults rather than environmental concerns drove the provisions that defined the building regulations in the post-war era. Despite such outstanding initiatives as Entenza's Case Study House Program which popularized the mid-century modern style among more affluent urbanites, most Americans, for reasons of taste and economy, chose the traditional cottage, yet accepted all the modern appliances that came with it. Their dream home became a well-standardized commodity.

2.5. 1960s: Standard 55, Thermal Environmental Conditions for Human Occupancy, ASHRAE (1966) & the National Environmental Policy Act (1969).

This closing section offers an account of the decade which gave rise to the modern environmental movement. It first provides an overview of the dynamics that continued to shape residential construction, paying particular attention to the increasing role of mechanical engineering in climate-control, and the decreasing interest in the pursuit of socio-economic progress among architects. It then focuses on the early environmental action and legislation which, while still disconnected from individual households and building regulations, addressed the impact of environmental degradation on human health and welfare.

After an initial economic downturn, by 1965 economy was thriving again and concentration shifted from a passing interest in denser housing products and communal space back to the basic provision of affordable housing. Federal programs were launched to develop cheaper and faster construction technologies, yet once again, construction practices remained essentially unaffected. Builders continued to rely on wood-framing. Attention of the architectural establishment shifted away from technology, environment, and social progress, to form and meaning. In the meantime, mechanical engineering continued to define the norms for climate-control, ***ASHRAE Standard 55*** which established the first boundaries of human thermal comfort was published in 1966. While some architects and academic researchers explored other, passive or form-driven environmental-management strategies, their efforts had little influence on mainstream construction. Fortunately, while American houses were losing touch with the environment, ecologists –activists were redefining the modern environmentalism. Significant acts were passed to revert the negative impact of post-war economic growth, and the decade culminated with the ***National Environmental Policy Act of 1969***. Yet, although activists were hopeful to subvert the old orders, and some economists supported them by questioning continuous economic growth, their efforts were to meet with resistance.

***

According to Ned Eichler "There was little advance in technology, methodology, organization, or any other facet of home building in the next twenty years."[85] By the end of the 1950s, the organization of the industry was defined, the post-war housing emergency was over, and the early 1960s saw a recession. Gradually, the overall focus shifted from single-family tracts to higher-density products,[86] and to planning of communities and new towns.[87] While the issue of density was perceived as an opportunity by developers, the focus on community became an urgency for planners. This trend was famously epitomized in Jane Jacobs's 1961 book *The Death and Life of Great American Cities* in which she defended public space, mixed-use developments, and socio-cultural diversity. Reflecting this changing climate, in 1961 the Case Study House program included a community-oriented proposal designed by Jones and Emmons for

[85] See *The Merchant Builders* (Eichler 1982, 78). Later, he elaborates on this point as follows: "Our work in the 1950s convinced me that labor unions, building officials, bankers, and similar villains were not preventing fundamental technological change that could improve the product and/or reduce cost. They never got the chance. The kinds of houses desired by most Americans, (even if they were avant-garde Eichler types), were most efficiently built with a wood frame, siding, sheetrock, and all the other materials and components then in use. A number of new materials would be developed among them: plastic pipe, aluminum siding, and plastic bath fixtures. And builders would continue to refine methods of precutting, off-site assembly, and the way they organized the work. But this had little if anything to do with technology for none existed in industry research centers which could be applied efficiently. In fact, by the early 1960s the very subject of technology was all but forgotten by merchant builders as they turned their attention to other matters" (138-9).

[86] Ned Eichler mansions three types of products: patio houses (5-7 per acre), townhouses (7-12 units), and quads (12-15 units per acre). The patio houses were still within the traditional range: D.J. Waldie specifies that while the typical pre-war density was 5 units per acre, Lakewood's density (1950) was already 8 units per acre (2005, 12). Eichler confirms that quads and townhouses were the predominant products in the 1960s and 1970s (1982, 142-3).

[87] Among others: Reston in Virginia, or Irvine in California.

the Eichler Homes.[88] However, although CSH #24 included greenbelts and communal recreation areas, and houses were located below grade to provide more greenery, due to rigid regulations and no existing strategies on how to maintain common areas, the zoning variance was not approved, and the scheme was denied the permit. By the mid-1960s the economy was again booming and satisfying the demand for dwelling units became once more the main focus. In 1965 the government created the Department of Housing and Urban Development (HUD), which absorbed the Federal Housing Administration, and although it continued to release its underwriting standards, their role slowly declined.[89]

Although yet again the government hoped to streamline construction by encouraging technological innovation, federal efforts such as Operation Breakthrough failed to modernize the housing industry.[90] For different reasons, both merchant builders and architects lost faith in technology. To echo Banham, the house became a stylized container for ducts, wires, pipes, and vents, "nothing but a hollow shell."[91] The perfectly-rationalized stick frame become a scaffold both for the ducts and for post-modern stylistic explorations. In 1964 Venturi's *Mother's House* announced an era of new possibilities and contradictions. Radical projects such as Lautner's 1960 *Chemosphere* represented a potential, to use Banham's expression, "future of the recent past" (Fig.2. 21). David Sellers' *Prickly Mountain* design-built experiments, and Soleri's *Arcosanti* would influence experimental architecture of the '70s, and later ecologically-driven design-built research programs such as *Yestermorrow* (1980) or the *Rural Studio* (1993), yet they failed to influence mainstream residential construction. A less-radical but carefully

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[88] For a detailed discussion of CSH #24, see *Case Study Houses 1945-1962* (McCoy 1977, 189).

[89] The last edition of *Minimum Property Standards, One and Two-Family Dwellings* was published in 1982. "In 1983, Congress passed Public Law 98-181, title IV, Sec. 405, permitting HUD to allow compliance with model or local building codes as a means of satisfying mortgage insurance requirements, thereby virtually eliminating the need for the one- and two-family MPS except for specifying allowable codes and determining code comparability." See *Part 1 of a Study of the HUD Minimum Property Standards for One- and Two- Family Dwellings and Technical Suitability of Products Programs* (National Institute of Building Sciences 2003, 10)

[90] By launching *Operation Breakthrough*, the Housing and Urban Development Act of 1968 initiated "a program under which public and private organizations [were to] submit plans for the development of housing for lower-income families, using new and advanced technologies, on federal land made available for that purpose, or on other suitable land. Five plans from among those submitted were to be selected." The aim was "to achieve the construction of at least 1,000 dwellings units a year over a five-year period for each of the various types of technologies proposed in the approved plans," and it "authorized insurance of mortgages financing the projects under the FHA experimental housing program." See *A Chronology of Housing Legislation and Selected Executive Actions, 1892-2003* (U.S. Congressional Research Service 2004). Retrieved July 24, 2016: https://www.gpo.gov/fdsys/pkg/CPRT-108HPRT92629/html/CPRT-108HPRT92629.htm

[91] In his celebrated essay *A Home is not a House* Reyner Banham says: "When Groff Conklin wrote (in "The Weather-Conditioned House") that "A house is nothing but a hollow shell… a shell is all a house or any structure in which human beings live and work, really is. And most shells in nature are extraordinarily inefficient barriers to cold and heat…" he was expressing an extremely American view, backed by a long-established grass-roots tradition" (1965, 73).

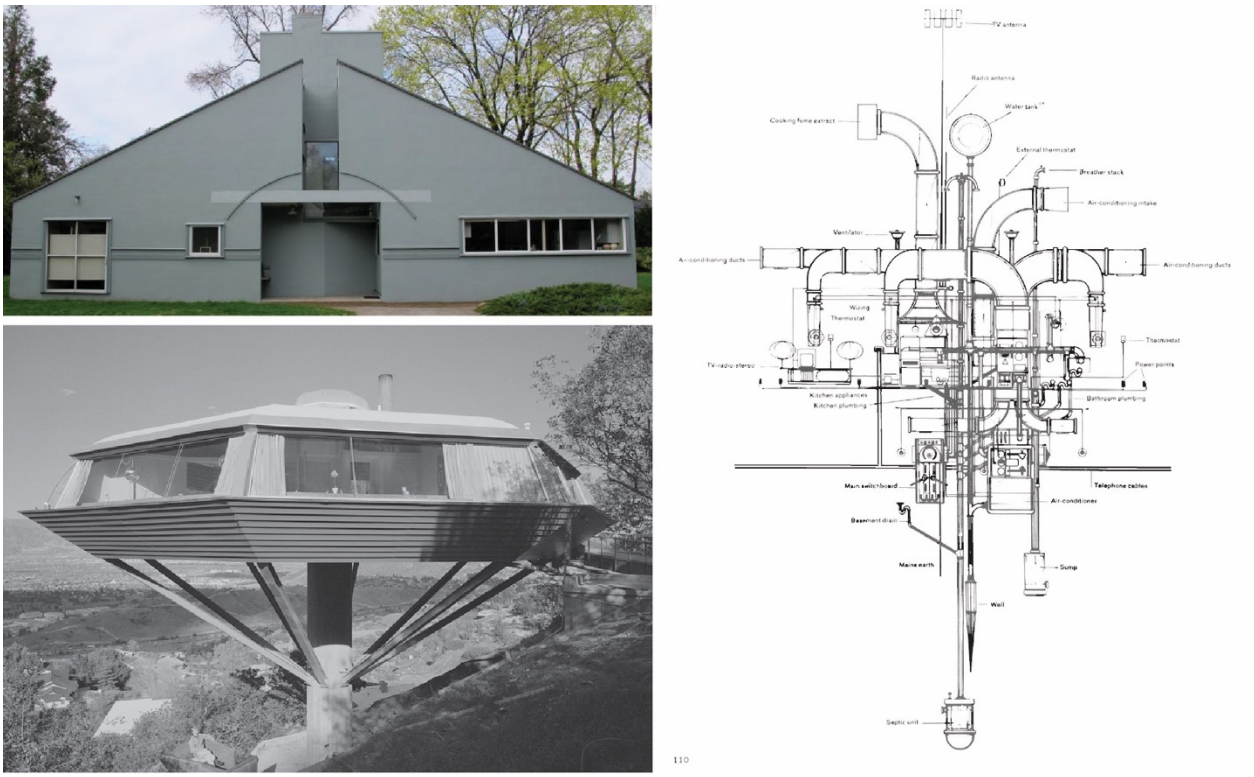
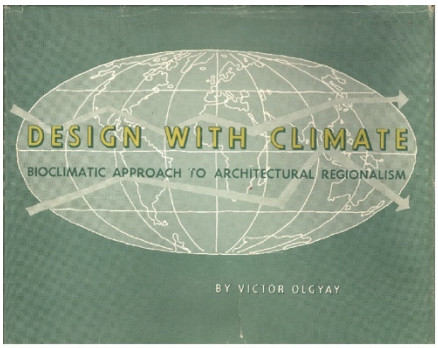


Fig.2. 21 Venturi's Mother's House *(top left), Lautner's* Chemosphere *(bottom left), an illustration from Banham's "A Home is not a House" - "Anatomy of a Dwelling" by Francois Dallegret (right).*

integrated into the landscape *Sea Ranch Condominium* (1964) stands out as a singular example of a realistic future in harmony with nature – one that arrived in the late 1980s in form of (an apparently modest) 'sustainable vernacular'.[92]

Although important research around the topic of bioclimatic design was carried out in the late 1950s and 1960s by, amongst others, the Olgyays at Princeton (*Design by Climate,* 1963) (Fig.2. 22), Baruch Givoni in Israel and at UCLA (*Man, Climate and Architecture,* 1969), or later Ralph Knowles at USC (*Energy and Form*, 1974), low-tech passive climate management techniques struggled to compete with the ducts and wires and influence the mainstream housing industry. In 1966, ASHRAE published the first edition of its *Standard 55 Thermal Environmental Conditions for Human Occupancy*, which included the 1924 *Comfort Zone* Diagram and established performance criteria for thermal acceptability for people engaged in

[92] In *American Masterworks*, Kenneth Frampton separates this 1964 project from all the other "late-modern houses" (post-1964) and includes it in the "Blueprints for modern living: The American House and the Pax Americana 1945-65" (2008, 155). The *Sea Ranch* (designed by Moore, Lydon, Turnbull, and Whitaker) stands as a beautiful blueprint for many less spectacular examples of 'sustainable vernacular' that fill the pages of magazines such as *Dwell* until today.



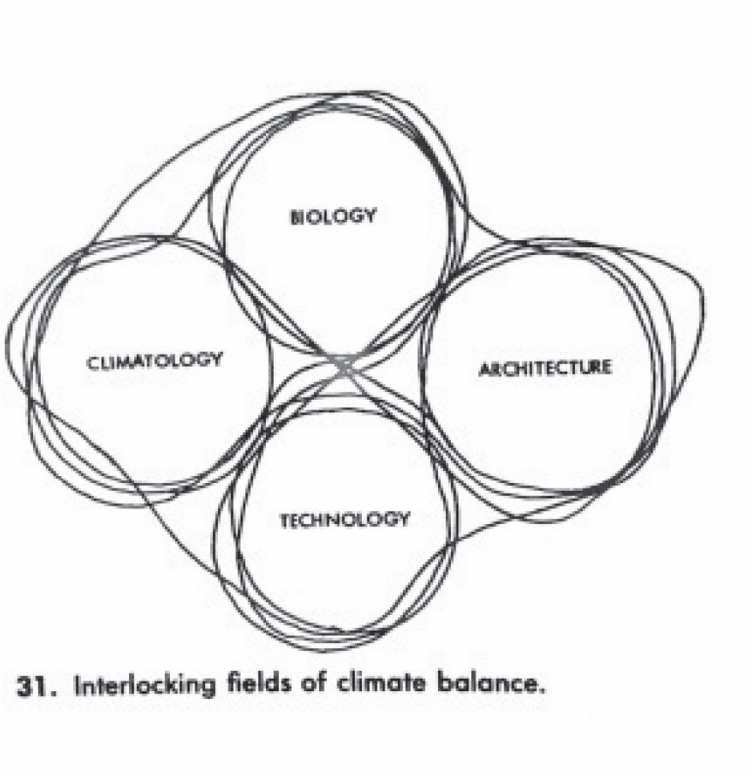
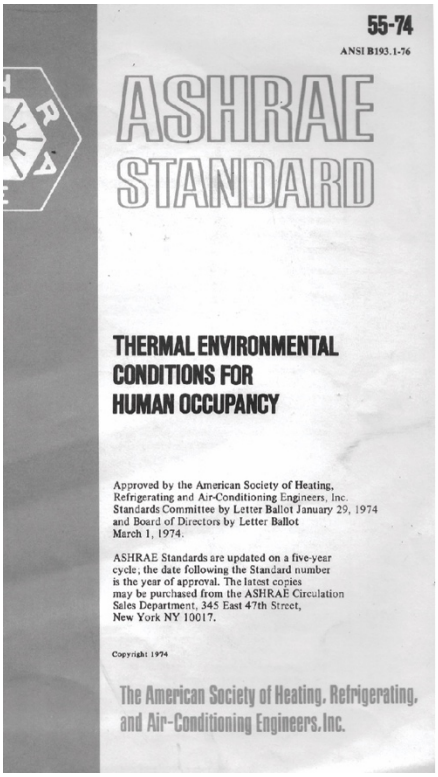


Fig.2. 22 The cover of Design with Climate (top left), Victor Olgyay with his brother Aladar (bottom left), a diagram from the book (right).



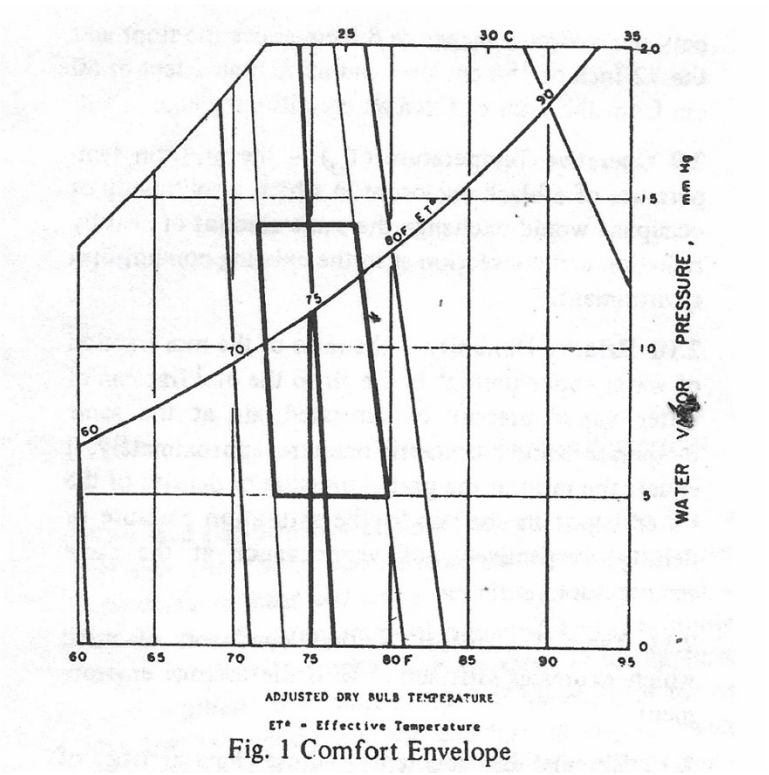


Fig.2. 23 ASHRAE Standard 55 (left), diagram of the "comfort envelope" included in the standard (right).

sedentary activities such as office work (Fig.2. 23). A year later, in 1967 ASHRAE released its *Handbook of Fundamentals* which replaced and expanded the 1922 *ASHVE Guide.*[93] The *Handbook* now includes all basic principles as well as issues separately covered by individual standards: indoor environmental quality, load and energy calculations, HVAC design, building envelope, and materials.[94] Consolidated into a well-funded and thoroughly-studied field of expertise, mechanical, electrical, and plumbing technologies took over passive low-tech design strategies developed by academic researchers, and tested by with little funding and less systematically by few architects passionate both about human health and comfort, and the environment.

The 1960s were obviously a period of intense civic and environmental activism. Among many victories of the civil rights movement, discrimination in access to housing was outlawed by the *Fair Housing Provision, Title VIII of the Civil Rights Act of 1968,* and the decade brought many social and environmental victories which would shape the future of environmental policies and regulations in the United States. O*ikos* was still far from home - the focus of legislators was not yet on the individual shelter - but the attitudes towards the larger environment that we all share were changing. Many important events shaped public awareness in the decade preceding the first Earth Day. In 1958, Barry Commoner co-established the Committee for Nuclear Information to attract public opinion to the issue of nuclear tests and atomic fallout. As pointed out by Worster, "Their campaign against the radiation threat to the planet set a precedent for scientists taking up political issues (…)" (1994, 347). Eventually, the *Nuclear Test-Ban Treaty* was passed by the U.S. Senate in 1963. In 1960, a report entitled *California, Going, Going* was published by an influential environmental organization *California Tomorrow* to increase public awareness of the environmental implications of the growing population, and economic development in California. This, and many other less known publications[95] prepared ground for Carson's *Silent Spring* (1962) which became the best-heard cry against environmental devastation, passionate enough to trigger a nationwide ecological movement, and precise enough to convince federal authorities to investigate further. *Silent Spring* addressed the harmful effects of synthetized chlorinated hydrocarbon used in organic pesticides, exposing the environmental effects of the arrogance with which the chemical industry has shortsightedly

[93] In 1967 building code-makers also formed the National Conference of States on Building Codes and Standards *(NCSBCS)* to further uniform the expanding regulatory apparatus across states.

[94] See the ASHRAE website for table of contents. Accessed May 29, 2017. https://www.ashrae.org/resources--publications/handbook/toc-2017-ashrae-handbook-fundamentals

[95] For example, Lewis Herbert's 1962 book *Our Synthetic Environment*.

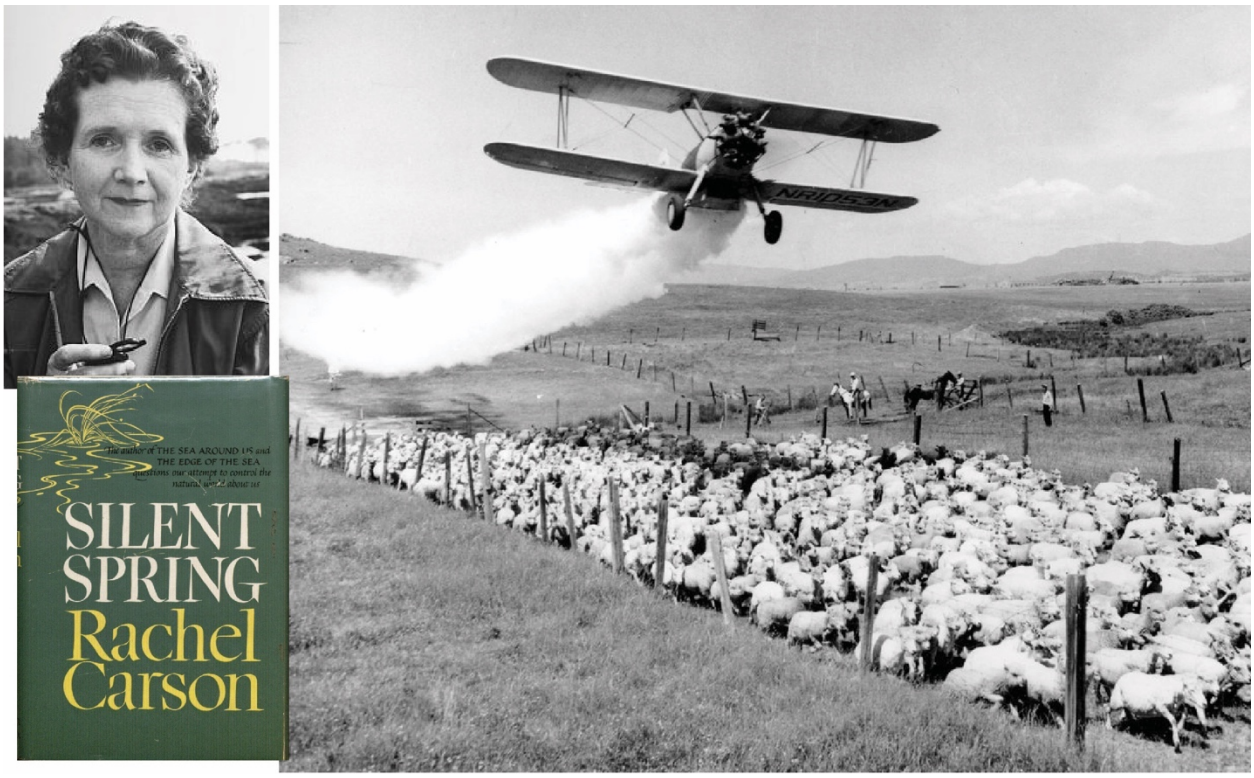


Fig.2. 24 Rachel Carson (top left), the cover of her book Silent Spring (bottom left), a crop-duster spreading DDT in 1948 (right).

manipulated certain, seemingly confined aspects of nature (Fig.2. 24).

While Carson was reporting the vulnerability of the natural environment demonstrating the general interconnectedness of apparently disconnected realities, Edward Lorenz was mathematically proving that the behavior of complex systems could not be predicted also because apparently insignificant events (such as a butterfly flapping its wings) could potentially trigger highly complex and unpredictable events.[96] While nature was appearing more and more sensitive and chaotic, and social ecologies were soon to reach states *far from equilibrium*, the ecologist H.T. Odum was perfecting his energy-based models of ecosystems, while the computer engineer Jay Forrester was fine-tuning his system dynamics models at MIT.[97] While preoccupied with different flows, both contributed to a vision of the world that described complex systems as well-defined circuits in a motherboard, providing tangible tools to the emerging field

[96] Discoveries published in a 1963 paper entitled *Deterministic Nonperiodic Flow.*

[97] Jay Forrester first applied systems dynamics methods to simulate industrial business cycles. The results were published in the 1961 book *Industrial Dynamics*.

of urban metabolism,[98] environmental (and urban) policy-making, and eventually for environmental accounting as we know it today.[99] While many ecologists disagreed with H.T. Odum's unifying theories, opposed public involvement, and chose to concentrate on specialized research,[100] the majority supported the environmental movement, calling for a more comprehensive approach to conservation.[101]

It was in this context that the federal government initiated the era of modern environmental planning. As pointed out by Jeremy Caradonna in his recent book *Sustainability*, Carson's battle had a tangible effect on the first wave of environmental policy-making: "By 1975 all of the chemicals discussed in *Silent Spring* had either been banned or severely restricted in the United States." (2014, 97) Thanks to such progressive leaders as Stewart L. Udall who, while serving as the Secretary of Interior,[102] published his 1963 book *The Quite Crisis* which continued to spread Carson's message, the environmental movement became policy. Air pollution was first addressed in the 1963 *Clean Air Act*, and then in the 1967 *Air Quality Act*. In 1965 *Solid Waste Disposal Act*, and *Water Pollution Control Act* were passed. Decades of land conservation efforts were acknowledged in the 1964 *Wilderness Act*, the 1965 *Land and Water Conservation Act*, and eventually in the 1966 *Endangered Species Preservation Act*. Fundamental in setting stage for future legislation, these acts concentrated on defining key terms and methods, giving authority to special agencies, and allocating funds. While the decade was crowned with the passage of the *National Environmental Policy Act (NEPA),* which introduced environmental assessment as a prerequisite for all decision-making at the federal level, 1969 also brought the Fire on the Cuyahoga River and the Santa Barbara Spill, two man-made disasters which clearly confirmed the urgency of the environmental cause.

In parallel to criticism expressed by environmental scientists and activists, condemnatory voices started to emerge among economists who began to question the fundamental dogmas of the growth-obsessed framework. They were saying that human o*ikos* was suffering from an artificial separation of economics

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[98] The concept was first introduced by Abel Wolman in his seminal article *The Metabolism of Cities* (1965).

[99] See, for example: Los Angeles Sustainable City pLAn. The project website provides a "dashboard of sustainability metrics related to the nearest-term goals identified in the pLAn." Accessed September 29, 2016: https://performance.lacity.org/sustainability

[100] Robert MacArthur who made a major impact on many areas of community and population ecology was one of those ecologists. As explained by Worster: "He would seek a theoretical ecology based on narrower research, more mathematics, and stronger predictability" (1994, 374), an attitude which tended "to reduce nature's complexity to a "network of mechanistic, one-to-one causal chains" (378).

[101] For example, in 1965 Raymond Fredric Dasmann, a professor in conservation biology published *The Destruction of California*, an important sign of conservationists expanding their field into environmentalism and recognizing the need to protect the environment as a whole rather than as a series of isolated islands of wildlife.

[102] The U.S. Department of the Interior oversees such agencies as the Bureau of Land Management, the United States Geological Survey, and the National Park Service.

from ecology. The British economist E. J. Mishan was among the first ones to point out the ecological side-effects of the neoclassical economics in his 1967 book *The Cost of Economic Growth*. He spoke out about the opportunism with which the inconvenient costs referred to as "external diseconomies" were regularly ignored. As observed by Caradonna, "the bad stuff was nudged out of the model even though it led to "'social conflict,' health problems, and eco-disasters" (2014, 127). Many other voices, all critical of the system which considered the natural environment as an external source of precious resources and a convenient sink for trash, were simply pointing at a specific (economic) instance of a more general epistemological fallacy.[103] Gregory Bateson described it superbly in the following parable: "You decide that you want to get rid of the by-products of human life and that Lake Erie will be a good place to put them. You forget that the eco-mental system called Lake Erie is a part of your wider eco-mental system - and that if Lake Erie is driven insane, its insanity is incorporated in the larger system of your thought and experience."[104] Paradoxically, most economists (and industrialists) refused to acknowledge that there was only one *outside*, and that Lake Erie (or Planet Earth) was inevitably both source, home, and sink. In March of 1969, while speaking in defense of an environmental bill, Bateson postulated that the widely-spread idea that "We live within an infinitely expanding 'frontier,'" and that "Technology will do it for us,"[105] might simply be false. Ironically, three months later a man-made spaceship successfully took man to the moon.

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Although the decade started with a shift towards a denser and more community-focused design, by the mid-1960s the demand for housing was such that both builders and authorities again concentrated on simply delivering affordable homes. Operation Breakthrough was launched by the federal government to address the emergency by modernizing construction technologies, yet the builders resisted change. While assembly and construction systems remained largely unaffected, most builders and architects accepted the wooden scaffold, mechanical engineering continued to define indoor climate management. Although researchers and architects invested significant efforts to develop environmentally-friendly, passive climate-control strategies, it was the ASHRAE and its standards that defined how climate would be controlled and regulated in the future. Venturi's *Mother House* confirmed that most architects lost interest in practical problems all together to concentrate on cultural meaning and form. While architects delegated climate control to engineers, ecologists turned into activists to launch the modern era of environmentalism.

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[103] For example, Kenneth Boulding who, in the 1966 article "The Economics of the Coming Spaceship Earth," called for a new economy seen as a 'closed' system that includes the natural environment; or Garrett Hardin, whose 1968 paper "The Tragedy of the Commons" criticized the excessive exploitation of common resources driven by the desire to maximize individual profits, a practice which eventually proves detrimental to all.

[104] See "Pathologies of Epistemology" (presented in 1969), in *Steps to an Ecology of Mind* (Bateson [1972] 2000, 492).

[105] See "The Roots of Ecological Crisis" (presented in 1970), in *Steps to an Ecology of Mind* (Bateson [1972] 2000, 500).

Carson's *Silent Spring* spurred the passage of first significant environmental acts meant to curb industrial contamination. While activists were disturbing established equilibriums, scientists questioned nature's own propensity towards balance, and precursors of ecological economics asked whether continuous economic growth was feasible and environmentally acceptable. All three would meet with strong resistance from mainstream economists, more pragmatic ecologists, and a society dependent on consumer products. They would struggle to influence the increasingly standardized, technologically-driven, and growth-obsessed world.

CHAPTER 3 – Environmental Protection and Sustainable Development: 1970s - 1980s.

3.1. 1970s: Energy Policy and Conservation Act (1975) & California Energy Conservation Standards (1978).

The previous chapter presented an account of the decades that preceded the passage of the *National Environmental Policy Act* in 1969. The primary reason for such a detailed narrative was twofold. First of all, the aim was to identify which agendas shaped building regulations before the rise of environmentalism, and to fully grasp the extension of regulatory measures which were in place long before the introduction of first environmental standards. Secondly, the objective was to demonstrate how far apart the architecture of individual dwellings and the protection of natural environment stood while building regulations were gradually introduced to improve safety, health and welfare of American citizens, and to minimize financial risks faced by merchant builders.

This chapter continues to analyze the key events that shaped the environmental protection movement and residential regulations as the two come closer together in the energy-obsessed 1970s, and then parted again in the 1980s regardless the decade's contribution to the modern idea of sustainability. The first of the two section focuses on the regulatory hinge that connected the environment with the house through specific legally-binding measures which targeted energy in the 1970s. Two issues will hopefully become clear. Firstly, the actual reasons for the adoption of energy conservation standards, and secondly, the agendas which shaped the specific character of the adopted measures. The section will try to answer why specific regulatory measures were adopted and will attempt to clarify why specific types of solutions were treated preferentially.

Various ecological theories continued to multiply while the environmental protection movement was evolving both in the U.S., and internationally. The first Earth Day, and the Stockholm Conference on the Human Environment refocused everyone's attention on the ongoing deterioration of the natural environment, and its impact on human health. Various socio-economic reports, among them *The Limits to Growth,* rose alarm about the state of the planet. An alternative, ecological approach to

economics, as best expressed in the work of Herman Daly, also reached maturity in this period. A second wave of environmental legislation that the U.S. experienced in the 1970s was triggered in part by the above events and attitudes, and in part by the 1973 oil crisis. For the first time, federal and state regulations, and third-party, standard-setting initiatives directly focused on the relationship between residential construction and an aspect of natural environment, the provision of energy. Of particular importance in this period are the 1975 ***Energy Policy and Conservation Act***, and the first in the nation ***Energy Conservation Standards*** adopted by California in 1978. Both merchant builders and most architects responded to the new environmental, and energy-conservation imperatives by opting for active technologies available as consumer products and rejecting passive design strategies perceived as an expression of an alternative niche culture. In this pivotal moment, most architects turned away from the natural environment to concentrate on cultural heritage.

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While Bateson continued to expose epistemological errors hidden in the conventional ideas about the relationship between man and his environment, scientists were challenging ideas of stability and order, questioning 'the balance of nature' which Aldo Leopold exposed as a common yet misleading "figure of speech" more than twenty years earlier.[1] Ecologists Drury and Nisbet criticized the idea of emergent order and predetermined direction in ecological succession.[2] Robert May emphasized the co-existence of order and chaos.[3] They were all pointing out, as explained by Worster, that "nature could exist in a variety of states, some ordered, some chaotic, all connected in a continuous spectrum" (1996, 411). Although supportive of the idea of stability, Borman and Gene were also acknowledging irregularities in their exemplary Hubbard Brook studies, to eventually describe their observations as a "shifting-mosaic steady state."[4] In *A Succession of Paradigms in Ecology*, Daniel Simberloff (1980) adamantly criticized all super-organismic notions as deprived of material substance. For him it was all driven by chance.

Less concerned with understanding whether the universe was a game of dice, or result of a grand scheme, what the general public was clearly seeing was smog and polluted water. In 1970 the first Earth Day brought together millions of U.S. citizens disillusioned with the side-effects of the American Dream, and

[1] See "The Land Ethic," in *A Sand County Almanac* and Sketches Here and There (Leopold 1949, 214).

[2] See *Nature's Economy* (Worster 1996, 391), and the paper he refers to: Drury William H., and Ian C.T. Nisbet. 1973. "Succession." Journal of the Arnold Arboretum 54 (July 1973): 331-368.

[3] See *Nature's Economy* (Worster 1996, 408), and the paper he refers to: May, Robert. 1974. "Biological Populations with Nonoverlapping Generations." Science 186 (November 15, 1976): 645-647.

[4] See *Nature's Economy* (Worster 1996, 397), and the paper he refers to: Bormann, Herbert, and Gene Likens. 1979. "Catastrophic Disturbance and the Steady State in Northern Hardwood Forests." American Scientist 67(November/December 1979): 660-669.

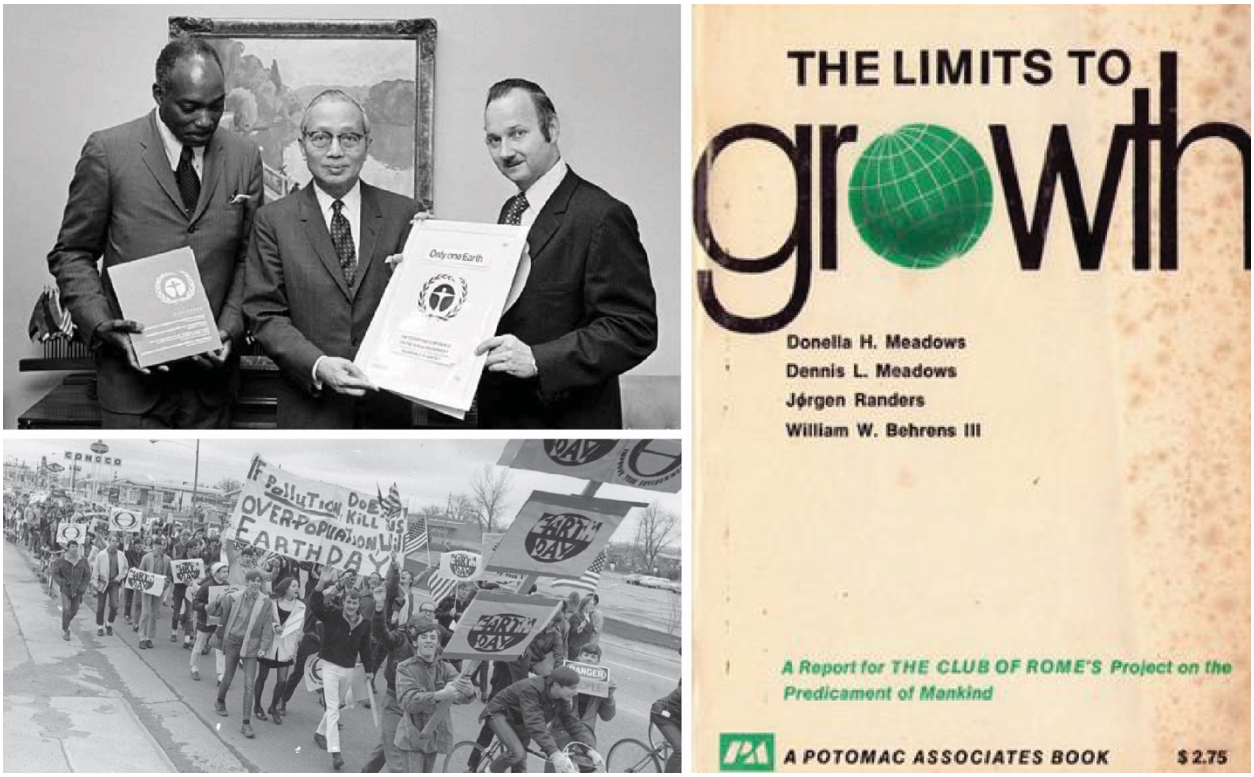

Fig.3.1 The UN Conference on the Human Environment, presentation of the conference poster "Only One Earth" (top left), the first Earth Day in Denver (bottom left), the cover of the report The Limits to Growth (right).

eager to reconnect with the cybernetic mesh of the environment. Two years later, in 1972, the first UN Conference on the Human Environment acknowledged the link between the condition of the natural environment and human well-being. Unfortunately, while the conference recognized that all nations equally depended on the health of our planet, the conversations were divided, and the ultimate focus remained on the distribution, management and conservation of resources rather than the well-being of "one Earth."[5] The principal challenge was how to improve environmental conditions without changing, as Bateson would put it, the basic rules of the game – continuous economic growth (Fig.3.1).[6] The Principle 14 of the Declaration stated: "Rational planning constitutes an essential tool for reconciling any conflict

[5] "Only one Earth" was the motto of the Stockholm conference. In his book *Sustainability: a Cultural History*, Ulrich Grober describes the interests that conflicted during the conference, and how they shaped the future notions of sustainable development (2012, 161-4).

[6] In a 1966 paper entitled "From Versailles to Cybernetics," while discussing use of game theory in international policy making, Bateson concluded: "I submit to you that what is wrong with the international field is that the rules need changing. The question is not what is the best thing to do within the rules as they are at the moment. The question is how can we get away from the rules within which we have been operating for the last ten or twenty years, (…)" ([1972] 2000, 484-5).

between the needs of development and the need to protect and improve the environment."[7]

In December of the same year, the celebrated Blue Marble photograph taken be the Apollo 17 crew pictured Lovelock's Gaia in its awe-inspiring wholeness, and… undeniable fragility. The Earth appeared both fluid and in stark isolation from a larger, and possibly infinite, thermodynamic universe. This powerful image became a symbol of the environmental movement, but rather than celebrating expanded energetic possibilities, it was used to communicate - perfectly in line with the overall spirit of those years – the idea of closeness and scarcity. This bleak vision was catastrophically laid out in a 1968 book entitled *Population Bomb* in which the biologist Paul Ehrlich was warning against the environmental effects of overpopulation, and actively promoted zero-population growth. A similar vision was simulated with computational precision by Jay Forrester when his systems dynamics method (first published in the 1971 *World Dynamics*) was applied to support the argument contained in *The Limits to Growth, the Report for the Club of Rome's Project on the Predicament of Mankind* presented in 1972. Although considered imperfect even by the authors,[8] and criticized for the initial assumptions and concluding predictions,[9] the overall warning attracted immediate attention from environmentalists, while the seductive precision of Forrester's computer model triggered fierce criticism among mainstream economists. While it did not stop the growth, the report initiated an important debate and influenced policy-making in the 1970s. It inquired into the causes and interconnected effects of "five major trends of global concern - accelerating industrialization, rapid population growth, widespread malnutrition, depletion of nonrenewable resources, and a deteriorating environment" (Meadows et al 1972, 22). It drew attention to the risks related to overpopulation and excessive economic growth and warned against the ecological and social consequences of declining resource quality and industrial pollution. The message was that "the earth is finite" (86). Although erroneous from the thermodynamic point of view, the statement recognized the fact that the rate at which most resources renew is simply too slow in comparison to the voracity with which

[7] See *Declaration of the UN Conference on the Human Environment* (United Nations Environment Program (UNEP) 1972). Accessed September 28, 2016: http://www.unep.org/documents.multilingual/default.asp?documentid=97&articleid=1503

[8] In the introduction, the authors of *The Limits to Growth* admitted: "The model we have constructed is, like every other model, imperfect, oversimplified, and unfinished." (Meadows et al 1972, 21)

[9] In his book *Tools for Thought*, C.H. Waddington discusses the limitations of Forrester's *seductive* system models used in The Limits to Growth (1977, 225-30). He warns: "The computer will turn out a result from a lousy model just as happily as from a good one, in fact it can't tell the difference" (225). He points at the importance of initial assumptions about basic components and interactions, which are based on common sense combined with historical data which is often either insufficient, excessively aggregated, or irrelevant as humanity evolves due to technological advancements. No matter how perfect the modeling engine is, the data and assumptions about future interactions and actions make the results questionable.

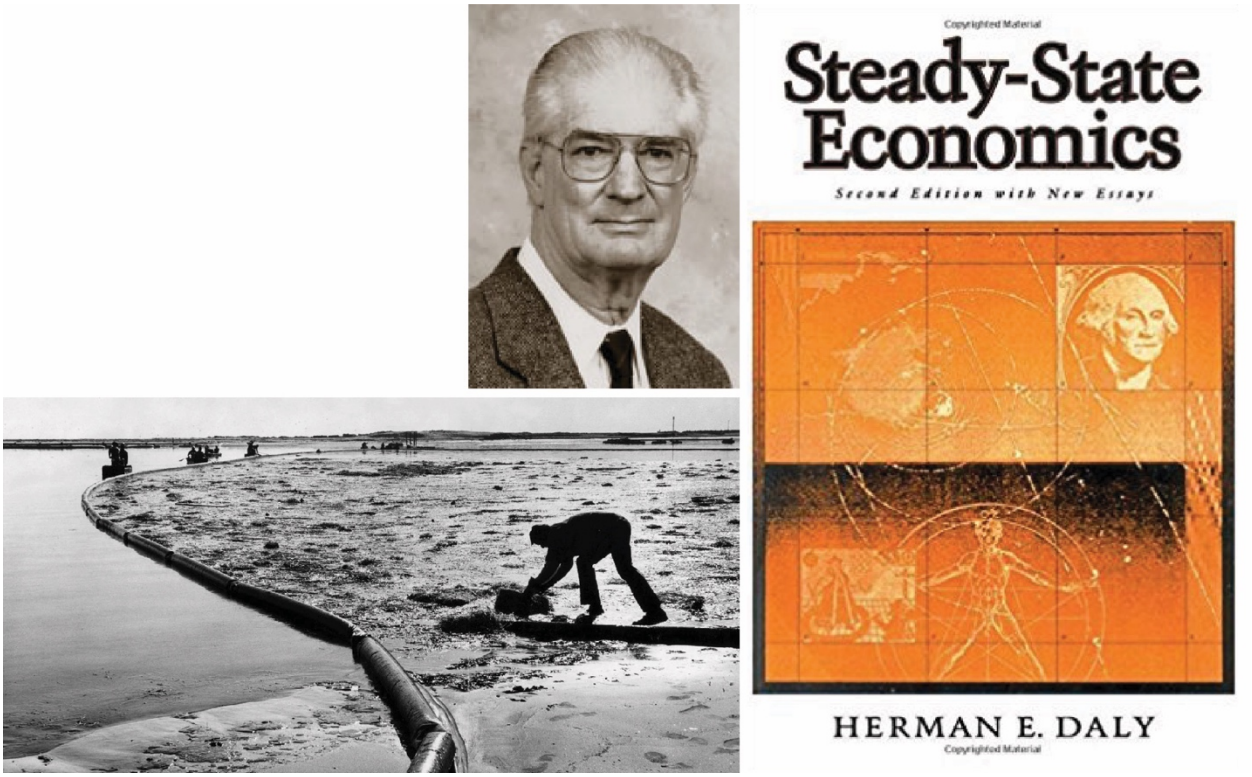

Fig.3.2 Environmental costs: Santa Barbara Spill, 1969 (bottom left), Herman Daly (top left), the cover of his book Steady-State Economics (right).

we consume them, and in relation to their spatio-temporal distribution which does not necessarily correspond to our localized needs or available extraction methods.

The natural way to address the externalities was to include them in the equations and models. In a sense, this is what the Club of Rome tested in some of the scenarios, but as Herman Daly observed in his 1977 book *Steady-State Economics*, "Internalizing externalities into relative prices deals only with relative scarcity, not at all with absolute scarcity" (Fig.3.2). Quoting this passage, Caradonna observes: "Not only did internalizing externalities fail to deal with absolute declines in nonrenewable resources, (…), but it also did nothing to prevent ecosystem destruction, pollution, and all those social costs of growth discussed above." (2014, 128). What Daly advocated for was a coordinated program that would set absolute limits for the market. ([1977] 1991, 69). Notably, only in those of the *Limits to Growth* scenarios that assumed a restricted industrial output a relative form of equilibrium was reached.[10] One possible way to more effectively internalize "external diseconomies," and this was proposed by E.F. Schumacher in his 1973

[10] See *Limits Revisited, a Review of the Limits to Growth Debate* (Jackson and Webster 2016, 6).

book *Small is Beautiful*, was to reduce reliance on large, centralized economies and technologies managed by companies with little incentive to care for the land and resources that they managed far from their headquarters. He believed, and it was embraced by the Appropriate Technology movement,[11] that smaller-scale, decentralized systems would make people feel more empowered and at the same time more responsible as the land they exploited was the land they also inhabited. For Schumacher, however, modern economics needed to rethink fundamental values, not simply its modus operandi: "Just as a modern European economist would not consider it a great economic achievement if all European art treasures were sold to America at attractive prices, so the Buddhist economist would insist that a population basing its economic life on non-renewable fuels is living parasitically, on capital instead of income" (1973, 41).

Clearly, while the fundamental message delivered by the Club of Rome was shared by many economists and ecologists, they often disagreed on the ontological plane, or adopted different epistemological lenses. In a 1976 book *Social Limits to Growth*, Fred Hirsch was warning that the biophysical limits emphasized by the Club of Rome may be less impending than the social ones. To paraphrase Bateson, our eco-mental system may well go insane first. Ezra J. Mishan also criticized the ethos of economic growth on a similar plane, saying that it disregarded not only the natural environment, but also human well-being and happiness, factors which, to use his words "possibly not measurable but certainly meaningful – do not lend themselves easily to the number system."[12] He questioned "the cult of efficiency" which, in the spirit of scientific management and post-war technocracy, continued to disregard socio-cultural values, and, myopically focused on short-term profits. The same was criticized by Daly who called for a more ethically-driven economics and condemned the modern obsession with equations.[13] He criticized the ubiquitous use of indexes of growth such as GDP, pointing out that they did not reflect the distribution of wealth, or the ecological effects of its acquisition. Daly pointed this paradox out in *Steady-State Economics*: "We devote more effort and resources to mining poorer mineral deposits and to cleaning up increased pollution, and we then count many of these extra expenses as an increase in GNP and congratulate

[11] The successes and failures of the Appropriate Technology movement are discussed again in Chapter 5.1. See notes 9 to 14 and accompanying text.

[12] See *The Cost of Economic Growth* (Mishan 1967, xix).

[13] In *Steady-State Economics*, Daly writes: "Layer upon layer of abstruse mathematical models were erected higher and higher above the shallow concrete foundation of fact. The behavior of a peasant selling a cow was analyzed in terms of the calculus of variations and Lagrangian multipliers. From the angelic perspective of hyperplanes cavorting in n-space, economist overlooked some critical biophysical and moral facts" ([1977] 1991, 3).

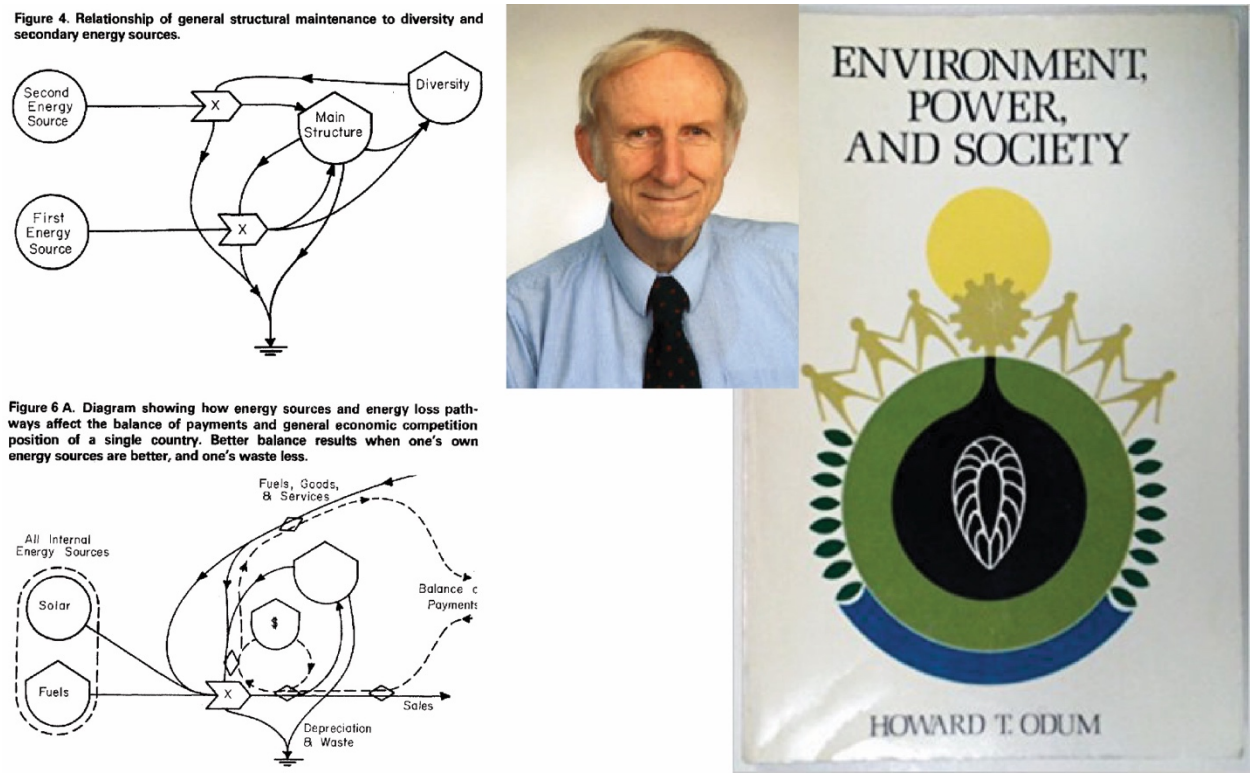

Fig.3.3 Diagrams from Odum's paper "Energy, Ecology, and Economics" (left), Howard T. Odum (middle), the cover of his book Environment, Power, and Society (right).

ourselves on the extra growth!" ([1977] 1991, 9). As observed by Caradonna, "This ubiquitous metric, ecological economists noted, is so ethically impoverished that it perversely counts environmental disasters as a good thing, since environmental cleanups are profitable for certain businesses."[14]

Particularly significant in the era of oil shocks was the emphasis that H.T. Odum put on the energetic basis of economy (and politics) (Fig.3.3). In 1971, he postulated: "To understand a whole system and the full interaction of the parts, we must use a common denominator that expresses all the flows and processes together. Power is a common denominator to all processes and materials."[15] Lack of an overarching energetic model is what H.T. Odum criticized in Jay Forrester's symbolic language used to diagrammatically

[14] Caradonna points out that the 1989 Exxon Valdez oil spill boosted the US GDP by at least $2 billion. See *Sustainability* (2014, 130).

[15] See *Environment, Power, and Society* (Odum 1971, 21).

represent the relationships embedded in the digital models developed for *The Limits to Growth*.[16] In a 1973 paper "Energy, Ecology, and Economics" Odum summarized 20 general energetic principles (in part following Lotka's work from the 1920s) to explain why he believed that our culture needed to gradually convert from growth to a steady-state. He drew attention to the fundamental difference between gross and net available energy, which made many predictions regarding available reserves overly optimistic. He also pointed at the importance of the scales of energy - the fact that potential work depended both on quantity and quality of available energy. For this reason, he doubted whether the diluted, low-quality solar energy could ever do significant work without being 'subsidized' by high-quality energy obtained from highly-concentrated fossil fuels (1973, 224). While Odum somewhat doubted that the future of our economy could depend on solar energy, Amory Lovins (who later founded the Rocky Mountains Institute) was optimistic that the new technologies would advance fast enough for solar energy to become a viable alternative. In his 1977 book *Soft Energy Paths* he criticized "hard" energy sources such as nuclear power and fossil fuels and argued for a "soft" option based on renewable energy sources. He believed that they would not only be more environmentally friendly but also more democratic as they would rely on smaller-scale technologies, and decentralized management systems. This position not only followed in on Schumacher's critique of large, centrally-controlled systems in which responsibility was hard to locate, but also reflected the general spirit of survivalism that characterized the era of oil crises and nuclear arms race and pushed many communities and individuals to search for energetic self-sufficiency.

The overall verdict pronounced by all these voices was that the assumptions underlying our economy should be reconsidered, and the 'motherboard earth' needed to be urgently 're-circuited.' And, while the basic trend to promote economic growth continued relatively undisturbed - the early ecological economists did not manage to change the basic assumptions, the 1970s were a time of important environmental re-circuiting (Fig.3.4). It was in the atmosphere of a peculiar mix of scientific questioning, passionate activism, sense of catastrophic urgency, and bio-economic management, that the U.S citizens witnessed the creation of the first comprehensive federal environmental protection framework. Among many legislative victories, one should mention the 1970 *Clean Air Act*, the 1972 *Clean Water Act*, 1973 *Endangered Species Act*, and the 1974 *Safe Drinking Water Act*. Although it may sound inappropriate to

[16] In *Ecological and General Systems*, first published in 1983 as *Systems Ecology*, Odum observes referring to Forrester's method: "No recognition is given to pathways of materials and information as being embodied energy. Fuels and lower quality energies are represented as separate flows such as any commodity without any effort to account for energy in the sense of the first law. *There are no heat sinks.* [Odum's emphasis] The external sources are drawn as infinite pools whose limitations are indicated by pathway coefficient multipliers rather than as contributing inherent characteristics" (1994, 86).

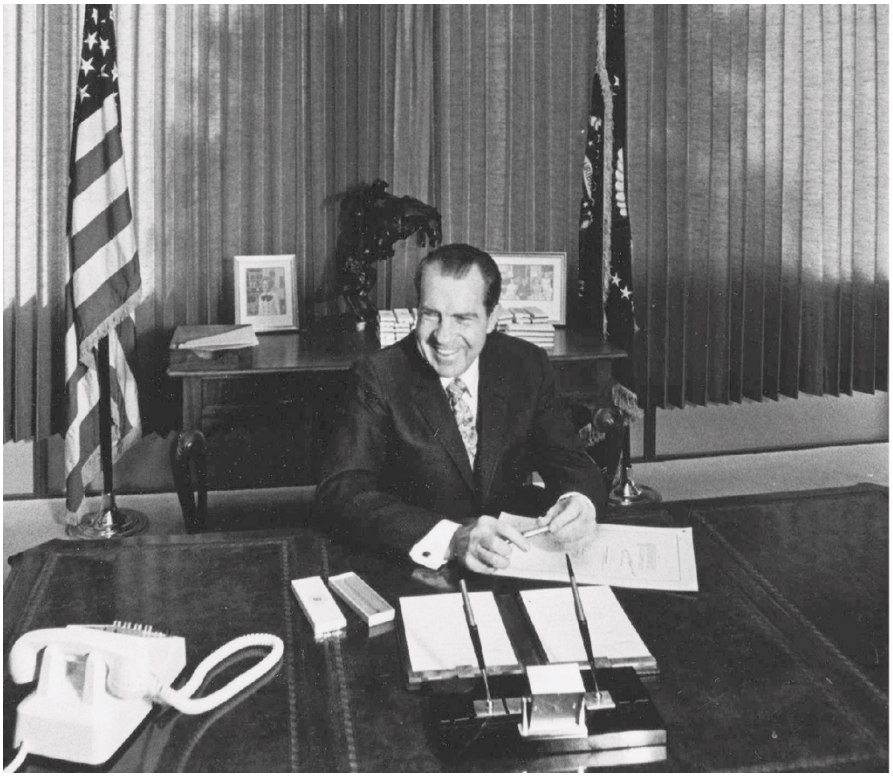

Fig.3.4 President Nixon signing the National Environmental Policy Act of 1969 (left), the emblem of the Environmental Protection Agency created in 1970 (right).

question what was achieved in the 1970s as it clearly slowed down environmental degradation by curbing harmful industrial practices, it is worth pointing out that the precision of command-and-control that the government aspired to (and was expected to provide in order to justify the restrictions imposed on private entities), inevitably reduced a complex reality to a series of segregated (and inevitably quantifiable) issues. Not only a qualitative approach was not part of the current epistemology, but also an all-inclusive quantitative approach proved unattainable even for such a comprehensive agency as NEPA.[17] As Caradonna observes, aggregation of interconnected issues is something that would characterize the sustainability of the 1980s and 1990s but was absent in the early period of environmental policy-making (2014, 111).

As federal acts gradually targeted a problem at a time, in the mid-1970s one issue emerged as a concrete

[17] In *The Death and Life of Great American Cities*, Jane Jacobs observed: "Even more discouraging (…) is the sense one soon gets of problems which are out of the control of everyone. Their ramifications are too complex; too many different kinds of trouble, need and services are interlocked in a given place – too many to be understood, let alone helped or handled when they are attacked, one-sidedly and remotely, by the sprawling municipal government's separate administrative empires, each by each" ([1961] 1992, 406-7). Inevitably, a similar, if not greater, problem affected the environmental cause at a federal level.

cause for an impending (economic) catastrophe, and hence became the central concern for policy-making. It was the lack of cheap energy that could sustain economic growth expected to continue uninterrupted - a preoccupation and an attitude which persist 40 years later. Policy-makers followed Odum's call to concentrate on energetics, but ironically did not avoid following old mistakes. Mindless of the Jevons paradox,[18] the initial call for conservation of energy quickly transformed into a quest for efficiency. It disregarded warnings from Herman Daly who echoed Jevons and, as pointed out by Caradonna, "argued that efficiency is a false panacea for overconsumption since it ends up backfiring and driving resource depletion."[19] It also ignored the following observation made by H.T. Odum: "Most of our century of progress with increasing efficiencies of engines has really been spent developing mechanisms to subsidize a process with a second energy source. Many calculations of efficiency omit these energy inputs."[20]

The acts that addressed conservation of energy were the first environmental legislations which had a direct impact on buildings. With few exceptions (e.g. the 1971 *Lead-Based Paint Restrictions Act* which addressed use of toxic substances in households), conservation of energy was the only environmental issue that the early environmental legislation addressed in case of individual dwellings. One could even risk saying that the reasons were economically rather than ecologically-driven. A year after the 1973 oil crisis, first federal acts were passed to encourage research programs for the development of solar energy systems and their application in residential dwellings.[21] In 1977, the federal administration announced the *National Energy Plan*, and established the Department of Energy, providing a consolidated framework for a comprehensive national energy plan implementation. Thanks to these plans and programs, research centers such as the National Renewable Energy Laboratory (NREL) were established to develop and assess renewable energy and energy efficiency technologies and practices. Demonstration projects such as *Brookhaven House* continue 40 years later under such names as *Solar Decathlon*, *Race to Zero*, or *Zero*

[18] In an 1865 book *The Coal Question*, the British economist William Jevons observed that technological progress which increased efficiency of engines (in terms of energy use) triggered increase in the rate of consumption of the same type of energy because of increasing demand due to improvement in efficiency. See *Sustainability* (Caradonna 2014, 76).

[19] See *Sustainability* (Caradonna 2014, 76). In *Steady-State Economy* Daly explains the hidden dimensions of efficiency and gives an example: "the durability of a fiberglass boat is greater than that of a wooden boat (higher artifact maintenance efficiency), but fiberglass is made from nonrenewable resources (lower ecosystem maintenance efficiency)" ([1977] 1991, 79).

[20] See "Energy, Ecology, and Economics" (Odum 1973, 223). Herman Daly makes a similar argument: "For each calorie of food produced in the United States in 1970, about seven calories of nonfood fuels were consumed by agriculture and related activities" ([1977] 1991, 10).

[21] See the 1974 *Solar Heating and Cooling Demonstration Act* (Public Law 93-409), and the 1974 Solar Energy Research, Development, and Demonstration Act (Public Law 93-473).

Energy Ready Home.[22] In 1975, the *Energy Policy and Conservation Act* (EPCA) was enacted by the federal government establishing a program which defined test procedures, labeling, energy targets for consumer products, and efficiency standards for major household appliances. The act also required all states to adopt energy standards for new buildings. This request was met a year earlier by the state of California which created the first legislative framework for building energy conservation at the state level, requesting that its Energy Commission adopts, implements, and periodically updates energy efficiency standards for both residential and nonresidential buildings.[23]

In the same period, the National Conference of States on Building Codes and Standards (NCSBCS) established in the 1960s to improve uniformity of building codes in the U.S., commissioned the National Bureau of Standards (NBS) to develop guidelines for energy conservation in buildings. It was the first time that the building code-makers addressed an issue which was not directly related to life safety or welfare. It was therefore even more expected this time that the code-makers would outsource the work to yet another non-governmental agency with a long pedigree of standards-setting expertise in… the field of mechanical systems and engineering. The resulting document produced by NBS and entitled *NBSIR 74-452 Design and Evaluation Criteria for Energy Conservation in New Buildings*, provided the basis for the *ASHRAE Standard 90 Energy Conservation in New Building Design*, released in 1975. In 1977, the first *Model Code for Energy Conservation (MCEC)* which referred to *ASHRAE Standard 90-75* was published by the Council of American Building Officials (CABO), and California published its own *Energy Conservation Standards for New Residential and New Nonresidential Buildings* (now *Building Energy Efficiency Standards* Title 24, Part 6). Although the California code did not reference the *Energy Conservation Standard 90,* it did refer to other ASHRAE norms, including the recently revised *Standard 55-74 Thermal Environmental Conditions for Human Occupancy*. Eventually, in 1978 the *National Energy Conservation Policy Act* imposed the inclusion of new energy efficiency in the *FHA Minimum Property Standards*, although as mentioned in the previous chapter, *MPS* did contain basic energy conservation requirements meant to reduce maintenance costs already in 1950s.[24]

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[22] *Brookhaven House* was a collaborative project which involved private and public actors: DOE-funded, the project was designed by Total Environmental Action architects, and built, monitored, and tested on the premises of the Brookhaven National Laboratory. For a critical assessment of Brookhaven House and other demonstration projects promoted by DOE in the 1970s, see the doctoral dissertation "The Ecology of a Healthy Home: Energy, Health, and Housing in America, 1960-1985" (Wolfson 2012). See DOE website for current initiatives: https://energy.gov/eere/efficiency/homes

[23] See *California Public Resources Code*, Sections 25402 and 25402.1.

[24] See note 81, in Chapter 2.

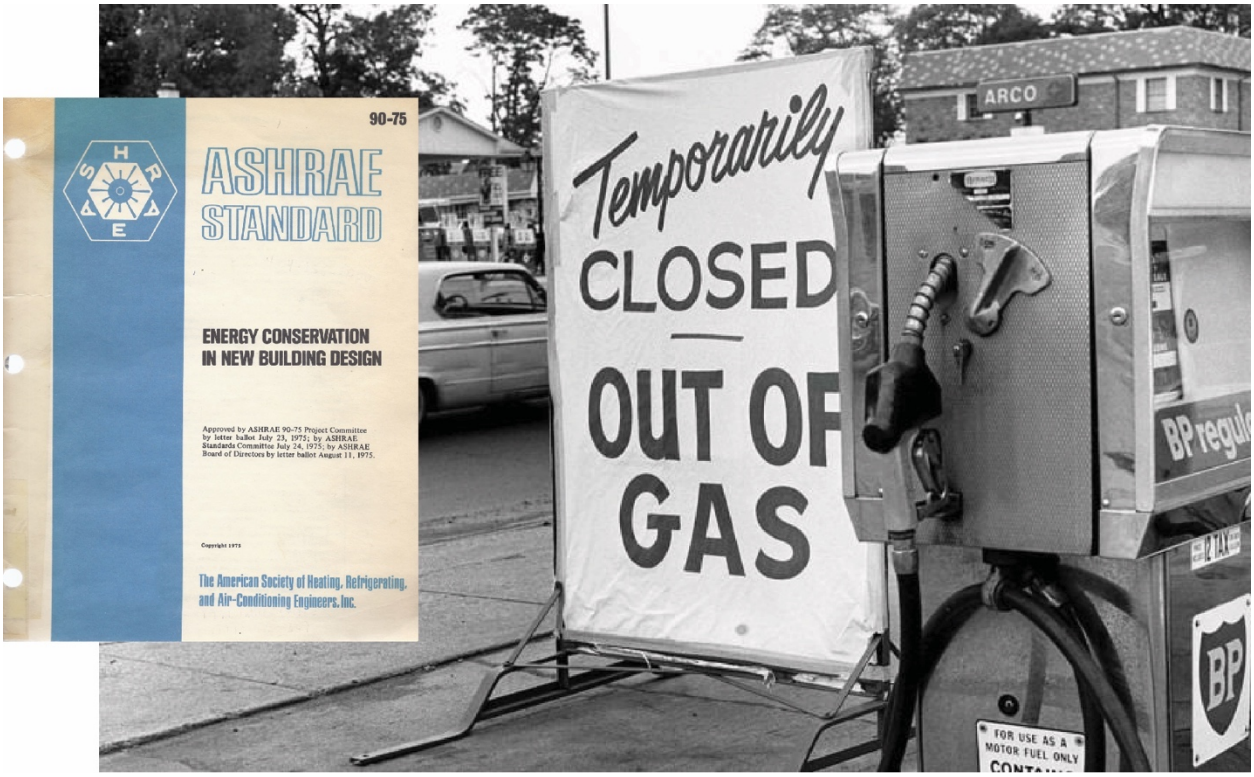

Fig.3.5 ASHRAE Standard 90-75 (left), effects of the 1973 oil embargo (right).

To stimulate adoption of residential and industrial energy-efficiency measures, tax incentives started to be introduced in the late 1970s. The 1976 *Energy Conservation and Production Act* (ECPA) included loan guarantees for energy conservation in public and commercial buildings, and a weatherization program for low-income homes.[25] The *Energy Tax Act* of 1978 contained a tax credit for residential conservation and renewable energy investments, and it supported such measures as weather stripping and insulation.[26] Increasingly standardized regulations (*CABO One and Two Family Dwelling Code* was introduced in 1971 to unify residential construction standards across the country[27]), coupled with first energy codes and economic incentives, seemed a perfect solution to the UN Principle 14 dilemma, as to how to reconcile

[25] See the *Energy Policy and Conservation Act* (Public Law 94-163), and *Energy Conservation and Production Act* (Public Law 94-385).

[26] See the *Energy Tax Act* (Public Law 95–618), part of the 1978 *National Energy Act*. Another NEA act, the *National Energy Conservation Policy Act* (Public Law 95–619) established the Residential Conservation Service program designed to improve energy efficiency of the residential sector. See *The History of Energy Productivity* (Alliance Commission on National Energy Efficiency Policy 2013, 7).

[27] This code combined model building code requirements applied specifically to housing, and as a joint effort of four model code-makers: BOCA, ICBO, SBCCI, and the American Insurance Association.

endless economic growth with environmental protection. The effectiveness of this approach remained unverified at this initial stage, only 6% of U.S. households participated in the Residential Conservation Service program during the following decade,[28] as the Reagan administration opposed these measures, and discontinued most of the energy conservation programs in the go-go '80s.

The housing industry experienced a boom in the first years of the 1970s and continued to thrive after a long-due, and clearly exasperated by the oil crisis, recession registered in 1974. According to the HUD, 26 million dwelling units were required in the 1970s to cater for the new generation coming of age.[29] Although the industry did face new challenges brought by the environmental movement and the energy crisis, the demand was so high that the builders successfully adapted to the new conditions, and Americans absorbed the higher costs by working longer hours and sending women into waged work.[30] As Ned Eichler explained, "Under the banner of words such as conservation, ecology, and environmental protection, local, state, and even the national government were asked to enact new laws to limit growth" (1982, 180). In 1971, a first moratorium on development was imposed by the small town of Petaluma in Northern California, concerned with its capacity to provide adequate municipal services to new residents without compromising the quality of the environment.[31] Municipal standards were also changing, forcing developers to provide (and finance) more community services and build less dwelling units. Zoning restrictions, together with more and more stringent and complicated building regulations increased the cost of housing products. Regardless these changes, from its recovery in 1975, the industry continued to generate high profits till the end of the decade due to favorable monetary policies, cheap credit, and simply due to increasing demand for both basic housing units and material for real-estate speculation. Paradoxically, while local governments were limiting growth through various zoning provisions, the federal government was traditionally encouraging construction (read: economic growth) through specific financial mechanisms such as provision of easily available mortgage loans (Eichler 1982, 233). It is noteworthy that mortgage securitization which, as Immergluck explains, led to the widespread "vertical disintegration" of the lending process, and was one of the causes of the recent subprime mortgage crisis, was introduced by

[28] See note 26 above.

[29] See *The Merchant Builders* (Eichler 1982, 166).

[30] AS explained by Robert B. Reich in the documentary entitled *Inequality for All* (Kornbluth et al, 2013).

[31] Eichler also remarks that environmental motivations were sometimes abused by those who wanted "to be the last beneficiaries of the good life, and to raise their property values (…)" (1982, 182). An example of this phenomenon is also given by Mike Davis in *City of Quartz* where he explains how Los Angeles homeowners associations used environmental protection laws to their advantage: "The 'greening' of the Santa Monicas, (…), was widely seen as a hypocritical attempt by the rich to use ecology to detour Vietnam-era growth around their luxury enclaves." (1990, 173).

the federal government, and not as many believe by the private sector.[32]

Although burdened by the new energy codes which imposed use of expensive technologies, the merchant builders were even less convinced by the alternative methods proposed by architects and researchers fascinated with the solar. A possible alternative to the technologically-oriented approach promoted by governing bodies and code-makers was proposed by, among others, Ralph Knowles, who in 1974 published the results of a decade of studies in his book *Energy and Form (*Fig.3.6*)*. In the very introduction, he stated: "A new attitude is required that will make long-term conservation of our natural resources a governing purpose for design" (1974, 1). Following in d'Arcy Thompson's steps, but decades before the 'parametric turn,' he and his students demonstrated how non-renewable energy could be conserved (and renewable energy exploited) through a strategic manipulation of morphological (rather than technological) features of the built environment. In the same book, Knowles said: "(…) the low diversity of the [spatial] arrangement does not reflect the variety of environmental conditions that result from the cyclic forces of nature" (1974, 1). The 1970s saw a wave of interest in active solar technologies and passive techniques. Both institutes and independent architects contributed to this trend. Upon the invitation from the HUD, in 1976 the AIA Research Corporation published the *Solar Dwelling Design Concepts* to support designers and homeowners interested in the potential domestic applications of solar energy. In 1977, the Colorado-based Richard Crowther published *Sun Earth: How to use Solar and Climatic Energies*. The Santa Fe *Balcomb House* by William Lumpkins was built in 1979. However, as more and more demonstration projects were successfully built, and the performative effects were better understood, researchers started to point out that solar technics and technologies applied to low-density, single-family homes provided little saving in energy consumption and hardly affected the overall environmental impact. They provided autonomy and affordability, but to address environmental impact of inefficient land use, denser solar communities needed to be built.

Merchant builders, city planners, and traditionally-oriented customers did little to support these independent efforts. If few passive solar homes were actually constructed, and many were red-tagged for

[32] In *Foreclosed*, Dan Immergluck explains that "it was the Government National Mortgage Association (Ginnie Mae), the federal agency that facilitates the purchase of FHA loans, that issued the first residential mortgage-backed securities (RMBS) in 1970, guaranteeing interest and principal payments on pools of FHA- and Veteran Administration-insured mortgages" (2009, 35).

Fig.3.6 Balcomb House by William Lumpkins, 1979 (left), the cover of Knowles's book Energy and Form (middle top), Ralph Knowles and his sun machine (left).

violation of building codes,[33] even fewer solar communities were built.[34] Unfortunately, a decades-long process of optimization of construction protocols and increasing mechanization of environmental services in buildings made it easier to focus on the efficiency of appliances rather than on spatial arrangements. As any merchant builder (or mortgage underwriter) would say, formal (or morphological) diversity is squandered energy. Introduction of efficient appliances, on the other hand, will boost the economy. In 1980 the first house powered by photovoltaics was built in Carlisle, MA. While the Department of Energy would continue its 'race to zero,' projects such as Steven Baer's 1972 *Zome House,* or the *Integral Urban House* experiment were to become examples of a *potential future of the recent past* - oddities conceived

[33] In her doctoral dissertation "The Ecology of a Healthy Home: Energy, Health, and Housing in America, 1960-1985," Wolfson discusses the story of the Mendocino County owner-built houses, and the struggle of the owners to defend their right to healthy and affordable housing despite the violation of building codes (2013).

[34] For an account of the early active and passive solar systems, see *The Greening of Architecture* (Tabb and Deviren 2013, 52-68).

by the alternative desert culture of the Southwest, and the progressive community of Berkeley.[35] Similarly, Olgyay's bioclimatic principles, Givoni's psychrometric chart,[36] and Knowles's solar envelope method were rarely applied in mainstream projects, further distancing the architecture of American dwellings from a holistic approach to ecology. As Dolores Hayden argued, adding efficient gadgets to a Victorian house not only boosted the economy but it also helped maintain the old dream house and the model family structure untouched.[37] And, while Hayden notes that the Farallones Institute urban homesteading experiment "did not stress rethinking family life so much as the introduction of urban agriculture and ecosystem analysis" (2002, 67), Rayner Banham, on the other hand, worried that the heavy physical activity involved in the daily operations of a 'passive' house like *Zome'* would fall to the women (1984, 288). The question turned out to be even more complicated: as prices swell, women went to work to help maintain the family structure, and the efficient functioning of the American dream homes fell back to technology.

Disillusioned with the positivism of the modernist era, critical of the reductive obsession with energy performance, and in general cynical about architecture's role as a problem-solving discipline; most architects questioned the modernist imperative that derived form from function. They withdrew into a world of semiotics and linguistics, searching for the *sense of place* in cultural (and natural) heritage. While in 1964 Christopher Alexander proposed a cybernetic method as to how to deal with complexity in design, by 1977 he was calling for return to archetypal patterns.[38] Although symptomatic of a general shift in the field, his work was far from representative of it. It remained ignored by the post-modern architectural establishment, as it promoted use of archetypal patterns to solve problems that occur in human environment, as opposed to questioning their relevance all together.[39] Alexander, on the other hand, criticized the *mannerist* attitude with which post-modern architects used architectural history and cultural

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[35] In the mid- 1970s the Farallones Institute of Berkeley, California, converted a Victorian mansion into an urban homestead. It promoted self-reliance through urban gardening, meat raising, aquaculture, waste management, and passive solar heating. See *Integral Urban House: Self-Reliant Living in the City* (Farallones Institute 1982). For a short account, see an article by Julie Reynolds, entitled "Urban Homesteading: The Integral Urban House" published in Mother Earth News, November/December 1976. Accessed January 16, 2017. http://www.motherearthnews.com/homesteading-and-livestock/urban-homesteading-zmaz76ndztak

[36] Givoni expanded the *Comfort Diagram* by indicating zones of comfort that could be achieved by adopting various passive strategies, such as natural ventilation, or thermal inertia.

[37] See "Awakening from the Dream," in *Redesigning the American Dream* ([1984] 2002, 67).

[38] See respectively: *Notes on the Synthesis of Form* (Alexander, 1964), and *A Pattern Language* (1977).

[39] While criticized by academia, Alexander's *Pattern Language* had a strong influence on New Urbanists. Highly successful developments such as Seaside, Florida (the setting for *The Truman Show*) and other trademarked historicizing communities were built (and generated profit) in the 1980s in attempt to 'replicate' what worked in the past.

heritage.[40] While deconstructing socio-cultural norms embedded in form, post-modern architects further deconstructed our relationship with the environment. And so, the pure white volumes of Meier's *Douglas House* (1973) celebrated nature by standing (classically) in stark contrast to it, Eisenman's *House VI* (1975) questioned the basic norms of domestic life by exploring the autonomy of universal formal principles, and the *Gehry Residence* (1978) deconstructed the ubiquitous stick frame, deriding the very bones of the familiar body of the American suburbs. While questioning the modernist orthodoxy, most architects returned to what they know best – cultural production of meaning. Once again, they left ecological dilemmas, and climate management in the hands of researchers, engineers, standard-setters, and code-makers. Ironically, their disregard for the environmental cause coincided with a change in the political climate – during the next decade environmental regulations in the U.S. experienced a backlash, developers were encouraged to speculate, and architects were given a carte blanche to play.

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While ecologists continued to debate whether nature was driven by stability and order, or chaos and chance, the negative environmental impact of economic growth persisted in the 1970s. United in Stockholm, the international community acknowledged the threats posed by uncontrolled development, yet it again focused on resource security rather than the health of the planet. The landing on the moon, and the images of the earth taken from space inspired fear next to awe as the planet appeared isolated and finite. More and more voices were warning that it was also getting full, the 1972 report *The Limits to Growth* depicted a bleak future of overpopulation and scarcity. Some economists, among them Daly, Schumacher and Mishan warned against the effects of unrestraint growth, and disregard for externalities. They criticized the excessive concentration on efficiency and numerical indices as indicators of economic health and social happiness. Yet, their voices were to be systematically ignored. Due to its importance for prosperity, Odum's focus on energetic basis for economy received more attention, but his conclusions were largely ignored. Renewable energy sources started to be exploited, and, among others, Lovins criticized reliance on hard sources, and promoted the autonomy offered by the solar. Yet, increased efficiency of appliances, and new sources of energy acted as an invitation to further growth rather than a way towards a steady-state economy.

Although subtler (or inconvenient) recommendations were ignored, the fear of imminent catastrophe triggered another wave of environmental legislation. Quality of air and water improved but in the process the environment was gradually reduced to discrete subject matters, each managed separately. One issue, fundamental to national security and prosperity – energy – received particular attention. Energy conservation was the subject of first environmental acts which specifically targeted single-family dwellings. The 1973 oil embargo triggered immediate action meant to reduce residential energy consumption to avoid mortgage defaults and reduce the overall demand for energy. In 1975 the *Energy Policy and Conservation Act* imposed first efficiency and conservation standards, and in 1978 California had the first in the nation *Energy Conservation Standards* added to

[40] This is how Alexander referred to the work developed by Postmodernists and Structuralists in the famous 1982 debate between Alexander and Eisenman. Accessed September 24, 2016: http://www.katarxis3.com/Alexander_Eisenman_Debate.htm

the existing set of codes. In the meantime, first economic incentives were introduced to stimulate use of energy-efficient appliances. The first residential energy-conservation measures were clearly inspired by the oil crisis rather than environmental concerns. Need for energy conservation was replaced by an economically-profitable quest for energetic efficiency.

Due to a recession aggravated by the oil crisis, the housing industry experienced a momentary slow-down but recovered again in the mid-1970s. Despite the burden of the energy-conservation standards and federal environmental regulations, it boomed due to high demand, and support from other, pro-growth, parts of the federal government. Yet, although financially challenged by the new energy-conservation requirements, builders opted for technological solutions offered by the market, rejecting alternative spatial strategies. The solar movement flourished in the 1970s, but it remained a niche while more convenient environmental-management technologies (both focused on energy efficiency and renewable energy generation) supported by manufacturers and federal programs, and embraced by customers, steadily expanded. Disillusioned with most modernist discourses, architects abandoned problem-solving and concentrated on the production of meaning. In this pivotal moment, architectural establishment focused on cultural heritage, leaving the environment to mechanical engineers.

3.2. 1980s: The Brundtland Report (1987).

The second section of this chapter concentrates on the 1980s, a decade in which the international community intensified the efforts to protect the environment under the banner of sustainable development. It was during the same decade that American homeowners joined developers to engage in an increasingly deregulated real-estate speculation, while most architects continued to focus on cultural heritage rather than natural environment.

The aim in this section is to explain the events and motivations that shaped architecture, economy, and environmental action immediately before sustainability gained momentum in the 1990s. The objective is to highlight the many conflicting interests that characterized the 1980s. Firstly, to demonstrate the disconnection between the agendas that drove architecture and residential construction, and those that shaped the environmental movement, a disconnection evident in an almost complete lack of environmentally-driven building regulations. Secondly, to make evident the growing gap between the international environmental protection efforts and the expanding global markets.

In the 1980s, architects freely experimented with the past, and when they engaged with natural environment they often treated it as cultural heritage. Historical and vernacular references appealed to the middle-classes, and the tendency was exploited by the first TV home improvement shows which capitalized on the American dream to own a historic, or at least an old cottage. The shows mixed the old with the new, promoting traditional joinery next to the latest (often environmental) technologies generously underwritten by manufacturers. As house values increased, DIY home improvers turned into real-estate speculators. Environmentally-oriented research laboratories also adopted a market-driven approach, the Rocky Mountains Institute emerged as a powerhouse in environmental strategies and technologies. Model energy conservation standards continued to be improved, although the Reagan administration suspended the federal programs launched in the 1970s. Among few advancements, indoor air quality and urban storm water became better understood and regulated. Toxic and nuclear waste were also addressed by federal acts, yet the tendency was to manage rather than prevent. New developments in ecology exposed the instable nature of environmental processes, preparing ground for the first international action focused on climate change, an agenda which due to its immediate threat to humans would eventually monopolize the environmental discourse. Market-driven environmental

decision-making became evident as various international committees worked towards a definition of sustainable development. The *World Conservation Strategy*, Brandt's *North-South*, and eventually the 1987 ***Brundtland Report***, also known as *Our Common Future,* all struggled to reconcile sustainability and development. In the meantime, the planet experienced a decade of spectacular environmental disasters of human making.

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Although the 1988 MOMA exhibition Deconstructivist Architecture curated by Philip Johnson and Mark Wigley celebrated a somewhat *disfigured* face of architecture, the 1980s were multifaceted. While, according to the curators, Frank Gehry's *Santa Monika Residence* (1978) epitomized the deconstructivist house, his painterly *Winton Guest House* completed a decade later (1987) brilliantly exemplifies the plurality of the decade. In general, Gehry's exploratory attitude was emblematic of the diversity with which the post-modern architects would dialogue with the cultural heritage and break from the modernist past. In *American Masterworks*, Kenneth Frampton observes the increasing heterogeneity of the American modern houses starting in the early 1980s (2008, 164). Attitude towards climate management and the environment in general were equally heterogeneous, and predominantly symbolic. In Krueck & Olson's 1980 Steel & Glass House, Frampton recognizes traces of Californian Case Study tradition next to Miesian influences. In David Rockwood's 1984 Rockwood House in Portland, he notes the combined interest in the mid-century obsession with prefabrication, and a neo-platonic minimalism in which purity of spatio-structural grids which recall Terrani come together with impeccable resolution of technological detail. When discussing the 1988 Miller House by Atelier Wylde-Oubrerie, Frampton brings attention to the coexistence of Le Corbusier's béton brut and brise soleil, with a quintessentially American stick-frame and wood siding, next to Scarpian craftsmanship, and technological 'bowelism' in the exposed tubes and ducts. A cosmic connection with the land and its natural and cultural history is celebrated in the regionalism of Antoine Predock's 1987 Fuller House in Phoenix. Ricardo Legorreta's Greenberg House built in Los Angeles in 1991 exemplifies the Mexican minimalism. Due to their interest in the vernacular building traditions and environmental techniques of the South-West, the last two projects continue (even if only symbolically) the ecological holism of the 1970s. Legorreta's use of volumes, colors, and light also announces the 1990s fascination with minimalism imbued with spirituality, and a nostalgia for a lost connection with the universe.

As in previous decades, certain decontextualized features of these diverse masterworks influenced the

Fig.3.7 This Old House team at work (left), This Old House team as depicted on the TV show poster (left).

character of the common houses built in the 1980s.[41] The post-modern fascination with cultural heritage and vernacular forms was, unsurprisingly, of particular appeal to the upper-aspiring middle-classes. This tendency temporally brought architects and nostalgic suburban dwellers closer together. If one were to identify a house included in Frampton's collection that best exemplifies the homeowners' dreams in the 1980s, it would probably be the Neoclassicist antimodernism of Graves House (1977-1993), and his fascination with complex spatial sequences, opulent upholsteries, and collector's objects. The appeal of the old, both formal and vernacular was successfully exploited by the early home improvement TV shows, most famously *This Old House*, which first aired in 1979.[42] At first, featured houses were relatively small, and owners contributed 'sweat equity' to reduce costs, with time the show focused on luxury mansions

[41] In *A Field Guide to American Houses*, Virginia Savage McAlester (2013) painstakingly analyzes the many historical styles of American domestic architecture, often pointing at how styles were 'launched' by singular masterpieces: Americans owe Craftsman houses to the brothers Greene, Prairie houses to Frank Lloyd Wright, and when it comes to the International style the European exiles are the culprits.

[42] For a brief story of the show, see "This Old House: An Oral History," a conversation with creators and participating homeowners which appeared in Boston Magazine in 2009. Accessed January 5, 2017. http://www.bostonmagazine.com/2009/01/this-old-house/

renovated by tradespeople. Noteworthy, the show has been generously underwritten by major manufacturers and distributors of construction materials and services (e.g. The Home Depot). Also, homeowners whose property was featured on the show received donations from manufacturers eager to promote their merchandise. This inevitably impacted their choice of products and construction methods. As the early 1980s recession faded, the 'do-it-yourself' gave way back to 'hire,' and 'reuse and restore' turned into 'replace.' Budgets became unpredictable as ambitions fueled by free donations increased. In a truly post-modern way, replication of period detail went hand in hand with promotion of the latest energy-efficient technologies. In line with post-modern trends, pluralism went hand in hand with contradictions: ecological benefits of 'adaptive re-use' were counterbalanced by new additions. The early episode descriptions reflect the spirit: "Our host discusses plans for a new, historically compatible five-car garage. (…) a solar energy expert recommends the best location for a solar collector." Another episode emphasizes the importance of technological upgrades: "It's time to insulate the house, remove the old furnace, and replace it with a new-energy-efficient heating system."[43]

The reasons for the initial success of this almost four-decade-old show were numerous. On one hand, the housing crisis of the late 1970s and early 1980s triggered interest in do-it-yourself and home improvements. The aging of post-war-built housing stock and the delusion with its poor quality and lack of identity further increased the popularity of *This Old House* in its early days. There was also the failure of the orthodox modern (mono) style to captivate the culturally-diverse American homeowners.[44] The historicizing decor was particularly appealing to the increasingly wealthy (but shrinking and more indebted) middle class desiring to exhibit new money as old. On the other hand, the continuous rise in house prices (often 20-30% a year) encouraged those who already owned a home to engage in micro real-estate speculation through house flipping which often involved improvements and additions. Those who did not dare or could not afford to (homeownership rate remained stagnant in the 1980s, housing became a speculative commodity), simply enjoyed watching the Joneses flip…

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[43] The descriptions relate to the following episodes of *This Old House: Season 2 Episode 7, The Newton House,* and *Season 1 Episode 4, The Dorchester House*. Accessed January 5, 2017. https://www.ovguide.com/tv_episode/this-old-house-season-2-episode-7-the-newton-house-7-243121 and https://www.ovguide.com/tv_episode/this-old-house-season-1-episode-4-the-dorchester-house-4-243105

[44] In the 2013 revised edition of her 1984 book, McAlester names a new style – "the New Traditional." Considering the list of sub-styles, it is a revival of anything but the International style. In short, the house preferred by the majority of American homeowners, and by the New Urbanists, and, as she points out, ignored by the AIA and architectural press… (725-26). McAlester is careful to distinguish the "New Traditional" from what she calls the "Millennium Mansions" an aberration which she defines as "oversized in comparison with adjacent homes or disjointed in style" (708).

As observed by Massey, "Following the oil shock of 1973, inflation raised house prices, making homeownership more challenging but also a potentially more rewarding investment. Many consumers began investing a greater proportion of their money in housing, buying larger and more expensive houses as a way of turning their homes into speculative investments" (2012, 39). This was facilitated by a gradual deregulation of the mortgage market, decreasing interest rates, and various property tax incentives created by Economic Recovery Act of 1981.[45] As explained by Immergluck, "the eventual dominance of securitization in mortgage markets by the late twentieth century is perhaps best attributed to the federal financial deregulation of the early 1980s followed by some specific industry-supported legislation later in that decade."[46] In this period the importance of FHA and VA mortgage circuit dramatically decreased as other more accessible (but also more risky) products became available. While FHA racial bias started to be openly criticized in the 1970s and 1980s,[47] its obsolescence and negative impact on affordability of housing were criticized in a 1980 report to HUD.[48] Ultimately, *the FHA Minimum Property Standards, One and Two Family Dwellings* saw the final edition in 1982, after having shaped American building regulations, practices, households, and dreams for almost 50 years.[49] In 1990, access to affordable housing, and civil rights of people with disabilities were addressed by the U.S. Congress in two landmark

[45] For a brief account of how these phenomena influenced the real-estate market in the 1980s, see "The 1980s: (Too) easy money fuels a new building boom!" a 1999 article written by Tyson Freeman for the National Real Estate Institute. Accessed January 6, 2017. http://nreionline.com/mag/real_estate_easy_money_fuels

[46] In the introduction to a detailed discussion of federal acts that deregulated the mortgage system in the 1980s, Immergluck continues: "By explicitly favoring the securitization circuit over the traditionally dominant S&L circuit, federal policymakers provided crucial help in shifting the structure of the mortgage industry from a predominantly local to a predominantly national system and from one in which most loans were made by relatively more regulated lenders (S&L) to one in which predominantly unregulated mortgage companies and a growing set of essentially unregulated mortgage brokers dominated" (2009, 41).

[47] For an account of community activism and policy making related to the phenomenon of 'red-lining,' see *Foreclosed*, "Chapter 2: Mortgage Market Disparities and the Dual Regulatory System in the Twentieth Century" (Immergluck 2009).

[48] The report was prepared by the National Association of Home Builders Research and entitled "Solutions to Permit Compatible Use of the One- and Two-Family Code and the Min Property Standards," for more details see *Part 1 of a Study of the HUD Minimum Property Standards for One- and Two- Family Dwellings and Technical Suitability of Products Programs* (National Institute of Building Sciences 2003, 7-9).

[49] The above-mentioned document specifies: "In 1983, the Congress passed Public Law 98-181, title IV, Sec. 405, permitting HUD to allow compliance with model or local building codes as a means of satisfying mortgage insurance requirements, thereby virtually eliminating the need for the one- and two-family MPS" (National Institute of Building Sciences 2003, 10).

acts, both signs of an expanding notions of ecology, into the realm of social justice.[50]

While architects and general public indulged in historicizing designs, and real estate was enjoying the first season of deregulation before the housing bubble would burst in 1989, standard-setting and research institutions continued to define how buildings should relate to the environment. Although ecologically-driven, radical groups such as the New Alchemy Institute,[51] continued to develop holistic solutions, the idealism of the 1970s was slowly giving way to the pragmatic art of the possible and… profitable. The 1970s preoccupation with energy continued to shape their agendas. The Rocky Mountain Institute (RMI) was established in 1982 by Amory Lovins. Despite a general backlash in federal attitude towards energy conservation, the institute was particularly successful. This was possibly due to a technologically, and economically-driven premise of: "unlocking market-based solutions that can be replicated and implemented now."[52] Model Energy Codes continued to be perfected thanks to third-party efforts initiated in the 1970s. The 1977 *Code for Energy Conservation in New Building Construction* was released as *Model Code for Energy Conservation (MCEC)* in 1981 and then published as the *Model Energy Code (MEC)* by the Council of American Building Officials (CABO) in 1983. No significant action towards energy conservation was taken at the federal level until 1987, when the *National Appliance Energy Conservation Act* established minimum efficiency standards for common household appliances (i.e. room air conditioners, refrigerators, and washers), by amending the 1978 *National Energy Act* which directed the DOE to

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[50] The *Cranston-Gonzalez National Affordable Housing Act* (Public Law 101-625) addressed funding of affordable housing and access to homeownership for low-income residents. The issue continues to stir debate which goes beyond funding of housing and directly address the design (and therefore cost) of the typical American residential neighborhoods and homes. In *Redesigning the American Dream*, Chapter 7 "Reconstructing Domestic Space," Dolores Hyden discusses the resistance to infills, accessory units, and other non-greenfield options. (2002, 193-224). The issue of accessory dwelling units permitted by many municipalities starting in the early 1980s, is also subject of a recent research carried out by the UCLA Luskin School of Public Affairs and the CityLAB, and entitled *Backyard Homes and Local Concerns* (Mukhija, Cuff and Serrano 2014). Retrieved January 29, 2017. http://citylab.aud.ucla.edu/files/publications/2014_BYH%20Report%20cityLAB%20UCLA.pdf

The *Americans with Disabilities Act* (Public Law 101-336), on the other hand, prohibited discrimination on the basis of mental and physical disability, and set standards which addressed both social and physical inclusion. This act had far-reaching repercussions in architecture as it imposed provisions related to physical accessibility (included in the *ADA Standards for Accessible Design*). For the text of the original act, see the ADA website. Accessed, January 29, 2017. https://www.ada.gov/archive/adastat91.htm In *Questioning Architectural Judgment*, Chapter 9 "Coding Disability," Steven Moore and Barbara Wilson discuss the socio-technical processes that led to the passage of this act (2014, 156-178). In Chapter 10 "Coding Affordable Housing" the authors also discuss the issue of accessory dwelling units on the example of the Austin-based Alley Flat initiative.

[51] The New Alchemy Institute was an organization which pioneered research into organic agriculture, aquaculture, and bioshelter design between 1969 and 1991. After 1991 the founders, John and Nancy Todd, continue the research as Green Center, and in 1981 they established another organization called Ocean Arks which concentrates on the design of natural wastewater treatment systems, among them the so-called eco-machines. See the respective websites: http://www.thegreencenter.net/ and http://www.oceanarksint.org/

[52] See the Rocky Mountain Institute website. Accessed January 15, 2017. http://www.rmi.org/Vision%20and%20Mission

establish energy efficiency standards but remained unimplemented under the Reagan Administration which did not consider it a priority.[53]

Although due to its economic urgency, energy conservation received paramount attention from standard-setters, and policy makers in the post-oil-shock years; adopted technological solutions quickly exposed unforeseen conflicts. The impact of air pollution on human health got caught in the tightly sealed and energy-efficient homes, and triggered a national discussion that dominated the first half of the decade.[54] While the controversial anti-pollution policy experiments such as the 1979 *Bubble Policy* exposed many important issues such as limitations of de-localized emission budgets, cost-effectiveness as a valid criterion, and economic incentives as an appropriate tool,[55] the small scale and clear boundaries of highly-controlled indoor environments simply made the pollution blatant – exposing both the connection between outdoor pollution and indoor air quality, and the impact of new and hardly-understood materials. A 1987 EPA report stated that indoor air pollution was one of the most important environmental risks to human health, and several important acts related to air pollution and toxic materials were gradually amended to provide technical support and funding for indoor-air-related research. In 1988, Indoor Radon Abatement Act was added to the 1976 TSCA (Schierow and Bearden 2012). However, while in itself of fundamental importance to human health, the issue of indoor air quality exposed a bigger epistemological problem. The failure of the reductionist method in face of the unpredictability and complexity of the ecological relations that the environmental health and our well-being depend on. While concerned with indoor air quality, the researchers demonstrated the need for a more comprehensive approach to environmental assessment and confirmed how hard it was to impose and maintain specific conditions even in such small and apparently closed environment as a well-tempered household, not to mention the chaotic and boundless industrial landscapes.

Another important issue addressed in the 1980s was urban storm water pollution. The *U.S. National*

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[53] See notes 25 and 26 above.

[54] In "The Ecology of a Healthy Home: Energy, Health, and Housing in America, 1960-1985," Mariel Wolfson analyzed Lawrence Berkeley Lab's program of research into indoor environmental quality in relation to residential energy-conservation research and legislation in the U.S. after the 1973 oil crisis (2012).

[55] The *Bubble Policy* allowed industries to decide how and where to reduce air pollution to comply with EPA standards. The policy was designed to reduce cleanup costs and stimulate technological innovation, but it was criticized for its excessive focus on cost-effectiveness for large industries, rather than environmental impact of specific facilities on their immediate surroundings. For a brief critical discussion, see for example the following New York Times article: "Bubble Policy: Pros and Cons" (Marcus 1983). Accessed January 3, 2017. http://www.nytimes.com/1983/06/30/business/technology-bubble-policy-pros-and-cons.html

Urban Run-off Program carried out by EPA between 1979 and 1983 recognized the importance of nonpoint source water pollution (i.e. storm water and snowmelt),[56] analyzed the type of pollutants, their concentration, distribution, and impact on receiving water quality. It also assessed various best management practices, promoting retention basins (wet basins), and suggesting need for more study of other potentially useful practices such as detention and dual-purpose basins, grass swells and wetlands. The program provided basis for the 1987 amendment to the *Clean Water Act* and authorized local authorities to develop and implement run-off management programs. The amendment made the disturbing nature of water pollution official: it came from everywhere and enveloped everything, it was 'ambient' like music, just more poisonous.

Other point source toxic industrial wastes that time made 'ambient' were addressed by the 1980 *Superfund Program* established to manage the cleanup of contaminated sites and coordinate response to future emergencies.[57] The most sinister of all was possibly the 1982 *Nuclear Waste Policy Act* meant to manage nuclear waste disposal by designating an Outside where to detain it 'safely' for at least 10,000 years. It's noteworthy that this managerial act was passed after two catastrophic events that occurred in 1979: the Three Mile nuclear meltdown, and the Church Rock nuclear waste spill - two disasters, which Charles Perrow called "normal accidents."[58] Normal because resulting from, to use the author's

[56] A Congressional Research Service report entitled *Clean Water Act - A Summary of the Law* specifies: "Prior to the 1987 amendments [Water Quality Act (Public Law 100-4)], programs in the Clean Water Act were primarily directed at point source pollution, wastes discharged from discrete and identifiable sources, such as pipes and other outfalls. In contrast, except for general planning activities, little attention had been given to nonpoint source pollution (runoff of storm water or snowmelt from agricultural lands, forests, construction sites, and urban areas), despite estimates that it represents more than 50% of the nation's remaining water pollution problems" (Copeland 2016, 3).

[57] As defined in the official description, the 1980 *Comprehensive Environmental Response, Compensation, and Liability Act*, also called the *Superfund* (Public Law 96-510) is: "An act to provide for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites." With time the impact of the program decreased due to funding issues and costs of litigation. In his book *Drosscape*, Alan Berger discusses how the program has been subject to real-estate speculation around contaminated and blighted sites: "In the past twenty years cities have become increasingly interested in reclaiming such places, returning them to productive use. This activity signals a paradigm shift for metropolitan and regional land-use-planning strategies, many of which consider sites containing environmental health risks a priority for redevelopment (rather than a liability). There are three reasons for this shift in thinking. First, the federal government has developed new programs, policies, and funding mechanisms to promote reclamation and reuse of a wide range of contaminated sites. Second, local planning agencies have discovered that redeveloping contaminated sites can generate significant tax revenue. In response, policies and funding mechanisms to subsidize this activity are developed at the local level. Third, public attitudes regarding pollution and contamination have relaxed as the result of pro-development public-relations campaigns that have been supported by local governments. These entities seek quick-fix solutions for deficiencies in affordable urban housing and property-tax revenues in order to help pay for expanding infrastructure." A map included in Berger's book shows approx. 1,600 Superfund sites among the total of 480,000 contaminated sites identified in the U.S. (2006, 65-66).

[58] See *Normal Accidents: Living with High-Risk Technologies* (Perrow 1984). (The book was published before Beck's *Risk Society* which was written immediately after the Chernobyl disaster in 1986 and published in English in 1992.)

expression, the inherent "interactive complexity" of systems, normal because triggered by local interactions between small technological or operational failures, rather than deficiencies in design or violent natural phenomena such as an earthquake. Despite significant nuclear whistleblowing, the government focused on the management of the waste product without questioning the technology itself.[59] While some scientific alarmists question whether our civilization will still exist in the next century,[60] EPA current standards address a 1-milion-year lifetime of toxic waste. Anyway, whoever is involved in the management of this human artifice, is safe. As Langdon Winner pointed out in his book *Autonomous Technology*, "The closer you are, the more innocent; the farther away you are, the more innocent. It is a magnificent arrangement in which everyone is safe except the victims." This applies both to proximity in space and time, the geological timeframe will make the concept of responsibility in this case even more "slippery" (1977, 302).

If it is hard to think about a nuclear meltdown as a *normal accident*, it is even more difficult to consider a hurricane anything else than a natural disaster even if we try to domesticate the phenomenon by giving it a human name: Allen, Alicia, Gilbert & Joan, Hugo… Yet, more and more scientists were realizing that next to fire, microbes, and predators, climatic fluctuations produce important short- and long-term disturbances which affect and periodically redefine ecosystems.[61] In a 1986 book entitled *Climatic*

[59] While California's last nuclear plant, the Diablo Canyon facility, has announced to shut down in the mid-2020s, the casks with spent fuel will remain on the Diablo Canyon site until the federal government finds a place for a repository. The casks accumulated around approx. 100 U.S. nuclear reactors concentrated in the Mid-West and on the East Coast are waiting to be permanently stored as well. The question that comes to mind is whether this temporary solution or the future permanent geological repository of toxic waste is not equally prone to suffer a normal accident at least once during the period of 10,000 or preferably 1 million years, which is according to current scientific knowledge the time of peak risk from the nuclear waste.

[60] In his book *Sustainability: A Cultural History*, Grober mentions a 2003 book *Our Final Hour* written by the British astrophysicist Martin Rees (president of the Royal Society) and observes: "He warned that the chances of our civilization surviving until the end of the century stood 50:50. Other experts warned of resource wars and of a 'long emergency'" (2012, 191).

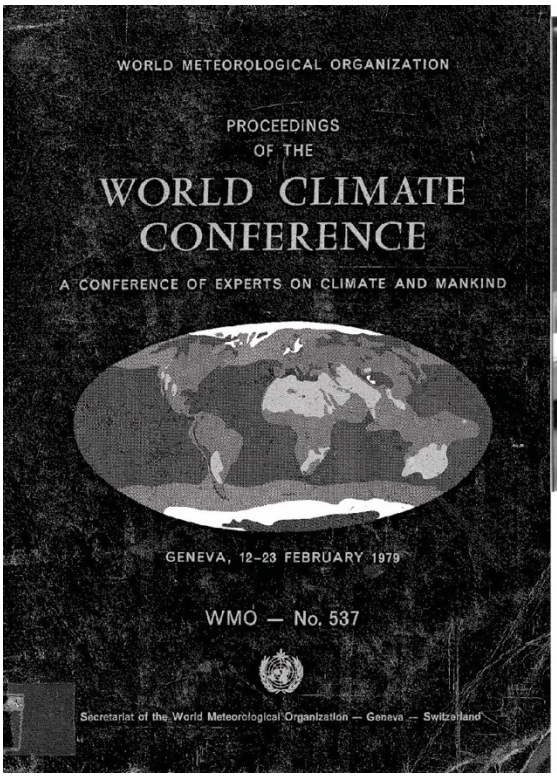
[61] In 1985 S.T. Pickett and P.S. White edited a volume entitled *The Ecology of Natural Disturbance and Patch Dynamics* in which the nature and consequences of disturbances were discussed by various ecologists. Their conclusions based on research carried out across the globe converged towards a new image of nature: a fluctuating dynamic system rather than a stable well-regulated organism (Worster 1996, 393-94). This idea was popularized in a 1990 book entitled *Discordant Harmonies*. In this book, Daniel Botkin – a biologist and environmental activist, illustrates the clash between change in nature (which as he says is "in at least some cases (…) necessary for the persistence of life" (9), and a vision of stability inscribed in most of the environmental policies, resource management, and conservation programs. He also promoted use of advanced technologies for tracking and simulation of dynamic ecological systems to improve our understanding and capacity to respond to these natural instabilities (119). (The JABOWA model of forest growth, co-developed by Botkin, was the first successful application of digital simulation to a complex natural ecosystem.) In his book Botkin advocated for flexible regulatory and management frameworks which respect randomness and variability of environmental phenomena by setting standards in terms of "acceptable ranges," rather than precise quantities (190). Botkin observes: "that nature moves and changes and involves risks and uncertainties and that our judgment of our own actions must be made against this moving image" (190). The uncomfortable conclusion is that while change is inherent in nature, we also alter it through our actions. As we alter nature, we must learn to tell which change is acceptable and which is not.

Instability, Time Lags, and Community Disequilibrium Margaret Davis, an expert in palynology (the study of fossil pollen), contributed her geological-time perspective to claim that climatic changes were responsible for a general instability in nature (Worster 1996, 395). Her conclusion was, as stated by Worster: "Determining whether nature is 'stable' or 'unstable' depends entirely on where the observer stands, on what time scale is chosen, and on how the terms are used" (396). At the same time, the chaos theory demonstrated that what we called disasters, were 'normal' events which occur in many highly-complex dynamic systems. In his Nobel-winning research and later in *Order out of Chaos*, Ilja Prigogine was explaining how dissipative structures, such as hurricanes and tornadoes, occurred when systems were pushed far from equilibrium (Prigogine and Stengers 1984). What was hard to accept was that such phenomena could be triggered by abnormal human activity as well. In general, the climatologists were starting to agree that the humans were propelling the environmental system into a state *far from equilibrium* and the consequences were to be magnificent and catastrophic for us at the same time.

In 1979 the World Meteorological Organization organized the World Climate Conference recognizing climate change as a serious threat to humanity. One of the effects of this important conference was the establishment of the Intergovernmental Panel on Climate Change (IPCC), which has been assessing and disseminating knowledge about climate, global warming, and possible response strategies since 1988, providing scientific basis for policies, and defense for vulnerable policy-makers (Fig.3.8). After decades of warnings from individual scientists, global warming – the other *hyperobject* that, as Timothy Morton says, we are caught in (2013, 3) - attracted international attention. Immediately after, in the absence of federal response during the Reagan presidency, California passed the first Climate Change Bill in 1988 (AB-4420) directing its agencies to inventory GHG emissions, study their effects, and make recommendations to avoid, reduce and address impacts. In face of this new emergency, global warming eclipsed all other environmental issues, and has dominated environmental legislation and regulations until today.

It's a peculiar entanglement of *hyperobjects* of our own making – free-market economy, global warming, and nuclear power - that we are *caught in*. The hegemony of energy efficiency and carbon neutrality is legitimized by the need to fight global warming, which is, to use Eileen Crist's words, "endangering *the culprit*."[62] In the meantime, the risks carried by nuclear energy and a myriad of other environmental issues are neglected, misinterpreted, or dealt with at scales and in ways that are functional to the free-market-

[62] See "Beyond the Climate Crisis: A Critique of Climate Change Discourse" (Crist 2007, 35).



IPCC
INTERGOVERNMENTAL
PANEL ON
CLIMATE CHANGE
WMO UNEP

Fig.3.8 The cover of the Proceedings of the World Climate Conference (left), the World Meteorological Organization and UN Environment Program establish the Intergovernmental Panel on Climate Change IPCC (right).

based (but low-carbon) economy.[63] In her essay, Crist concentrates on the issue of biodepletion following in the steps of E.O. Wilson who believed that preserving biodiversity was an ecological imperative.[64] As she observes, what E.O. Wilson saw looming as the Era of Loneliness, or of Emptiness, we have welcomed with pride (tinted with a hint of guilt) as the Era of Man - the Anthropocene.[65] Since there is no quick techno-fix, no aerosol that one can spray with a magic wand to replay the process of biological evolution,

[63] Crist specifies: "Climate change looms so huge on the environmental and political agenda today that it has contributed to downplaying other facets of the ecological crisis: mass extinction of species, the devastation of the oceans by industrial fishing, continued old-growth deforestation, topsoil losses and desertification, endocrine disruption, incessant development, and so on, are made to appear secondary and more forgiving by comparison with "dangerous anthropogenic interference" with the climate system" (2007, 35-36).

[64] In his book *Biophilia*, the Harvard entomologist Edward O. Wilson suggested that "the urge to affiliate with other forms of life is to some degree innate, hence deserves to be called biophilia" (1984, 85). (The term itself was coined by the German social psychologist Erich Fromm around 1965, and it refers to love of life or living systems.) According to E.O. Wilson, our deeply-rooted affiliation with nature is an effect of the evolutionary history of human species which has lived in close contact with plants and animals for most of its natural history. This connection got increasingly weakened due to technological advancements which have allowed humans to survive and thrive in isolation from nature. E.O. Wilson hoped that it was possible to build a new biodiversity conservation project on the basis of this innate 'love of life.'

[65] In his 2006 book *The Creation* Wilson proposed to call the times we live in "the Eremozoic Era." See "Beyond the Climate Crisis: A Critique of Climate Change Discourse" (Crist 2007, 51-2).

we ignore the issue. Since we do not fully comprehend the spatial and temporal processes that drive extinctions and cannot control them, we disregard the fact that ecological diversity promotes stability – our own as well.[66] We concentrate on problems which we identify as an immediate threat to our way of life and adopt solutions which do not question it.

Rather than leaving uranium underground we spend billions looking for a repository to safely store the spent fuel. Rather than protecting old-growth forests, we plant sustainable mono-crop wood plantations because wood is 'renewable.' Rather than sharing the vehicle we already have, we buy a new electric car despite the fact that the ecological footprint of the parking lot it will occupy will most likely exceed the savings from its efficient technology.[67] Rather than building smaller and more durable houses, we flip them green. In fact, the average square footage per person has almost doubled since the oil crisis, increasing from 551 sq. ft. in 1973 to 1058 sq. ft. in 2015, while household size decreased from 3.01 to 2.54.[68] Although this upward trend in living standards of many Americans and the 'good health' of the housing construction industry is clearly unsustainable, few seem to worry as long as housing technologies are energy-efficient and keep utility bills low. As a matter of fact, building-scale environmental measures appear inadequate if not simply offensive to common sense when we think about environmental perils that we face. Paradoxically, the global community came together to define the notions of sustainability that would influence the green building standards in the decades to come while the globe was being both disturbed and unified by another doctrine: the neoliberal economy of the free-market.[69] And while the

[66] The problem of spatial patterns gained a lot of attention in the 1980s, International Association for Landscape Ecology (IALE) was formed in 1982, and the *Landscape Ecology Journal* was launched in 1987. Landscape ecologists, among them Forman and Godron in their 1986 book *Landscape Ecology*, were pointing at the importance of spatial heterogeneity (patterns and their scales) for the functioning of ecosystems and emphasized the interconnectedness of biophysical and socioeconomic processes. The problem of temporal, spatial, and organizational scales that should be addressed to better understand the complexity of biophysical processes was subject of a 1991 book *A Balance of Nature*? written by ecologist Stuart Pimm. In this book Pimm adopted a large-scale and long-term perspective to discuss how stable states are achieved, maintained, and restored in form of resilience, variability, persistence, and resistance. While this book is a scientific study of stability in community ecology, it provides a set of tools that can help us better understand what affects stability in human communities as well, particularly in face of current socio-political and environmental disturbances.

[67] In the introduction to his book *Rethinking a Lot: The Design and Culture of Parking*, Eran Ben-Joseph says: "The question of parking is intensified by the fact that 95 percent of the time cars are immobile. One could plausibly argue that a hybrid Prius and a Hammer have the same environmental impact because both are parked the same amount of time and both occupy the same 9-by-18-foot standard rectangle of paved space" (2012, xi).

[68] This data is based on statistics provided by the U.S. Census Bureau as reported in a 2016 article published on the American Enterprise Institute website. Accessed January 13, 2017. http://www.aei.org/publication/new-us-homes-today-are-1000-square-feet-larger-than-in-1973-and-living-space-per-person-has-nearly-doubled/

[69] Grober observes: "'Only one world,' and the image of the blue planet, can be interpreted in a radically different way. The Earth is a homogeneous space, desirable, permeable and free from barriers, potentially subject to control down into its furthest recesses. Open for boundless economic expansion and the globalization of the market" (2012, 169).

minds behind the notions were genuinely interested in environmental and ethical dimensions of sustainability, the hands charged with rendering them executive were constraint by the market. While intergovernmental programs established in the 1980s were in part a reaction to the pressures of the accelerating economic development and its social and environmental consequences, they were inevitably shaped by it as well.[70]

In 1980, the International Union for Conservation of Nature, together with the United Nations Environment Program, and World Wildlife Fund published the *World Conservation Strategy*. The report established three interconnected objectives: 1) maintenance of essential ecological processes and life-support systems; 2) preservation of genetic diversity; and 3) sustainable utilization of species and ecosystems.[71] The report also defined two important terms. It described development as "the modification of the biosphere" which depends on social, ecological, and economic factors, and it expressed conservation as "the management of the human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations."[72] As observed by Grober, not only did it anticipate the key principles of the Brundtland Report but also marked a change in understanding of the term conservation.[73] During the 1970s the incompatibility of sustainability with economic development was questioned and the term sustainable development emerged as an apparent solution to this fundamental conflict. In the introduction to the World Conservation Strategy, we read: "11. Conservation must (…) be combined with measures to meet short terms economic needs. This vicious circle by which poverty causes ecological degradation which in turn leads to more poverty can be broken only by development.: (…)" (IUCN et al 1980). While it attempted to, in part, consider the need of underdeveloped countries to overcome poverty (as famously pointed out by Gandhi in Stockholm in 1972), it would soon be hijacked by the proponents of grow-based economy, and criticized as contradictory by radical environmentalists.

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[70] In *Sustainability: A History*, Caradonna provides an annotated list of notable international conferences and programs which defined the concept of sustainability and shaped the international politics between 1969 and 2012 (2014, 145-151).

[71] See "Executive Summary," in *World Conservation Strategy* (IUCN et al 1980). Retrieved January 3, 2017. https://portals.iucn.org/library/efiles/documents/wcs-004.pdf

[72] See *Sustainability: A Cultural History* (Grober 2012, 177). For the original context, see "Introduction," in *World Conservation Strategy* (IUCN et al 1980).

[73] Grober explains how the term underwent its first modern transformation in 1969 when IUCN embraced the concept of 'quality of life' as a focal issue in its program. The 1980 report marks a further evolution and opening towards issues of economic development (2012, 175-77).

While radical movements such as *Earth First!* called for uncompromising conservation of nature often through civil disobedience,[74] the meaning of development was forcefully questioned in *North-South: A Program for Survival*, a report published in 1980 by an independent commission under the leadership of the former West German Chancellor Willy Brandt.[75] While concentrating on the fundamental divide between the rich North and the poor global South, the report called for a culturally-diverse, socially-inclusive, and environmentally-conscious international cooperation. It criticized the systemic dependence of the South on the rich North and rejected the Western model of development as an appropriate blueprint to be imposed upon all nations and cultures. Brandt also forcefully urged the international community to question economic growth as the only satisfactory form of development. Instead, he envisioned it as a creative process of "unfolding of productive possibilities and of human potential."[76] Rather than concentrating on economic, social or environmental perils, he emphasized the priority of moral dangers. The *Brandt Report* addressed a vast array of interconnected issues from hunger and poverty, through energy and environment, to international trade and debt crisis, reiterating some of the perils listed in the *Limits to Growth*. However, his was a hopeful and truly inclusive vision of an equitable and sustainable development supported by a series of concrete recommendations. Unfortunately, it was doomed to fail during a decade shaped by aggressive economic measures promoted by Reagan and Thatcher. Twenty years later, James Quilligan, a member of the Brandt Commission, argued in *The Brandt Equation: 21st Century Blueprint for the New Global Economy* that the *North-South* report is still awaiting a response while the social, economic, and environmental pressures continue to rise.[77] In the closing paragraphs he speculates: "Perhaps only a world crisis will refocus the issues of wealth and need, generating new dialogue and the opportunity for change" (2002, 62) The opportunity in form of a crisis

[74] As stated on the website of the movement: "Earth First! formed in 1979, in response to an increasingly corporate, compromising and ineffective environmental community. (…) We believe in using all of the tools in the toolbox, from grassroots and legal organizing to civil disobedience and monkeywrenching. When the law won't fix the problem, we put our bodies on the line to stop the destruction." Inspired by deep ecology, "Earth First! does not accept a human-centered worldview of "nature for people's sake." Instead, we believe that life exists for its own sake, that industrial civilization and its philosophy are anti-Earth, anti-woman and anti-liberty." Accessed January 15, 2017. http://earthfirstjournal.org/about

[75] This report was produced by an independent commission, but the idea came from the President of the World Bank in 1977 in times of prolong economic recession and international tension. See *Sustainability* (Grober 2010, 177).

[76] Quoted by Grober (2012, 179-80).

[77] In the afterword Quilligan observes: "After twenty years of inattention and delay, the sheer momentum of market forces may be driving us to a fateful climax. Realistically, we could hardly expect to move from a world of politically independent states into a realm of global economic interdependence without some element of friction. Now, as we cross that threshold, it is not comforting to know that there are no democratic international economic institutions in place to greet our arrival" (2002, 60). Retrieved January 12, 2017. http://www.brandt21forum.info/brandtequation-19sept04.pdf

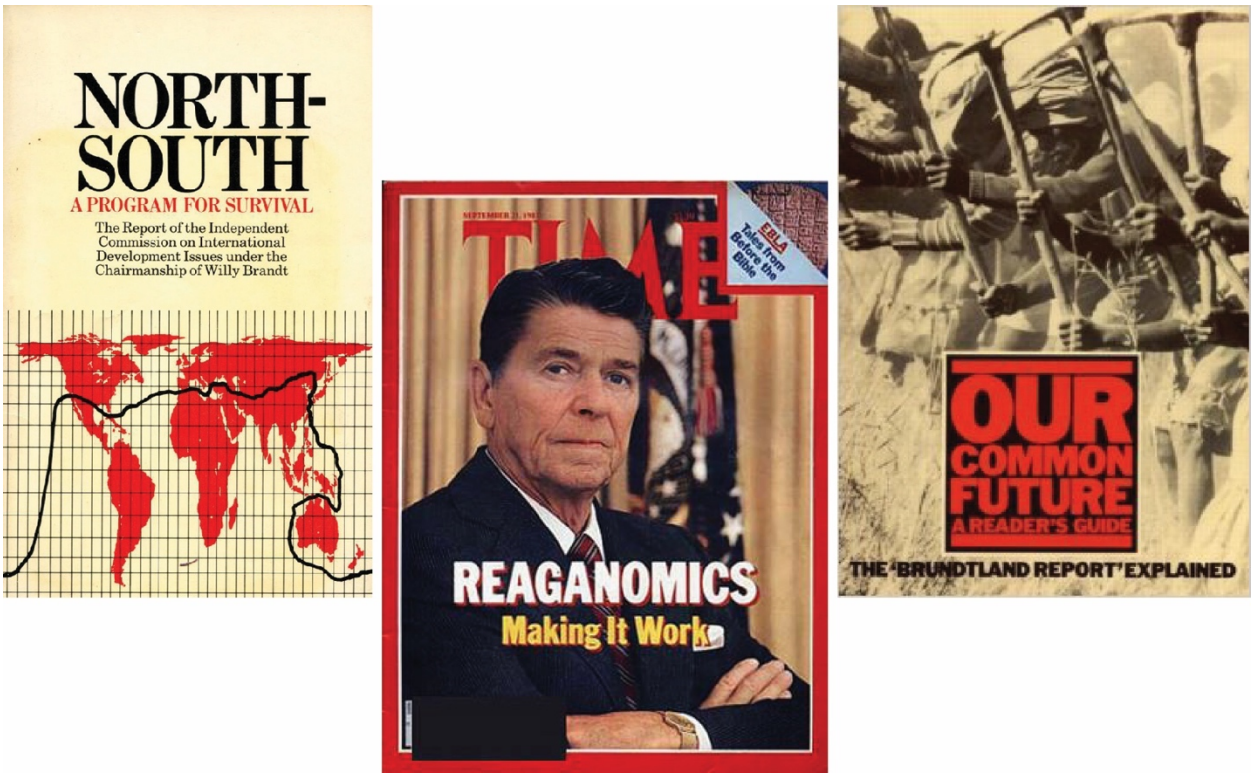

Fig.3.9 The cover of North-South, the report prepared by Brandt's commission in 1980 (left), Reagan on the cover of the Time magazine as an expression of the era in which the reports were presented (middle), the Brundtland Report presented in 1987 (right).

arose in 2008, we are still to see if it generates a new dialogue.

In 1983 the UN created the World Commission on Environment and Development to continue the work done by Brandt's commission and develop "a global agenda for change" promoting international cooperation driven by common environmental concerns.[78] Presented in 1987, the final report produced by a team led by Gro Harlem Brundtland and entitled *Our Common Future* declared the need to consider sustainability as the guiding principle in global politics and economic planning - an ethical imperative (Fig.3.9). Initially meant to address environmental issues only, it established its future legacy by forcefully emphasizing the intricate interdependencies between economy, ecology, and equity. The *Brundtland Report* echoed the document prepared by Brandt by emphasizing: "Sustainable development involves more than growth. It requires a change in the content of growth, to make it less material- and energy-intensive and more equitable in its impact."[79] It also recognized the complex interactions between

[78] See "Chairman's Foreword;" *Report of the World Commission on Environment and Development: Our Common Future* (WCED 1987). Retrieved January 12, 2017. http://www.un-documents.net/our-common-future.pdf

[79] See Part I, Chapter 2. III. Strategic Imperatives, 2. Changing the Quality of Growth: 35 (WCED 1987).

seemingly unrelated policies and regulations by saying: "Moreover, environmental regulation must move beyond the usual menu of safety regulations, zoning laws, and pollution control enactments; environmental objectives must be built into taxation, prior approval procedures for investment and technology choice, foreign trade incentives, and all components of development policy."[80] Brundtland also emphasizes the importance of flexibility,[81] an issue poignantly illustrated by Bateson in his parable of the acrobat who is free "to fall of the wire" while his movements are accurately regulated by laws.[82]

The decade that lead to the Rio Earth Summit in 1992 produced a series of environmental reports, agendas, and pledges, and some legally-binding protocols. Especially worth of mention due its effectiveness was the 1987 *Montreal Protocol* which initiated the international phase-out of ozone-depleting compounds, successfully reverting the problem observed by the international scientific community in the 1970s and confirmed by the NASA discovery of the ozone hole in Antarctica in 1985. Unfortunately, the 1980s also saw some of the most catastrophic man-made environmental hazards, or 'normal accidents' as Perrow called them. A toxic gas cloud killed thousands in the 1984 disaster at the Bhopal pesticide plant. Two years later, the Chernobyl nuclear power facility blast enveloped Western Russia and most of Europe with a radioactive cloud (Fig.3.10). While each of these 'normal accidents' spurred an emergency response which was meant to improve the workings of the *megamachine*, accidents kept on coming. In 1989, Exxon Valdez tanker spill covered thousands of square miles of ocean with crude oil causing a collapse of the marine population. This environmental catastrophe caused by, yet another unforeseen human mistake triggered the adoption of two more acts: *The Oil Pollution Act*, and *Pollution Prevention Act*, both passed in 1990.

A question that arises is after how many normal accidents we should declare a system abnormal. In

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[80] See Part I, Chapter 2. III. Strategic Imperatives, 7. Merging Environment and Economics in Decision Making: 79 (WCED 1987).

[81] In the conclusions to "Chapter 2: Towards Sustainable Development," we read that sustainable development requires: "an administrative system that is flexible and has the capacity for self-correction." See Part I, Chapter 2. IV. Conclusions: 81 (WCED 1987).

[82] This parable is used in a 1970 paper presented at a planning conference and entitled "Ecology and Flexibility in Urban Civilization". Bateson notes: "To maintain the ongoing truth of his basic premise ("I am on the wire"), he must be free to move from one position of instability to another, *i.e.,* certain variables such as the position of his arms and the rate of movement of his arms must have great flexibility, which he uses to maintain the stability of other more fundamental and general characteristics. If his arms are fixed or paralyzed (isolated from communication), he must fall. In this connection, it is interesting to consider the ecology of our legal system. For obvious reasons, it is difficult to control by law those basic ethical and abstract principles upon which the social system depends. (…) On the other hand, it is rather easy to write laws which shall fix the more episodic and superficial details of human behavior. In other words, as laws proliferate, our acrobat is progressively limited in his arm movement but is given free permission to fall off the wire." See *Steps to an Ecology of Mind* (Bateson [1972] 2000, 506).

Fig.3.10 The site of the Chernobyl disaster (left), the cover of Perrow's book Normal Accidents (right).

Brundtland's report, *Our Common Future,* everything was ecologically-imbued and administered in a flexible way. In reality, when one considers technological systems, economic activities, and social dynamics that affect the natural environment, the problem of sustainable development becomes tricky, if not - to use Rittel and Webber's term - *wicked*.[83] We can address isolated aspects of the problem and attempt to regulate them with specific policies and standards to minimize normal accidents, but it will not make sustainability a *tame* problem. As a socio-economic rather than environmental issue, sustainability is doomed to remain ill-defined, open, and with no ultimate solution. It cannot be enforced. It can only be practiced – over and over again. It is not a task but a state of mind; it requires integrity before integration, attention before action, and ethics before efficiency – indeed a *wicked problem* in a world based on

[83] Rittel and Webber observe: "As distinguished from problems in the natural sciences, which are definable and separable and may have solutions that are findable, the problems of governmental planning-and especially those of social or policy planning-are ill-defined; and they rely upon elusive political judgment for resolution. (Not "solution." Social problems are never solved. At best, they are only re-solved-over and over again.)" According to Rittel and Webber most scientific problems are *tame*: "For any given tame problem, an exhaustive formulation can be stated containing all the information the problem-solver needs for understanding and solving the problem-provided he knows his "art," of course." They then conclude: The formulation of a wicked problem is the problem!" See "Dilemmas in a General Theory of Planning" (1973, 160-61).

discretization, speed, and standardization.

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The American houses designed by prominent architects in the 1980s expressed many heterogeneous ideas, often borrowing from the past. Engagement with the natural environment was either inspired by vernacular tradition or heavily managed with modern technologies, often it was both. This pragmatic shift away from the modernist purity appealed to the middle-classes. It was the same nostalgia for the old that defined the character of the first TV home improvement shows which seamlessly combined "historically-compatible" additions with the latest environmental-management technologies sponsored by manufacturers and distributors of construction materials. As the real-estate market continued to thrive thanks to the overall economic prosperity, and new, more flexible mortgage products, many homeowners got involved in real-estate speculation. During this first decade of financial deregulation, house flipping became a profitable hobby, and as it continued to artificially inflate the overall feeling of prosperity, both its environmental, and economic repercussions were for the moment ignored.

The economic benefits drawn from the diffusion of household technologies were clear to the author of *Mrs. Consumer*, and decades later, the underwriters of *This Old House*. Similar market considerations drove the most successful environmental research organizations, among them the *Rocky Mountains Institute* which skillfully advanced the environmental project throughout the 1980s despite the unfavorable context of the Reagan era. Among few advancements, the importance of indoor air quality and urban storm water was highlighted, yet new important problems were simultaneously exposed. While new poorly-tested materials made well-isolated, energy-efficient homes more toxic, rain distributed ambient air pollution even further. At the territorial scale, toxic waste was regulated by federal acts passed in reaction to a series of spectacular disasters. Yet, the focus remained again on managing and minimizing the risks rather than eliminating the very possibility of accidents by banning the noxious (yet economically profitable) activities all together. Natural climate fluctuations became better understood by ecologists, and human role in the on-going climate change became more and more accepted by the scientific community. This new agenda quickly monopolized the environmental discourse due to its fundamental importance to immediate economic prosperity and global security, and despite the importance of other, older problems, such as loss of biodiversity.

Accelerating economic development both triggered and defined the nature of the global environmental debate in the 1980s, when the international community united to determine a practicable definition of sustainable development. Among many important international efforts to establish an environmentally-respectful development agenda, three stand out: the 1980 *World Conservation Strategy* prepared by nature conservationists and with nature in mind, Brandt's *North-South* concentrated on environmentally-conscious, and socially-inclusive cooperation between the rich and the poor nations, and the 1987 *Brundtland Report* established sustainability as the global imperative for all future decision-making. While all three reports attempted to redefine the meaning of development in defense of the environment, the terms and guidelines were to be regularly misinterpreted by the pro-growth establishment. The imperative acquired a clear name - sustainable development- but it remained a wicked problem.

CHAPTER 4 – Green Economy and Green Building Standards: 1990s-present.

4.1. 1990s – mid-2000s: Energy Policy Act (1992) & Leadership in Energy and Environmental Design Certification, USGBC (2000).

The first chapter of this historical overview concentrated on the events and ideas which shaped building regulations before the rise of environmentalism, demonstrating the extensiveness of measures that were already in place when the first environmental acts were enacted in the 1960s and early 1970s. It also tried to highlight the distance between American residential architecture, and environmental protection movement in the period when building regulations were being defined. Furthermore, the chapter demonstrated that what defined the character of building regulations in those formative decades were safety, health and welfare first, and management of financial risks later. The house and the environment were disconnected. The second chapter focused on the regulatory hinge that connected the environment with the house, by providing an account of the events that led to the adoption of first energy conservation standards, and by highlighting the economic agendas that shaped these measures. It then analyzed the conflicts that characterized the 1980s, the global efforts towards sustainable development versus accelerating economic growth and financial speculation. The aim was to explain the character of the decade which saw few environmental building standards but transformed the construction industry that would set them in the 1990s.

The aim of this chapter, the last one in this historical overview of ideas and events, is to understand the context in which green architecture and green building standards as we know them today were born. The first section discusses the context from which green construction standards emerged, and the character of the non-governmental initiatives in the 1990s. The main issues discussed here are the international environmental action and U.S. regulations in the context of globalization of markets, and green economy as a pragmatic response to the sustainable development imperative. The aim of this section is to understand the agendas that shaped the green movement in architecture, and the motivations behind third-party rating systems that preceded

the adoption of state green building standards codes in the next decade.

In the 1990s, sustainable development became a global agenda, yet free trade rather than redistribution of wealth drove the 1992 report with which the World Trade Organization promoted sustainable growth. Herman Daly's call for "enoughness" lost to the pragmatism of Pearce's economic valuation of natural capital. In an attempt to decouple economy from environmental impact, command-and-control instruments previously used to curb pollution were replaced with market-based instruments such as cap-and-trade. Markets thrived as the Communist block collapsed, China entered the WTO, and the U.S. signed the NAFTA, yet environmental protection measures were often perceived as a covert form of sabotage against free trade. Although a series of federal acts banned a number of highly-polluting technologies, the decade was more interested in trading than curbing. The green spirit affected all branches of economy, labels certified the greenness of cities and light bulbs. In architecture, the U.S. Green Building Council successfully launched its ***Leadership in Energy and Environmental Design*** rating system as an industry standard. Other more ambitious certificates emerged raising questions about the limits of green metrics. Yet, metrics, guidelines and green databases proliferated, replacing old-style design manuals to assist professionals disoriented by the choices offered by the market. In 1992 the ***Energy Policy Act*** introduced federal efficiency standards to assist the market itself in the greening process. The global spirit affected model building code-makers before they reacted to the sustainable call. The International Code Council was established in 1994, culminating the efforts towards uniformization of codes just when the term *local* had acquired a positive environmental connotation. Many architects embraced the green spirit, some by delegating the greenness to yet another consultant. In the meantime, the real-estate market thrived due to further deregulation. Extreme lending practices inflated prices and triggered a second wave of speculation.

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When during the 1992 Rio Earth Summit the countries of the South asked the North to rethink its lifestyle, the U.S. President George H. W. Bush responded that the American way of life was not negotiable (Grober 2010, 184). In this light, Herman Daly's position: "If we are serious about helping the poor, we shall have to face up the moral problem of redistribution and stop sweeping it under the rug of aggregate growth "([1977] 1991, 8) was of course, untenable. Although the Rio *Agenda 21* reasserted sustainable development as "the global guiding principle for the 21st century," the concept matured in an era of unrestricted free-market growth. From a radical quest for a no-growth stability in *The Limits to Growth*, through a vision of non-material cultural growth promoted by the *Brandt Report*, it evolved into a pragmatic principle of sustainable development expressed in *Our Common Future.* The environmental agreements signed after the *Brundtland Report* provided an increasingly flexible framework for the free-trade economy to flourish in.

Although a 1992 World Bank report entitled *Sustainable Development Concepts* confirmed that the issue was on everyone's agenda, even the bastion of abstract exchange flow, Herman Daly who then worked for the World Bank criticized the failure of the report to question the sustainability of unlimited economic

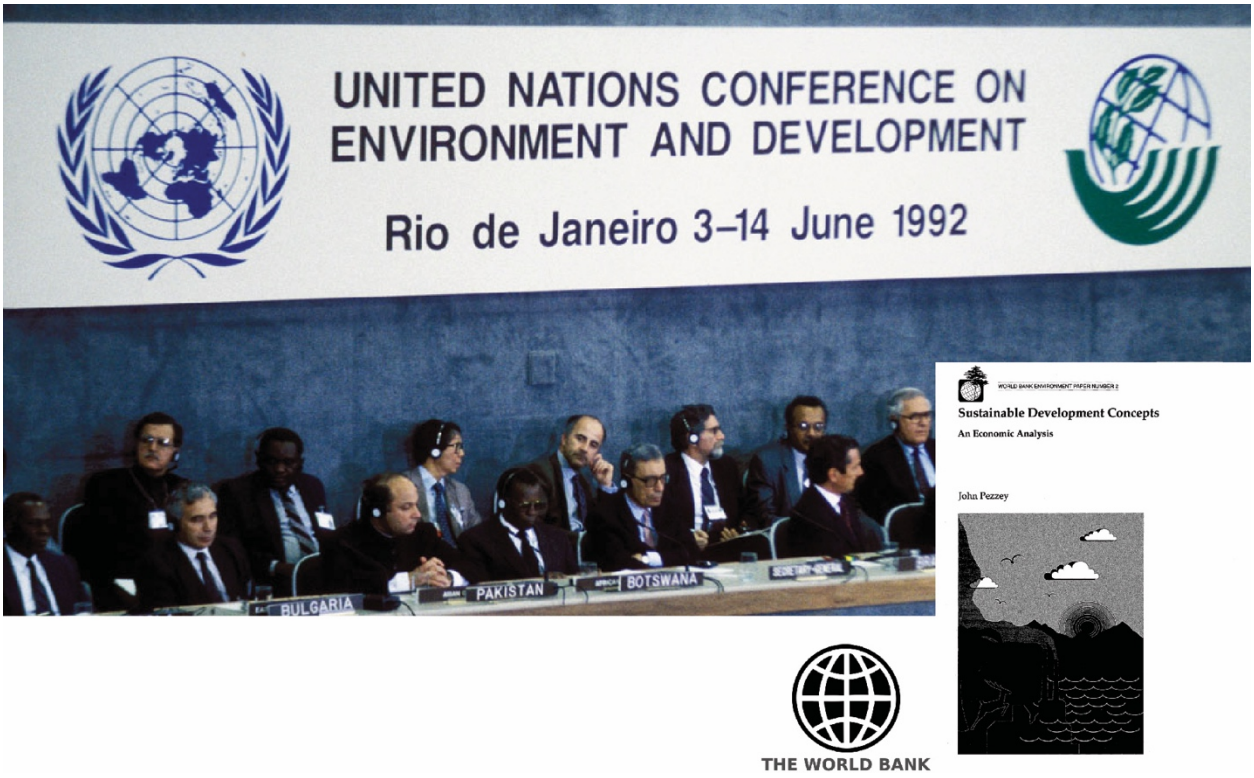

Fig.4. 1 The Rio Summit (top), the cover of the World Bank report entitled Sustainable Development Concepts published the same year. Note the tree in the World Bank logo on the cover (bottom left).

Growth (Fig.4. 1).[1] The vision was to maintain the status quo, and work on "sustainable growth" – a concept that he saw as an oxymoron, considering the size of the world economy in relation to the environment that hosts it. While Daly warned against excessive globalization of trade,[2] according to the World Trade Organization (est. 1995), "open, equitable and non-discriminatory multilateral trading system has a key contribution to make to national and international efforts to better protect and conserve environmental resources and promote sustainable development. This was recognized in the results of the 1992 UN Conference on Environment and Development in Rio (the "Earth Summit") and its 2002 successor, the World Summit on Sustainable Development in Johannesburg."[3] Regardless the plea to protect the planet, and the 350-page-long guidelines on how to achieve it, the WTO built its mission on

[1] In a book entitled *Beyond Growth: The Economics of Sustainable Development* he summarized his critique of the World Bank position on sustainable development (1996, 5-10).

[2] In the above-mentioned book, Daly listed "Four Parting Suggestions for the World Bank." One of them read: "Move away from the ideology of global economic integration by free trade, free capital mobility, and export-led growth (…) (1996, 92). Unfortunately, sympathizing with Keynes was not fashionable in the era of neoliberal economy.

[3] See the WTO website. Accessed January 26, 2017. https://www.wto.org/english/thewto_e/whatis_e/tif_e/bey2_e.htm

carefully selected messages contained in *Agenda 21*: "Economic policies of individual countries and international economic relations both have great relevance to sustainable development. The reactivation and acceleration of development requires both a dynamic and a supportive international economic environment and determined policies at the national level."[4] The WTO interpreted it as a call to accelerate economic growth. When the *Earth Charter* was signed in 2000 the speed of development was such that hardly anyone notices its uncompromising plea: "We must realize that when basic needs have been met, human development is primarily about being more, not having more."[5] Unfortunately, "being more" escapes quantification and hence cannot be inserted as an input in an economic model.

While Daly was calling for a more morally-driven economy based on "values of enoughness, stewardship, humility, and holism" ([1977] 1991, 47), a more practical approach to environmental economics was being proposed by his British colleague David Pearce. Pearce believed that in order to consider the value of the environment it has to be somehow economically evaluated. In response to those who believed that the value of the environment could not be appraised, he stated that what needed to be measured were "*human preferences* for or against changes in the state of environments" (1992, 7). He pragmatically added that: "If environmental improvement is to be achieved, it will require policies that use selfishness rather than opposing it," and specified that: "Green economic policies avoid the infringements of human liberties implied in ever stronger 'command and control' measures" (3). He admitted that some form of scientific cross-examination should be established to balance "preference-based valuations," adding that "Economists do not deny that 'other' values exist." Yet, he insisted that: "They make no claim to be working with other values, only economic values (…)" (7). Whether this was an instance of the 'art of pragmatism' or a case of what Whitehead called the "fallacy of misplaced concreteness," it provided practical solutions to governments.[6]

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[4] See *Agenda 21: Program of Action for Sustainable Development,* Chapter 2: International cooperation to accelerate sustainable development in developing countries and related domestic policies, 2.1 (UNCED 1992). Unfortunately, the message contained in Chapter 4: "Changing Consumption Patterns" had less impact on the WTO agreements. Under point 4.3, we read: "While poverty results in certain kinds of environmental stress, the major cause of the continued deterioration of the global environment is the unsustainable pattern of consumption and production, particularly in industrialized countries, which is a matter of grave concern, aggravating poverty and imbalances." Retrieved January 27, 2017. https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf

[5] See t*he Earth Charter* (Earth Charter Commission 2000) Retrieved January 27, 2017. http://earthcharter.org/invent/images/uploads/echarter_english.pdf

[6] As Daly pointed out: "Probably the major disservice that experts provide in confronting the problems of mankind is dividing the problems in little pieces and parceling them out to specialists" (1991, 7). Daly applied Whitehead's notion at many occasions, recognizing that it was Georgescu-Roegen who first used it in reference to economics. He repeated after him: "It is … beyond dispute that the sin of standard economics is the fallacy of misplaced concreteness." (280).

Fig.4. 2 The cover of Blueprint for a Green Economy, the report co-authored by David Pearce (left), a poster promoting economic benefits of eco-efficiency (right).

While some believe that the environment is invaluable, others tend to think of it as a free source and service. Pearce believed that valuing natural capital and reflecting the social costs of its use in the price of products would help regulate demand and hence curb excessive depletion (1989, 154-6). Pearce's pragmatic and practical "middle position" which he called "constant capital" school was initially presented in a 1989 report entitled *Blueprint for a Green Economy* (Fig.4. 2). The vision was embraced by environmental policy makers across the globe as it advocated for a "*complementarity* of growth and environment" (21) and aimed at decoupling of economic activity from environmental impact without drastically reducing the size or rate of economic growth. Pearce believed that only market-based incentives (such as cap-and-trade) would encourage polluters to address environmental problems now, rather than later (1989, 5). As he pointed out: "One reason for postponing action is that future costs are less burdensome than current costs," a simple example of "discounting the future" (1989, 7, 135-7). Creation of pollution trading markets and market-based incentives provided an anticipatory, preventive measure meant to reduce risks and future costs of adaptation to, for example, climate change, without directly curbing the freedom of individuals polluters (1989, 165).

By the time the international community united to celebrate the 25th anniversary of the *Stockholm Declaration* and signed the *Kyoto Protocol on Climate Change*, the U.S. environmental planners had tested Pearce's methods, and learned how to successfully trade in emissions. The argument that "the way to reduce pollution is to create a market for it"[7] resulted in the cap-and-trade mechanisms which replaced previous policies based on simple limitations on individual polluters but also triggered a new form of speculation (Klein 2014, 179, 195-97). In 1990, the U.S. Congress passed a *Clean Air Act* amendment which introduced a national cap-and-trade system to reduce sulfur dioxide emissions. This strategy later served as a model for reduction of GHG emissions under the *Kyoto Protocol* (Daniels 2008, 186-7). While the *Acid Rain for Sale Program* contributed to an overall reduction of national levels of sulfur dioxide and is now being tested at the state level to fight excessive greenhouse gas (including CO_2) emissions,[8] the fairness of this scheme has been questioned. One of the discussed issues is that the coarse resolution of the cap-and-trade model neglects the uneven spatial and temporal distribution of certain co-pollutants.[9] From a global perspective, it might also prove difficult to reach an agreement regarding the distribution of the right to pollute that is fair to underdeveloped countries.

Although major international climate summits took place during the 1990s, the collapse of the Communist block further diverted international attention towards issues of economic growth and triggered a wave of expansion of capitalist markets. What was to determine the course of global dynamics over the next two decades, were the *North American Free Trade Agreement* (NAFTA) signed during the Clinton presidency in 1994, and the establishment of the World Trade Organization (WTO) in 1995, rather

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[7] See: *23 Things They Don't Tell You about Capitalism,* Thing 16 (Chang 2010).

[8] In 2006 the State of California enacted the *Global Warming Solutions Act* (Assembly Bill 32). The goal of this act was to bring the state GHG emissions to the 1990 level by the year 2020. Among various measures the act introduced a cap-and-trade system targeting energy sold in California and on large manufacturing plants. Since the cap-and-trade system was only introduced in 2013, its performance has not been fully assessed yet.

[9] While the risk of CO_2 hot spots is low (it mixes in the upper atmosphere and distributes globally), and cap-and-trade seems an effective method to lower its overall levels, many unregulated co-pollutants tend to concentrate locally and are harmful to health of nearby residents. The possibility of offsetting emissions with out-of-state credits aggravates this problem by further concentrating pollution. Also, big polluters tend to be more often located near underprivileged neighborhoods which rises issues of social equity. These problems are discussed on the example of California in "A Preliminary Environmental Equity Assessment of California's Cap-And-Trade Program," produced by researchers from USC, UC and Occidental College in Los Angeles. (Cushing et al 2016) Retrieved January 28, 2017. http://dornsife.usc.edu/assets/sites/242/docs/Climate_Equity_Brief_CA_Cap_and_Trade_Sept2016_FINAL2.pdf

In a 2012 paper Daniel A. Faber (Berkeley Law) also discussed pollution hot spots in relation to disadvantaged communities and suggested the introduction of local ceilings in addition to cap-and-trade to offset this problem. See "Pollution Markets and Social Equity: Analyzing the Fairness of Cap and Trade." Retrieved January 28, 2017. http://scholarship.law.berkeley.edu/cgi/viewcontent.cgi?article=3047&context=facpubs

Fig.4. 3 A protest against NAFTA (left), a Protest in Hong-Kong against WTO (right).

than Clinton's pro-environmental policies, or any of the international environmental protocols signed in the same period. While natural disasters continued to hit the U.S. at an abnormal rate,[10] climate change deniers were publishing misleading reports meant to antagonize the scientific community and confuse the public.[11] This and other similar actions undermined the credibility of the scientific community in the matter of climate change, and simultaneously detracted attention from other pressing environmental issues which require immediate action regardless the 'ifs and whys' of the global warming. In the meantime, in 2001 China entered the WTO (2001), while the U.S. withdrew from the *Kyoto Protocol* and

[10] In chronological order: Hurricane Andrew (1992), Great Flood (1993), Super Storm (1993), Louisiana Flood (1995), Chicago Heat Wave (1995), Ice Storm (1998), Oklahoma tornado (1999), and then a series of storms and hurricanes: Allison (2001), Charlie, Frances, Ivan (2004), and eventually Katrina in 2005.

[11] In 1998 an organization called the Oregon Institute of Science and Medicine published the *Oregon Petition* which aim was to undermine the consensus around the science underlying the international climate change action. The content of the report formatted to resemble a scientific article published by the National Academy of Sciences, was disowned by the Academy and criticized as contradicting all research previously published by the Academy members. See the website of the National Academy of Sciences. Accessed January 26, 2017. http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=s04201998

failed to ratify the global POPs convention signed the same year.[12] While opinions about socio-economic benefits of free-trade treaties depend on the perspective, many agree that both climate action and the climate itself have suffered from the increasing deregulation and opening of global markets. It seems that the "depletion quotas" that Daly advocated for are harder to implement than caps on pollution.[13] The NAFTA opponents argue that it has been detrimental to local communities and environments and should not serve as a model for future agreements (Fig.4. 3).[14] Strikingly, as part of its fundamental principles, the WTO "permits" members to protect the environment but "members must not use environmental protection measures as a means of disguising protectionist policies."[15] While environmental protection is "permitted" as long as it does not harm the trade, it seems that many WTO regulations have indirectly blocked programs and policies that address climate change by supporting renewable energy. In *Capital vs. the Climate*, Naomi Klein discusses the impact of the non-discrimination principle on the promotion of solar energy industry,[16] an issue which is part of a larger discussion concerning the WTO attitude towards

[12] For the current U.S. status, see the website of the *Stockholm Convention on Persistent Organic Pollutants* (POPs). Accessed January 28, 2017. http://chm.pops.int/Countries/StatusofRatifications/PartiesandSignatoires/tabid/4500/Default.aspx. For a brief discussion of the U.S. position, see the website of the Arctic Institute. Accessed January 28, 2017. http://www.thearcticinstitute.org/persistent-organic-pollutants-pops-in-the-arctic/

[13] In *Steady-State Economic*s he points out: "The usual recommendation of pollution taxes would seem, if the above is correct, to intervene at the wrong end with the wrong policy tool" (1991, 63). See Chapter 3: "Institutions for a Steady-State Economy, Depletion Quotas."

[14] In 2014, Sierra Club, together with the Mexican Action Network on Free Trade, the U.S.-based Institute for Policy Studies, and the Council of Canadians, released a report entitled *NAFTA: 20 Years of Costs to Communities and the Environment*. The authors concluded that the NAFTA significantly harmed communities and the environment and should not be used as a model for expanded agreements (such as the Transpacific Partnership). The report discussed the effects of large-scale, export-oriented farming methods, explosion of mining in Mexico, exploitation of Canadian tar sands, and increase in traffic-triggered air pollution. The authors also discussed the corporate power to influence environmental policy-making. "The result is inevitably that policies that might be necessary to protect the environment but might raise trade and investment challenges are discouraged at the outset" (Sierra Club et al 2014, 9). It's meaningful that while the NAFTA itself is binding, the independent *North American Agreement on Environmental Cooperation* (NAAEC) only provides non-binding recommendations. Retrieved January 26, 2017. https://content.sierraclub.org/creative-archive/sites/content.sierraclub.org.creative-archive/files/pdfs/0642-NAFTA%20Report_05_low.pdf

[15] See the WTO website. Accessed January 26, 2017. https://www.wto.org/english/thewto_e/whatis_e/what_stand_for_e.htm

[16] In *Capital vs. the Climate* Naomi Klein discusses the impact of WTO non-discrimination principle on local efforts to promote renewable energy sources and community-controlled local projects. She tells the story of an Ontario-based photovoltaic manufacturer that failed when WTO questioned the legality of its buy-local provisions: "Specifically, they [complainants] claimed that the requirement that a fixed percentage of renewable energy equipment be made in Ontario would "discriminate against equipment for renewable energy generation facilities produced outside Ontario." She concludes by saying: "How absurd, then, for the WTO to interfere with that success - to let trade trump the planet itself" (2015, 60). While Klein's concluding statement might be overly simplistic, the indirect effects of the WTO agreements is clearly hampering the main goals of the *Kyoto Protocol*.

renewable energy subsidies which favor national or regional interests.[17]

Next to market-based incentives (such as pollution charges and subsidies which promote environmentally-friendly solutions), traditional command-and-control policies continued being adopted in order to set or tighten overall pollution standards (which could then be 'traded').[18] Other measures were introduced to raise public awareness. In 1996, water suppliers were obliged to publish information about drinking water quality. Highly-polluting technologies were gradually banned, in 1996 the leaded gasoline was phased out, as a result of a 25-year-long program, and in 2004 *Clean Air Nonroad Diesel Rule* initiated a similar program meant to reduce emission levels by modernizing engines and reducing sulfur in nonroad diesel. This indirectly addressed pollution from equipment used by the construction industry. In 2000 Dursban, the most widely used household pesticide which posed a risk to children's health was banned.

The international success of the cap-and-trade method confirmed the free-market ethos of the era, and in general the focus of sustainists shifted from curbing trade, to promoting efficient products and green services that can be traded. In 2004 fourteen countries created the Methane to Markets Partnership to advance recovery and use of this greenhouse gas as an energy source. A celebratory EPA press release perfectly reflected the spirit of the era: "The Bush Administration welcomes this global partnership, a partnership that has the double benefit of capturing the second most abundant greenhouse gas and turning it to productive use as a clean-burning fuel."[19] Although, as Caradonna points out, "In the 1990s, 'reduce, reuse, recycle' became a mantra for every school kid" (2014, 163), recycling ever larger amounts of waste proved easier and more profitable than reducing. Unfortunately, as Naomi Klein says, "Policies based on encouraging people to consume less are far more difficult for our current political class to embrace than policies that are about encouraging people to consume green" (2014, 79). And hence, the economy went green. While the *Earth Charter* plead for "a new reverence for life," free-market

[17] By not considering global warming as an environmental exception in case of these subsidies, the WTO is clearly ignoring the *Kyoto Protocol* but, as usually, the problem is complex. Since subsidies can have negative impact on international trade, they are regulated by the WTO agreements. In a paper entitled "World Trade Organization, Renewable Energy Subsidies and the Case of Feed-In Tariffs: Time for Reform Toward Sustainable Development?" the authors explain: "China's subsidies for its solar exports have allegedly bankrupted solar companies in the United States and the European Union ("EU"), undermining their renewable energy sectors as they take root. Thus, renewable subsidies pit two legitimate policy concerns against each other: cultivation of renewable energy and prevention of unfair trade practices" (Farah and Cima 2015, 517).

[18] In 1995 EPA published *Municipal Waste Combustors* – a measure meant to reduce emissions from waste combustion, in 1997 New Air Quality Standards, and in 1996 *Safe Drinking Water Act* Amendments (Public Law 104-182) were passed. In 2006 EPA also introduced the *Ground Water Rule* - a set of measures against contamination of ground water.

[19] "International Methane to Markets Partnership to Enhance Clean Energy Sources and Reduce Greenhouse Gas Emissions." Release Date: 07/28/2004. Accessed January 31, 2017. https://archive.epa.gov/epapages/newsroom_archive/newsreleases/ad2f332a8d79d39885256edf005253f6.html

economists were claiming that we can only be sustainable in ways that generate profit. The decade was marked by a hopeful and operative approach towards sustainable strategies but, since economy was booming, sustainability needed to coexist with expansion.[20]

The green spirit spread across all scales of economy; from international trade to local commerce and affected many different domains of economic life; manufacturing, agriculture, construction, and services. Economy was to become eco-minded and highly efficient. At least in the wealthy North, it was the time of *Natural Capitalism (*Fig.4. 4*)*.[21] In the introduction to the book the authors write: "Natural capitalism recognizes the critical interdependency between the production and use of human-made capital and the maintenance and supply of natural capital" (1999, 3). The scale of the challenge changed, ecological knowledge advanced, and the accounting tools became more sophisticated, but the attitude towards natural capital remained almost unaffected since the times when Pinchot oversaw the U.S. Forest Service under Roosevelt. Be it "maintenance and supply" today, or "conservation and sustainable yield" in the early 1900s, the aim is the same. It is efficiency. In *Natural Capitalism,* we read: "(…) if there is to be prosperity in the future, society must make its use of resources more productive – deriving four, ten, or even a hundred times as much benefit from each unit of energy, water, materials, or anything else borrowed from the planet and consumed. Achieving this degree of efficiency may not be as difficult as it might seem because from a materials and energy perspective, the economy is massively inefficient" (1999, 8). Explaining their agenda, Hawken and Lovinces refer to Einstein's dictum: "problems can't be solved within the mind-set that created them" (1999, 6). And yet, we are trapped in the same mind-set.

As Hardt and Negri point out, no matter how much we resist, capitalism captures our desires and reflexes and converts them into power.[22] It absorbs, celebrates, and modulates resistances and differences (2001, 198), it transforms its own insufficiencies - energy scarcity, global warming - into new markets. It turns self-defense mechanisms – sustainable indexes, ratings, and ecolabels - into self-imposed discipline. All this to reemerge stronger under the green banner. And hence, the efforts to green economy without

[20] Caradonna quotes from a 1993 book by Paul Hawken, entitled *The Ecology of Commerce: A Declaration of Sustainability*: "The question is, can we create profitable, expandable companies that do not destroy, directly or indirectly, the world around them?" Hawken was responsible for bringing The Natural Step to the U.S. from Sweden where its founder Karl-Henrik Robert consulted such companies as IKEA on how to generate profit sustainably (2014, 167-8).

[21] See *Natural Capitalism: Creating the Next Industrial Revolution* (Hawken, Lovins and Lovins 1999).

[22] In *Empire*, they observe: "Each imperial action is a rebound of the resistance of the multitude that poses a new obstacle for the multitude to overcome" (Hardt and Negri 2001, 361).

Fig.4. 4 A selection of existing eco-labels (left), the cover of the 1999 book Natural Capitalism co-written by Hawken, Lovins and Lovins (right).

slowing its speed down created a market for pollution, waste, low-energy bulbs, eco cars, zero-mile diet, and solar panels. What was an alternative culture in the 1970s, became a green niche product in the 1990s. Thanks to a renewed interest in biomimicry, nature was again perceived as a source of invaluable (and now also profitable) knowledge.[23] Equipped with tools developed by systems ecologists and landscape ecologists, urban ecologists began to study spatial fragmentation and functional heterogeneity

[23] Janine Benyus who greatly contributed to the recent popularity of biomimicry promotes innovation inspired by nature convinced that understanding the richness of design solutions hidden in natural systems will make entrepreneurs, designers, and policy-makers more inclined to protect it. Her book *Biomimicry: Innovation Inspired by Nature* was published in 1997. In 2002, she founded the Biomimicry Institute which organizes field trips, workshops, and consultancy for engineers, and designers.

of urban regions, many in search of practical methods to deal with urban (un)sustainability.[24] Based on models previously developed by systems ecologists and industrial ecologists, environmental impact (and vulnerability) of countries, regions, and cities was quantified in terms of ecological footprint.[25] Created to quantify unsustainability and certify sustainable efforts, measurement tools and rating systems created new markets. Manufacturers improved the life-cycle assessment methods.[26] Business adopted the triple bottom line to promote financial, social, and environmental performance.[27] Commerce created various types of ecolabels to certify the origin and impact of products.[28] By the year 2000, environmental accountants measured, indexed, rated, and labeled the greenness of just about everything. Architecture included. And still, the Earth Overshoot Day falls each year slightly earlier. It fell on December 7th in 1990, in 2016 we entered the ecological deficit spending on August 6th.[29] In 1977, Daly observed with a dose of sarcasm: "Some ecologists have defined an economist as a person who is seeking the optimal

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[24] Although, as explained by McDonnell, the first ecological studies of human settlements were initiated as part of the Man and Biosphere Program launched by the UNESCO in 1971, it wasn't until the 1990s, that ecological studies of urban regions experienced a boom. See "The history of urban ecology: An ecologist's perspective" (McDonnell 2011, 8). In 1990, McDonnell and Pickett published a seminal paper "Ecosystem structure and function along urban-rural gradients: an unexploited opportunity for ecology." *Long-Term Ecological Research* projects on urban ecology (Urban LTERs) were launched by the US National Science Foundation in 1997. Urban issues were also increasingly addressed by landscape ecologists, and urban landscape ecology became a well-defined field of study in the 2000s. According to Jianguo Wu, use of terms "urban/urbanization" dramatically increased in the mid-1990s and next to "fragmentation" and "conservation" these issues continue to be among the most frequently addressed in articles published in the Landscape Ecology Journal of which he is the editor-in-chief. See "Urban Landscape Ecology: Past, Present, and Future" (2013, 40).

[25] The ecological footprint is an environmental accounting method and a planning tool developed in the early 1990s. According to this method, the U.S. has the highest per-person ecological footprint in the world, it exceeds its biocapacity twice. The State of California leads in the national ranking: its economy is the strongest, its biocapacity very low, hence its ecological footprint the largest. It might explain why its environmental bills should be among the most progressive. Although it is questionable whether independent footprint of such intricately-related economic and geographic entities as U.S. states is meaningful, the method illustrated the global overshoot, and exposed international imbalances. It also revealed political, ecological and economic vulnerability of seemingly independent political entities such as states and urban regions. *The Ecological Footprint Atlas 2010* explains that Ecological Footprint "measures the amount of biologically productive land and water area required to produce all the resources an individual, population, or activity consumes, and to absorb the waste they generate, given prevailing technology and resource management practices. This area can then be compared with biological capacity (biocapacity), the amount of productive area that is available to generate these resources and to absorb the waste." (Global Footprint Network 2010). Retrieved February 5, 2017. http://www.footprintnetwork.org/content/images/uploads/Ecological_Footprint_Atlas_2010.pdf For a general introduction to the method, see the above-mentioned *Atlas* and *Our Ecological Footprint* (Wackernagel and Rees 1996). For data related to the U.S., see *State of the States*, a report published by the Global Footprint Network (Global Footprint Network 2015) Retrieved February 5, 2017. http://www.footprintnetwork.org/content/images/article_uploads/USAFootprintReport_final_lores.pdf

[26] See *Cradle to Cradle: Remaking the Way We Make Things* (Braggart and McDonough 2002).

[27] See *Cannibals with Forks: The Triple Bottom Line of 21st Century Business* (Elkington 1997).

[28] For an annotated list of sustainability rating systems, including various ecolabels, see *Sustainability* (Caradonna 2014, 180-88).

[29] The Earth Overshoot Day is calculated by the Global Footprint Network. See the Overshoot Day website for details regarding the calculation method. Accessed February 5, 2017. http://www.overshootday.org/about-earth-overshoot-day/

arrangement of deck chairs on the Titanic" (1991, 89).

The green spirit obviously also affected the construction industry. While the first assessment method applied to buildings was formulated in the U.K. in the late 1980s and was launched as *Building Research Establishment Environmental Assessment Method* (BREEAM) in 1990, its U.S. equivalent was not launched until 10 years later. Nevertheless, the 1990s saw an explosion of green building initiatives, from *The Hannover Principles* which laid "the foundations of a new design philosophy" (McDonough & Partners 1992), through numerous practical guidelines, to proprietary rating systems and green certificates. The success of these initiatives depended on their capacity to leverage their constituencies to spread the agenda among industry leaders, customers, and eventually policy makers. The most powerful framework was established in 1993 when Rick Fedrizzi, David Gottfried and Mike Italiano (a marketing specialist, a real-estate expert, and an environmental lawyer) joined together to launch the U.S. Green Building Council (USGBC).[30] According to the council itself, "USGBC's constituency includes builders and environmentalists, corporations and nonprofits, elected officials and concerned citizens, teachers and students."[31] Support from such a broad spectrum of social groups offered unique opportunities. Although USGBC was launched by the construction industry (rather than, for example, a public advocacy organization), it did not directly represent it. Neither did it represent the government, or a specific professional body. A non-governmental organization, like USGBC, was a perfect structure to exert indirect influence, to use Guattari's expression, "best fitted to capture desire and harness it to the profit economy" (1984, 229). Green economy.

While undoubtedly the involved actors shared a concern for the environmental cause, they all agreed that the U.S. construction industry needed a green standard which, while improving the quality of construction, would also protect their interests. Their initial goal was to develop the standard within ASTM, but they eventually opted for an independent rating system which afforded them a greater degree

[30] It's interesting to look at the founders' background. David Gottfried holds a degree in Engineering Management, and previously worked as a real-estate developer and as a construction and property manager. His passion for green solutions is also the base of his company Regen360 which promotes green technologies, and Reset360 which sells health products. Rick Fedrizzi holds a Master in Business Administration, and previously worked as an environmental marketing officer at UTC's Carrier Corporation, the famous manufacturer of HVAC systems. Mike Italiano holds a degree in Environmental Science and Forestry and a Juris Doctor degree. While the American Institute of Architects hosted the founding meeting, USGBS owns its success to the support from the construction industry.

[31] See USGBC website for its constituency, and history. Accessed July 18, 2015. http://www.usgbc.org/about/history

of control.[32] Industries supported the standard-setting effort to make sure that the new standards did not render their products obsolete, real-estate developers were eager to quickly standardize the greening efforts to ensure smooth operations and enable economic valuation. Environmentalists, researchers, and students brought in expertise and an unbiased mindset which helped USGBC present itself as a trustworthy, third-party authority. It was a perfect framework to turn an important cause into a well-standardized system, which would not only be assimilated by the economy, but could create a new market as well.[33] Ultimately, since these third-party-negotiated standards reflected negotiated interests of various social groups, and could therefore be easily incorporated into legally-binding codes without the risk of being rejected by the market, their development received support from the federal administration under President Clinton.[34] Although the USGBC *Leadership in Energy and Environmental Design* (LEED) rating system met with criticism,[35] many U.S. states and cities adopted LEED standards as mandatory for certain types of construction.[36] By endorsing the criteria developed by USGBC, governments legitimized them as a national green standard monopoly. As green standards gradually gain acceptance (by blending in with the other, older ones) we should not forget that they are not natural or universal and represent values and interests of those who managed to dominate the field to dictate them first.[37]

While USGBC's LEED rating system originally aimed at minimizing negative impact and inefficiencies in the

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[32] See "White Paper on Sustainability" presented by Building Design & Construction at Greenbuild 2003 (2003, 7). Retrieved February 15, 2017. https://bdcnetwork.s3.amazonaws.com/s3fs-public/BD%2BC%202003%20White%20Paper%20on%20Sustainability.pdf

[33] It is noteworthy that the founder of USGBC, Rick Fedrizzi has recently published a book entitled: *Greenthink: How Profit Can Save the Planet* (2015).

[34] Although criticized for his neglect of NAFTA's environmental impact, President Clinton supported several pro-environmental policies and programs. Launched in 1993, the *Greening of the White House Initiative* was the first step to reduce the environmental impact of federal buildings. See the website. Accessed February 14, 2017. https://clinton3.nara.gov/Initiatives/Climate/greeningsummary.html

[35] In a 2013 article entitled "LEED Standards Fail Taxpayers," Drew Johnson, a senior fellow of Taxpayers Protection Alliance, described LEED as "a flawed standard that lines the pockets of a private organization with tax dollars." Accessed February 16, 2017. http://www.newsmax.com/DrewJohnson/LEED-Standards-Taxpayers-Environment/2013/04/03/id/497706/

[36] For a detailed list of cities that adopted LEED as a mandatory measure, see: "How Often Do Cities Mandate Smart Growth or Green Building?" (Lewyn and Jackson 2014). Retrieved February 16, 2017. https://www.mercatus.org/system/files/Lewyn-Mandating-SmartGrowth.pdf

[37] In the 1930s, "home" became a standardized real-estate product financed with a FHA-insured mortgage, the process of standardization naturally continues as construction industry responds to the pressure of sustainable imperatives. When in the 1930s, grouped under the FHA umbrella, builders, mortgage lenders, insurers, and realtors indirectly shaped and standardized local land-planning and building standards, their agendas were informed by the ideals promoted a decade earlier by *Better Homes*, a grassroots movement indirectly supported by Hoover and his Division of Building and Housing (part of the Department of Commerce). In the 1990s, construction industry successfully organized itself to establish a set of market-friendly green building standards before another (possibly less convenient) option appeared as an alternative.

Fig.4. 5 The logo of the USGBC's LEED label, its different levels and categories (left), promotional material for the Living Building Challenge, a certification program launched by the Living Future Institute (right).

operational phase, a more ambitious agenda was adopted by its off-spring, the Living Future Institute (LFI) (Fig.4. 5). In 2006, the Institute launched the *Living Building Challenge* (LBC) which is, according to Building Green, the most stringent green building standard in the world. Its idealism reflects the fact that it was developed by architects not real-estate experts.[38] In fact, it echoes the philosophy contained in *The Hannover Principles* more than any other certificate. Unlike LEED, LBC offers little flexibility and does not accept promises – all imperatives are mandatory, and the certificate is awarded based on the actual performance tracked during the first year of operations. Yet, what really distinguishes it from other methods is its restorative character. (Note that, a restorative LEED certificate is just about to be launched

[38] As stated in *Living Building Challenge 3.0, A Visionary Path to a Regenerative Future*: "Working with Berkebile at BNIM, Jason F. McLennan [an architect] guided the research and technology solutions for the EpiCenter [design for a never-built research center developed for the University of Montana] —in the process, he also began to conceptualize the requirements for what is now known as a Living Building" (Living Future Institute 2014, 62). Retrieved February 10, 2017. https://living-future.org/wp-content/uploads/2016/12/Living-Building-Challenge-3.0-Standard.pdf

as USGBC is "starting to see opportunities to push the market even further."[39]) Another notable (and slightly troubling) feature of the LBC method is that projects must 'score a point' for "beauty + spirit." While the ambition to restore environments is undoubtedly admirable, rating beauty seems problematic (but would probably be encouraged by David Pearce). Still, a more pressing question which persists is whether it is realistic to think that such ambitious standards are attainable in an era of unprecedented urban explosion. Aren't *Living Building Challenge* buildings simply a luxury niche product accessible to the wealthiest ones? Is their positive ecological impact real or purely symbolic? Can one flower (full of green petals[40]) transform a desolate land into a green pasture? I choose to hope that it might be able to inspire a trend. An alternative to rating isolated buildings which have a limited impact would be to rate entire cities. Technically, we can. Ecological footprint method tells us how unsustainable cities are, IBM is making them "smart," USGBC is now entering the market to certify how green they can be.[41] Should we be rating everything? Technically, we can. Would Gregory Bateson think that it is mentally sustainable? My guess is that the answer would be "no." Yet, most likely, we will continue to standardize and rate everything.

While most of the principles behind rating systems were available in environmental design handbooks and technical manuals before, what was missing was not only a comprehensive assessment of the energetic efficiency and environmental impact of strategies and technologies, but also a clear indication of what particular mix of solutions constituted a sustainable building (rather than a comfortable one). What was needed was clear metrics, and a universal, marketable green protocol. Previous guidelines were presented in form of traditional handbooks offering flexible design strategies whose choice depended on location: *Design with Climate* by the brothers Olgyay (1963), *Man, Climate and Architecture* by Givoni (1969), *Sun, Wind and Light* by DeKay and Brown (1985). Although the structure of the last book resembled a set of instructions, it did not provide a standardized checklist. In 1976, the AIA Research Corporation published the *Solar Dwelling Concepts*. In 1992 the Environmental Protection Agency joined with AIA/COTE (a branch of the AIA established in 1990 to promote environmentally-friendly design) to publish the *Environmental Resource Guide* which provided sustainable guidelines for architects throughout the 1990s. In 1992, Alex Wilson started publishing the *Environmental Building News*, now a monthly report by

[39] See a recent article on the USGBC website: "Bigger, broader and beyond with Arc: Toward a regenerative built environment" (Palanki 2017). Accessed February 9, 2017. http://www.usgbc.org/articles/bigger-broader-and-beyond-arc-toward-regenerative-built-environment

[40] The Living Building Institute groups the imperatives into petals: Place, Water, Energy, Health + Happiness, Materials, Equity, Beauty.

[41] See an article published by BuildingGreen: "LEED to Certify Entire Communities, Cities" (Pearson 2017). Accessed February 9, 2017. https://www.buildinggreen.com/newsbrief/leed-certify-entire-communities-cities

BuildingGreen, a source of knowledge on sustainable design strategies, materials, products, ratings and codes. Since it is not supported by advertising, it is highly trusted by designers. It is valuable, yet not easily marketable. Probably for this reason, in 1997 the format was expanded, *BuildingGreen Approved* product database was created, and a LEED accreditation support is now also available. In order to be part of the green system one must either certify or be certified. Sadly, David Pearce was right – everything needs to be valuated to acquire value in a market-based economy. And while ratings do not provide economic valuation they provide metrics which facilitate it. In fact, one of the first ratings was created by RESNET, a network established by the mortgage industry, in order to "develop national standards for home energy ratings and to create a market for home energy rating systems and energy mortgages" (Fig.4. 6).[42]

Since the market is free, a significant amount of effort (energy) is also dedicated to telling a good product from a bad one. For example, the Open Standard Health Product Declaration Collaborative reports building product content and associated health information. The tool is incorporated into many rating methods, including LEED v4.[43] Standard-setters compete to create sustainable standards to defend the interests of their constituencies, and ultimately, specific social groups acquire authority when their standards and ratings are incorporated into other, more comprehensive, systems, and when they are used in legally-binding codes. RESNET's *Home Energy Rating System* (HERS) Index is used to assess Energy-Star certified homes, and since 2008 the *DOE Zero Energy Ready Homes*. RESNET air tightness testing standards are incorporated into rating systems and codes. When the California Energy Commission incorporated one of its standards into the state energy code RESNET referred to it as a milestone.[44]

While most green initiatives born in the 1990s came from non-governmental organizations and standard-setters, and eventually from progressive states, some of them were triggered and accompanied by federal legislation. In 1992 the U.S. Congress enacted the *Energy Policy Act* (EPACT92, Public Law 102-486), which called the states to consider a revision of their residential building codes to meet or exceed CABO Model

[42] RESNET, the Residential Energy Services Network was established in 1995. See the website. Accessed February 10, 2017. http://www.resnet.us/about/our-history

[43] HPDC was launched by the Healthy Building Network and BuildingGreen. See the website. Accessed February 10, 2017. http://www.hpd-collaborative.org/about/

[44] See "State of California Incorporates RESNET Air Tightness Testing Provisions into Revised Energy Code" (Elam 2012). Accessed February 10, 2017. http://www.resnet.us/blog/state-of-california-incorporates-resnet-air-tightness-testing-provisions-into-revised-energy-code/

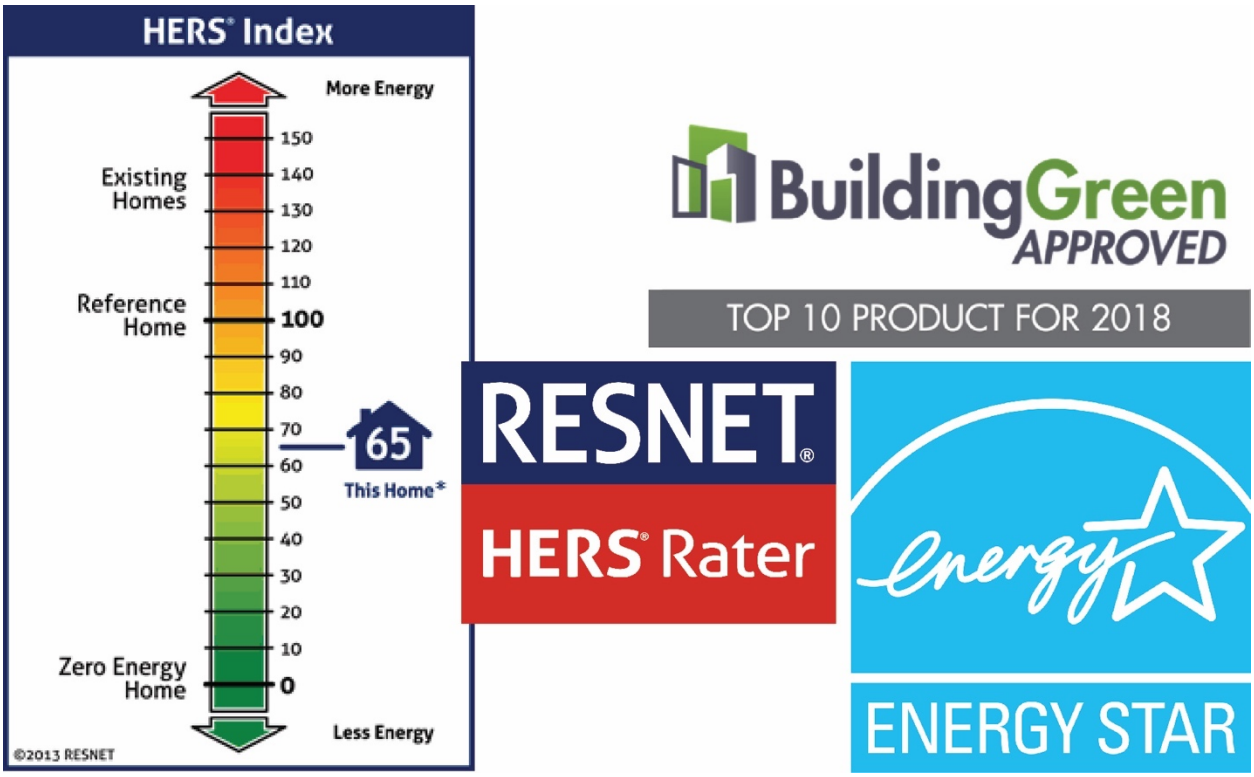

Fig.4. 6 A sample rating scale from RESNET's HERS Rating System (left), the logo of the BuildingGreen Approved rating system (top right), and the logo of the Energy Star system launched as part of the EPACT92 legislation.

Energy Code.[45] It also gave impetus to ASHRAE to finalize the new *Standard 90.2 Energy Efficient Design of Low-Rise Residential Buildings,* by referring to it as a benchmark for efficiency of manufactured housing.[46] EPACT92 also launched programs which introduced appliance efficiency standards.[47] Initially only a voluntary rating and labeling system applied to office equipment, *Energy Star* program (introduced by EPA, run in partnership with the Department of Energy) became an industry standard for energy efficiency of many household appliances (Fig.4. 6).[48] *Energy Star* standards have been incorporated into the LEED rating system, and many state energy codes. Although efforts to conserve water were initiated in 1990 by

[45] See EPACT92, Title I – Energy Efficiency, Subtitle A – Buildings, Sec.101.Building Energy Efficiency Standards. (a).

[46] See EPACT92, Title I – Energy Efficiency, Subtitle A – Buildings, Sec.104. Manufactured Housing Energy Efficiency. (c).

[47] According to the Alliance Commission on National Energy Efficiency Policy: "Five years after the enactment of the law, the Alliance to Save Energy and ACEEE ran a joint analysis determining that many of the law's provisions were voluntary and largely disregarded. However, the equipment efficiency standards were mandatory and, thus, were effective." (2013, 7) Retrieved October 13, 2016. https://www.ase.org/sites/ase.org/files/resources/Media%20browser/ee_commission_history_report_2-1-13.pdf

[48] See EPACT92, Title I – Energy Efficiency, Subtitle C – Appliances and Equipment Energy Efficiency Standards, Sec.125. Energy Efficiency Information for Commercial Office Equipment. (a). Retrieved February 10, 2017. https://www.gpo.gov/fdsys/pkg/STATUTE-106/pdf/STATUTE-106-Pg2776.pdf

a public advocacy group called WaterReuse, the first water-efficiency rating and labelling system was launched by EPA only in 2006. WaterSense, is now the standard used in LEED-certified homes, and in state codes (i.e. California Green Building Standards Code). Since the federal water-efficiency standards have not changed since EPACT92 was enacted, in 2007 the State of California adopted the first in the nation, high-efficiency standards, and many other state jurisdictions have followed since then.[49]

Most organizations and methods established in the 1990s were inspired by non-governmental initiatives born in the 1980s, which were in turn sparked by the activism of the 1970s. Unfortunately, two decades of efforts to reestablish a healthier relationship with the natural environment were embraced by the mainstream construction industry in an era which prioritized economic growth and favored deregulated free-trade and globalization. The focus on expanding markets encouraged further standardization of industrial practices, including construction and hence building codes. In 1994, the three regional model code groups merged to form the International Code Council (ICC).[50] This certainly simplified the regulatory system and allowed the code-makers to improve building performance, distribute safety standards, and spread technical expertise more uniformly across the country at a reduced cost. It also helped large construction companies and corporate clients to further standardize their practices across the country. However, state codes share model principles but are not equal. While ICC is the main code development organization and its codes cover all aspects of building regulations, states can write their own codes, and are free to adopt codes from other code makers as well.[51] It is true that state-developed standards at times provide a model for the model code-makers, and eventually resources invested by progressive states trickle down to other smaller, poorer, or less progressive states.[52]

Individual states adopt model codes with extensive amendments to assure compliance with state laws and eliminate conflicts with other model codes. Many state agencies, boards, commissions, and departments

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[49] See *The Status of Legislation, Regulation, Codes, & Standards on Indoor Plumbing Water Efficiency* (Alliance for Water Efficiency 2016, 3). The Alliance for Water efficiency was formed in 2007 as "a stakeholder-based nonprofit organization dedicated to the efficient and sustainable use of water." See the website. Accessed February 16, 2017. http://www.allianceforwaterefficiency.org/about/default.aspx

[50] The *International Building Code* (IBC) was first published in 1997; other codes followed: in 1998 ICC released the *International Energy Conservation Code* (IECC), and in 2000 the *International Residential Code* (IRC).

[51] California's Title 24 which consists of thirteen parts is composed of three state-developed parts, four parts based on the ICC model codes, two parts based on the International Association of Plumbing and Mechanical Officials (IAPMO) models, and one on the *National Electrical Code*.

[52] California, for example was the first state to introduce an *Energy Code*, and then the *Green Building Standards Code*. Respective model codes followed.

have the right to adopt, amend, add, and delete parts of the model text. Local jurisdictions can further amend state codes in response to climatic, geographic, and topographical conditions, providing the amendments are more stringent. The complications do not end there, if not stringent enough, state codes must be applied in conjunction with mandatory federal standards, such as the *ADA Standards for Accessible Design*. They are also often used in combination with optional guidelines provided by non-governmental rating organizations such as USGBC's LEED. While based on universal standards, codes are ultimately local and site-specific. While too specific for large national and international companies, they often seem too generic for environmentalists, and local neighborhood communities. The latter group found a solution in the common interest developments (CIDs), which are regulated by private covenants, conditions, and restrictions (CC&Rs), rules built into the deeds of individual homes, and enforced by homeowner associations and their boards. The later developed the green building ratings, which make standards more stringent but arguably less site-specific. While the first, as pointed out by Evan McKenzie in his book *Privatopia* are a sign of what Robert Reich calls "secession of the successful" (1994, 23), it is yet to be seen if green ratings of isolated homes and neighborhood will create another degree of social separation or environmental injustice. CIDs and green ratings are corporate islands of affluence, and archipelagos of voluntary environmental correctness. Both potentially unsustainable.

In the 1990s, the interest in sustainability among architects increased dramatically but was far from universal, or uniform. A lot of architects embraced the green building movement and expanded their expertise by becoming green consultants. The majority, overwhelmed with the new rules to abide by, hired them and continued to design buildings the way they previously did. This, however, does not mean that they disregarded the relationship between buildings and their natural environment. As previously, some continued to ignore it, others simply refused to measure or standardize it. Not necessarily green, new aesthetic attitudes emerged while old ones continued to evolve: some architects embraced the new regional vernacular, others continued to explore the modular prefab, and others yet saw an answer in the computer-generated (and at times performance-oriented) curvilinear forms inspired by nature. While Frampton's selection in *American Masterworks* reflects some of this heterogeneity, none of the presented built houses reflects the spirit of the new digital era. Never built, Frank Gehry's *Lewis Residence* is missing,[53] and the diagram of the *Mobius House* (1998) by UN Studio was not conceived in America.

[53] Although abandoned after a decade in 1995, the project became an incubation of formal and spatial ideas, design technics, and technological solutions for future buildings. As a side note, an option developed in 1993 was discarded as it failed to meet energy codes. See *Frank Gehry* (Lemonier and Migayrou 2015, 131).

While none of the projects appear ostentatiously 'green,' Frampton's masterworks intimately engage with landscapes and natural dynamics in search of delight rather than efficiency. Steven Holl's *Stretto House* (1989-92) frames an aqueous topography with stark simplicity and modulates light through a Scarpian treatment of surface and color. The rustic *Ledge House* by Bohlin Cywinski Jackson (1992-96) carves into the site with brute strength of its own coarse materials. The weathered surfaces of the 2001 *Tyller House* by Rick Joy sink into the rusty desert to let its dwellers appreciate the stars of the Arizona sky. The *Agosta House* by Patkau Architects (1996) "dams" the energy of an open meadow with a galvanized-steel wall while protecting the house-reservoir from deer and wild fires. "Proto-ecological," according to Frampton, the 2001 *House and Studio* by Barton and Vicki Myers is a series of open (Eames-inspired) pavilions scattered across a chaparral-covered hill. Crossed by natural breeze, and covered with a thin layer of cooling water, the prefabricated frames form indoor-outdoor environments that can easily be closed off thanks to a system of off-the-shelf garage doors. While intimately related to their landscapes, these *masterworks* are not ostentatious about their greenness, we do not know how impactful they are. The outcome is not given in numbers. To recall Banham's argument, the most successful U.S. modern houses were rarely a dogmatic demonstration of the "machine aesthetics," Schindler and Neutra practiced the art of "mechanical performance" instead.[54] One may hope that the future masterworks will similarly perform sustainability rather than dogmatically display a green aesthetic or a numerical proof of it.

The greening of the housing construction took place in an era of vertical disintegration of the residential mortgage industry.[55] In the 1980s, mortgage lending shifted from local Savings & Loans to national mortgage companies which were not subject to the same strict regulations. Mortgage companies benefited from securitization via government-sponsored enterprises (GSEs), and access to an expanding secondary mortgage market (Immergluck 2009, 33-4). Not only did they provide a less-regulated investment channel for new capital,[56] but also drew advantage from economies of scale due to expanded geographic scope. They became wholesale lenders of standardized products, and thanks to advances in technology they were able to sell mortgage packages through a nationwide network of independent

[54] See *The Architecture of the Well-Tempered Environment* (1969, 168-170).

[55] According to Immergluck: "Overall, if one is forced to point at a particular development as the single greatest factor in the growth of the subprime market in the 1990s, it would have to be the vertical disintegration of the lending industry – in turn made possible primarily by the growth of securitization and the decline of the competitive advantage of the traditional depository institution model within mortgage markets (Jacobides 2005)" (2009, 74).

[56] As explained by Immergluck, the dual regulatory system encouraged "the capital funding the higher-cost and higher-risk loans – loans with more potential for containing abusive terms and exhibiting high foreclosure rates – to flow to mortgage companies" (2009, 67).

brokers.[57] This not only helped them reduce operational costs, but also shift responsibility for the origination process onto the brokers. This structural disintegration provided a safety mechanism when highly profitable, yet often abusive lending practices increased in the 2000s. As new capital flooded the U.S. market in search of low-risk, high-return investments,[58] "private-label" (non-GSE) residential mortgage products proliferated to supply them (Immergluck 2009, 76-78). Private borrowers became a perfect target as the Wall Street investment firms bundled residential mortgages into mortgage bonds and sold those to global investors.[59]

Dynamics varied regionally, in California house prices peaked in 1991, and then plunged to reach the lowest point in 1997, and then return to the previous values in 2001.[60] The trend that made them continue to peak until 2006 was fueled by extreme lending practices which exploded around 2002. Exotic loans proliferated both in prime and subprime market, as capital continued to search for investments but borrowers (both creditworthy and high-risk) became scarce.[61] High-risk subprime mortgage-backed securities gradually dominated in collateralized debt obligations (CDOs). The distance between lenders and borrower was so vast that responsibility, in case of mortgage defaults, would be impossible to

[57] Immergluck identifies four types of innovation: "(1) geodemographic marketing tools; (2) data warehousing and mining; (3) Internet usage between wholesale lenders and brokers; and (4) credit scoring and automated underwriting (Gale 2001)" (2009, 83).

[58] In a 2009 radio program "The Giant Pool of Money," Adam Davidson and Alex Blumberg report that the amount of global savings (that is capital ready to be invested) doubled after the year 2000 due to the rapid growth of new economies such as China, and India. As they point out "There is twice as much money looking for investments, but there are not twice as many good investments" Accessed February 20, 2017. https://www.thisamericanlife.org/radio-archives/episode/355/the-giant-pool-of-money

[59] In the 2000s, residential mortgage interest rates varied between 5% and 9%, as compared with 1% federal interest rate on US Treasury bonds ("The Giant Pool of Money" 2009).

[60] A rapid economic growth experienced by California in the 1980s came to a halt with the decline of the defense industry caused by federal spending cuts, and when local exports decreased due to the general crisis of the early 1990s. See "America's 4 Nastiest Regional Housing Busts," an article by Luke Mullins based on data provided by the Federal Housing Finance Agency, published by U.S. News on June 19, 2009. Accessed February 20, 2017. http://money.usnews.com/money/blogs/the-home-front/2009/06/19/americas-4-nastiest-regional-housing-busts-2

[61] According to Immergluck, lending standards gradually relaxed, subprime exotic loans proliferated around 2002: from NIVA (no income verified asset), through NINIA (no income no asset), to NINJA (no income no job no asset), and ARMs (adjustable rate mortgages) (2009, 85). The author, however, explains that subprime loans experienced its first boom already in the mid-1990 in form of 'cash-out" refinances (2009, 68). These loans were used to extract money for purposes other than house purchase. As explained in "The Giant Pool of Money," later, during the housing bubble they were used to prevent foreclosures: "These loans, called home equity lines of credit, became very popular in the early to mid-2000s partly because they were easy to get, but partly because people needed them to continue making their original mortgage payments. To pay off their debts, they went into more debt" (2009).

Fig.4. 7 The cover of the TV series Flip this House (left), the series hosts in front of a "flipped" house (right).

locate.[62] Although some brokers expressed a feeling of guilt, they followed the trend and offered the same toxic products. What convinced them, was that "the software, the data, didn't seem worried at all," in fact as the reporters points out in *The Giant Pool of Money*: "It was the triumph of data over common sense." The rating agencies also contributed to the general misjudgment, by underestimating the risks of highly-engineered finance (now directly influencing homeowners' lives), and overrating the obligations (Immergluck 2009, 112). The market was in a speculative bubble, access to "affordable" mortgage increased, but affordability of housing decreased as prices continued to rise in response to high demand (92-3). Since realtors, lenders, and homeowners benefited from swelling prices, the vertiginous spiral of premature teardowns, renovations, expansions, and new constructions continued. Some built poorly, some built green, houses sprung everywhere. As pointed out by Jonathan Massey, "Prompted as they were by financial rather than physical obsolescence, such teardowns highlighted the centrality of

[62] It seems appropriate to return to Langdon Winner's argument: "The closer you are, the more innocent; the farther away you are, the more innocent." In the 2000s, the vertical disintegration of the mortgage industry created the same "magnificent arrangement in which everyone is safe except the victims," that Winner observed in the 1970s (1977, 302).

financing to the architecture of American houses." As he further observes, media fueled the investment fever in the early 2000s: "Television series titles included *Flip This House, Flip That House, Property Ladder, Designed to Sell, Flipping Out, Curb Appeal, The Stagers, and Extreme Makeover: Home Edition (*Fig.4. 7*)*. Within the genre of reality TV, these programs dramatized the possibilities of credit-fueled speculation, much as *Better Homes* demonstration houses (like *Everyman's House*) had explicated the economic and social potential of mortgage financing in the 1920s" (2012, 41).

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The 1990s became green, and they were connected. International efforts to promote sustainable forms of development struggled to compete with the global expansion of free markets. Although even the World Trade Organization addressed the issue in 1992, it depicted the global trade system as a way to better manage environmental resources. "Being more" failed to compete with selling more, and ecological economics were interpreted as a pragmatic way to estimate the value of natural capital in order to make a more sustainable (read: efficient) use of it. The efforts to decouple economy from environmental impact produced new environmental-management methods, cap-and-trade replaced command-and-control as a market-friendly way to manage pollution and greenhouse gas emissions. Global trade expanded after the collapse of the Soviet Union, and further accelerated when China entered the WTO. Multilateral trade agreements, such as NAFTA further intensified the global flow of money and goods, but they also raised questions about the environmental impact of the unconstrained economic connectedness. Although the federal government did impose new measures to reduce production of waste, and use of harmful fuels and pesticides, trading rather than preventing defined the spirit of the decade. Recycling became viable since it was profitable. Although the green economy transformed products and practices, the natural capital it relies on finishes each year earlier.

The greening of architecture was successfully institutionalized by the U.S. Green Building Council which represented the real-estate industry eager to standardize the green practices before anyone else. Although it often met with criticism, the *USGBC Leadership in Energy and Environmental Design* certification system became an industry standard, many municipalities incorporated it into their zoning or building codes. More ambitious rating systems such as the *Living Building Challenge*, while admirable, raise questions about the limits of what can be quantified and rated, to be then certified as sustainable. Since rating systems required standardized metrics, traditional design handbooks were replaced with databases and checklists. Although most progress was made by third-party organizations, the federal government relaunched some of the legislative initiatives initiated in the 1970s, and in 1992 passed the *Energy Policy Act* which encouraged cities to adopt energy conservation codes, and imposed new energy, and water-efficiency standards. *Energy Star* program (and *WaterSense* years later) was established as part of the federal efforts to promote environmental efficiency, and indirectly green economy. The era in which the term local denoted a positive environmental quality, also produced the first truly uniform model building code, published in 1997.

Architects embraced the greenness in various ways, while many masterpieces re-engaged with the environment searching for a cosmic connection with nature, others continued formal explorations delegating the environmental cause to the certified green standards consultant, and the mechanical engineer. Possibly, the most important thing to emphasize is that the green building standards were introduced to regulate construction in an era of increasingly deregulated real-estate market. Be it green or poorly-built, most houses were simply built in contradiction with Daly's ethic of "enoughness". They were too many, or too big.

Increasingly, their construction would be driven by financial rather than material obsolescence. While architecture was becoming greener, real estate development was becoming less and less sustainable.

4.2. Mid-2000s – present: California Green Building Standards Code (2008) & the American Recovery and Reinvestment Act (2009).

The second section of this chapter, and the last in this historical overview, concentrates on the end of the 2000s, and the current decade, a period defined by the subprime mortgage crisis, which paradoxically coincided with the culmination of the green building standards efforts. The aim in this section is to explain the context in which the green building standards were eventually adopted as code, one of extreme financial deregulation, real-estate speculation, and eventually socio-economic crisis. The objective is to highlight the contrast between the agendas that drove the adoption of green building standards, and the environmental impact of residential construction caused by the deregulated real-estate speculation. While the environmentally-related strengths and weaknesses of the building code will be explored in detail in the following chapters, this section will hopefully demonstrate the general limitations of the premises behind the green construction standards in face of the challenges posed by the speculation-driven economy.

In the late 2000s the housing industry was brought to its knees by the mortgage market collapse. While only serving the system, architects contributed to it by designing more and more mortgage collaterals in form of houses, which since often oversized or superfluous undermined the significance of the on-going environmentally-oriented efforts. Disregarding the financial aspect of construction, most architects responded to the crisis by promoting more technological innovation. Green prefab, as exemplified by Kaufman's houses, experienced a period of renewed success. Other, alternative ideas emerged in response to both social and environmental unsustainability of the housing market. Some emphasized the importance of size by promoting tiny houses, and others focused on local knowledge and resources. In the meantime, mainstream green architecture became elegant enough to be absorbed by the media. Design magazines and TV shows promoted the modern green spirit and expressed curiosity towards the tiny houses. Several important acts were passed to further improve energy-efficiency standards both before and after the subprime crisis. California passed the *Global Warming Solutions Act* acknowledging another reason for the adoption of energy-efficiency measures, while the federal government continued to make national standards more stringent. Importantly, the 2009 ***American Recovery and Reinvestment Act*** indirectly forced states to adopt energy conservation codes if they wished to receive federal funding. Eventually, in 2008 California adopted the first in the U.S. ***Green Building Standards Code***. Four years later, the International Code Council released its own model green construction code. As the attention of code-makers is now shifting towards construction resilience, the second wave of ecological economists is again questioning the basic premises behind the economy that triggers the need for these regulations in the first place, one that encourages management of consequences rather than their prevention.

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The hyper complex architecture of the financial market, built upon deregulated policies and advanced data technologies, successfully connected impatient investors, via dishonest arrangers and issuers, greedy brokers and 'inaccurate' appraisers, with inexperienced house-flippers, and, most worryingly, with

uninformed or desperate would-be homeowners.[63] As borrowers defaulted, foreclosed properties were put back on the market. 17% of subprime mortgage homes were foreclosed in 2008.[64] Suddenly, priceless tulips became ordinary flowers.[65] The crisis left house-flippers with worthless properties, and local lenders with unsold mortgages (Immergluck 2009, 107). As mortgage payments stopped flowing back, deluded investors returned to no-risk bonds. These led to a freeze of credit and economic growth. While the subprime crisis affected many different people, who hoped to make profit as the money trickled through the system, most actors only temporarily took risk while temporarily handling capital owned by others. While both investors and end borrowers paid a high price, the homeowners-occupiers who already owned very little, were the ones to lose everything. Both the greedy ones and the uninformed.[66]

Although highly complex, the mortgage-backed securities system itself included no safety mechanism to mitigate the impact of foreclosures. Unlike the traditional Savings & Loans, mortgage companies were unable to restructure the loans (which they did not own) to prevent foreclosures. To protect the interests of different tranches of investors, the trusts which held the loans had no right to modify the distribution of cash flow (Immergluck 2009, 122-3). Bundled, pooled, sliced up, and bonded back together into toxic pools, mortgages translated into strings of monthly payments, abstract data in a spreadsheet. Since homeowners were no longer concrete entities, their integrity was not protected. The risks and profits assigned to particular investor tranches were sacred. Perfectly-engineered, the system collapsed. Although in 2008 the Congress passed the *Housing and Economic Recovery Act* (HERA, Public Law 110–289), as foreclosures continued, the bail-out measures which protected the investment bankers came

[63] Immergluck explains: "Many parties involved in supplying mortgage credit had little capital at stake in the lending process and were rewarded merely for processing more and more loans through their systems" (2009, 99). Brokers (compensated with a percentage of the loan value) would often convince borrowers out of cheaper, and less risky, options (101-05, 141). Appraisers were pressured to inflate house values (105). Lenders would withhold information about loans from mortgage-backed security issuers (107). Rating agencies overrated securities as their income depended on issuers rather than investors. CDO arrangers sold toxic loans as AAA bonds to investors (109).

[64] Immergluck reports (per the Mortgage Bankers Association National Delinquency Survey), that the foreclosure rate of subprime mortgages was 5.8% in 1998, and it reached 17% in 2008. In the same period, prime mortgage foreclosure rate was approx. 0.8% until the general crisis affected it in 2007-08 and rates reached 2.4%. This was mainly caused by the increase in adjustable rate loans (2009, 136-7).

[65] In the 17th century, the Netherlands experienced a speculative frenzy of buying and selling tulips – the "tulipomania.' At the height of speculation, single flowers, bulbs, or even promissory notes were sold for sums that could buy a house. Michael Pollan tells the story of this frenzy in his *The Botany of Desire* (Chapter 2 "Desire: Beauty / Plant: The Tulip") (2001).

[66] Subprime lending was disproportionally high among minorities, especially African American who had historically a reduced access to prime mortgage channels (Immergluck 2009, 79, 81). It was also higher among, older, divorced, and female borrowers (102). Immergluck however also points out that many subprime loans borrowers were eligible for prime loans, but they were convinced or incentivized to take out riskier loans with, for example, high loan-to-value ratios or high debt-to-income ratios (2009, 142).

Fig.4. 8 A street of newly-built homes for sale due to foreclosure.

quicker and were more comprehensive than the steps undertaken by the federal government to save low- to average-income (and often minority) homeowners-occupiers.[67]

While not central to the subprime crisis, developers, construction companies, and architects were instrumental in the process. They were financially rewarded for developing new land and building bigger homes to satisfy market's need for attractive loan collaterals. Efforts towards sustainable development were offset by increase in household size, and frequency of premature home improvements. The centrality of financial speculation challenged the underlying premises of the green building movement

[67] As explained by Immergluck, many of the initial measures to help defaulting borrowers were too limited (such as the FHA Secure Program), only voluntary (Hope Now), or simply blocked by law-makers, while measures to rescue bankers and stakeholders were more decisive and comprehensive (2009, 184-92). Most famously, "the collapse of Bearn Stearns in early 2008 and the Federal Reserve's unprecedented involvement in rescuing the firm's bondholders and arranging for the firm's takeover by J.P. Morgan Chase" (134). Although, the 2008 HERA act was followed by the *American Recovery and Reinvestment Act* (ARRA, Public Law 111-5), and the *Preventing Mortgage Foreclosures and Enhancing Mortgage Credit Act* (Public Law 111-22) which provided further foreclosure mitigation measures in 2009, in late 2008, the Congress passed the controversial bail-out act, the *Emergency Economic Stabilization Act* (EESA, Public Law 110–343), which included the *Troubled Asset Relief Program* (TARP). The "too big to fail" were protected. (One of the aims of the 2010 *Dodd–Frank Wall Street Reform and Consumer Protection Act* (Public Law 111-203) was "to end "too big to fail", to protect the American taxpayer by ending bailouts, to protect consumers from abusive financial services practices."

which promoted energy and resource conservation in individual homes but disregarded the impact of overbuilding and environmental consequences of potential foreclosures. One could risk saying that it was the same speculative construction boom that financed the emergence of green standards and generated an ever-greater need for them. The wave of subprime crisis foreclosures damaged individual lives, disrupted social ecologies,[68] and scarred urban landscapes.[69] Ghost houses were abandoned to deteriorate before anyone got a chance to inhabit them. Homes built to satisfy financial rather than existential demand devoured land, destroyed vegetation and soils, and wasted power, water, and materials before anyone could even assess their overall greenness, or their operational energy efficiency. Thousands were eventually demolished to mitigate negative impact on neighborhoods and reduce maintenance costs to cities.[70] In a spectacular way, the subprime crisis reminded us the common etymological roots of ecology and economy. Sustainability of housing construction is possibly first a matter of financial and only then environmental civility.

Although rising prices and poor quality of quickly-built houses and McMansions could hardly be blamed on lack of advanced technology or green spirit, most architects underestimated the centrality of financial speculation. While it was the excessive demand and the value of scarce land (especially in urban areas), rather than construction costs, that priced ordinary people out of the housing market, they addressed the issue by promoting more architectural and technological innovation. The pragmatic aesthetic of modern

[68] Except for immediate financial losses, borrowers' default is inscribed for years to come into their credit history and scores which often determine what kind of property they can rent when forced to relocate after a foreclosure. Relocating forces families to abandon homes (which for most means family rather than an investments) and social networks that support them, including friends, family, community centers, churches, or child care, and education. It also weakens those structures for those who remain in the neighborhoods. Immergluck reports that many people who should default and relocate to minimize financial losses choose not to because of those social structures that they rely on (145-6). On the other hand, many renters were forced out of foreclosed properties.

[69] Among important consequences: 1) decrease in property tax revenues, and additional costs of management of vacant properties to municipalities (Immergluck 2009, 152); 2) negative impact of abandoned homes on the general quality of life and safety in neighborhoods with high rates of foreclosure; 3) lowering house prices in the vicinity of vacant property (149-50); 4) excessive development of cheaper outer suburban land.

[70] A 2015 Detroit News article "Volume of abandoned homes 'absolutely terrifying'", reports 139,699 total homes foreclosed since 2005 (1 in 3), and 56 percent of all mortgage foreclosures blighted, and requiring to be either demolished or foreclosed again for nonpayment of taxes. Accessed February 22, 2017. http://www.detroitnews.com/story/news/special-reports/2015/05/14/detroit-abandoned-homes-volume-terrifying/27237787/ In a 2013 guide entitled *On the Road to Reuse: Residential Demolition Bid*, the Environmental Protection Agency (meant to help reduce the environmental impact of demolitions) reports numbers for Ohio: "The most recent Census found that the vacant housing units grew by 44% from 2000 to 2010. Calculations of demolition demand in the eight largest cities in Ohio conservatively estimate over 40,000 potential demolitions over the next five years in those cities alone (Mallach 2012)." (2013, 7). Retrieved February 22, 2017. https://www.epa.gov/sites/production/files/2013-09/documents/road-to-reuse-residential-demolition-bid-specification-201309.pdf

Fig.4. 9 The cover of Michelle Kaufman's book Prefab Green (top left), one of her designs; Glidehouse (bottom left), a poster from the MOMA exhibition Home Delivery (right).

prefabricated houses experienced a revival in the 2000s and enjoyed popularity among a broader public even when prefabrication was abandoned and only the aesthetics remained. Success of Michelle Kaufman's prefabricated *Glide House* (2004) was officially confirmed when in 2006 its full-scale replica was exhibited at "The Green House: New Directions in Sustainable Architecture and Design" show at the Washington National Building Museum. Prefabrication was also recognized as an important trend in the 2008 MoMA exhibition "Home Delivery: Fabricating the Modern Dwelling." In the spirit of the *Better Homes* demonstration projects, the MoMA sponsored the design and construction of five prefabricated houses. Among them, the high-tech, SmartWrap-sealed, no-waste *Cellophane House* by Kieran Timberlake, and the *Digitally Fabricated House for New Orleans*, an ornamented yet fully digitally-fabricated shotgun house, a truly American combination of nostalgia and technology by Lawrence Sass, MIT.[71] Still, none of the recent prefabricated green homes found its place among Frampton's *American Masterworks*. Not even the winner of the 2007 AIA/COTE Top Ten Award for sustainable design, Ray Kappe's LEED Platinum-rated *Z6 House* designed for LivingHomes. One may wonder whether it is due to

[71] See the exhibition catalogue, *Home Delivery: Fabricating the Modern Dwelling* (Bergdoll et al 2008).

an excess in green zeal. Although many *Solar Decathlon* demonstration projects also deployed it as a 'signifier' of ecological, and after the crisis, economic restraint,[72] as in previous decades, prefabrication did not manage to threaten the stick-frame construction market this time either.[73] While the prefab green was launched as an antidote to environmentally, and economically unsustainable housing, it once again failed to provide an affordable alternative to rising prices of traditional homes or compete with the price of home kits sold online. It did create a new, green niche market instead.[74] In fact, despite the financial meltdown, Kaufmann's assets were acquired in 2008 by a luxury prefabricated green home manufacturer Blu Homes (Fig.4. 9).[75]

Another phenomenon which emerged as a result of economic and environmental unsustainability of available housing was the tiny house movement. While in 2011 less than 1% of Americans purchased a house smaller than 1,000 sq. ft.,[76] a typical tiny house is approx. 150-300 sq. ft., but tiny house village activists are building even smaller units hoping to provide "transitional micro-housing," and an address, to otherwise homeless people.[77] Acceptable according to the ICC model building code, the tiniest of tiny houses (approx. 90 sq. ft.) are too small to be considered an independent dwelling unit in many states.

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[72] The Solar Decathlon program was launched by the U.S. Department of Energy in 2002 and is now in its 8th edition. With few exceptions (such as the 2005 MiSo House designed by the University of Michigan team, or the 2011 CHIP House built by the team from SCI-Arc/Caltech), projects tend to embrace the simplicity of the prefab green construction. For a preview of the current contest, see the website. Accessed February 14, 2017. https://www.solardecathlon.gov/blog/archives/4363

[73] In his account of factory-assembled homes of the 1930s, Greg Hise observes: "The Gunnison prototype led many to believe that factory prefabrication would set home building on the desired track. However, residential construction was not amenable to this production type. Instead, quantity or large-batch production and the use of jigs and templates revolutionized home building." See "Manufacturing the Minimum House," in *Magnetic Los Angeles* (1997, 71-79). A similar argument is made by Ned Eichler when he discusses the impact of prefabrication in the post-war period in *The Merchant Builders* (1982, 67 and 77).

[74] While Kaufman's *mkLotus* house was advertised around 2009 at $125,000 ($181 per sq. ft.), the almost identical 640-square-foot *LotusMini* sold by Blu Homes starts at $425,000 ($358 per sq. ft.). See respectively, prefabs.com directory, and the Blue Homes website. Accessed February 18, 2017. http://www.prefabs.com/PrefabHomes/MichelleKaufmannDesigns/mkLotus.htm and https://www.bluhomes.com/lotus-mini Considering that the average cost of construction, as reported by National Association of Home Builders, was $103 in 2015 neither of them is an affordable alternative. See the NAHB website. Accessed February 18, 2017. https://www.nahbclassic.org/generic.aspx?genericContentID=248306

[75] While Kaufman's company did not survive the housing crisis, her 2009 book *PreFab Green* was very popular, and she was recognized as a pioneer of the prefabricated green homes movement. See the website of Blu Homes. Accessed February 14, 2017. https://www.bluhomes.com/news/press-release/blu-homes-acquires-assets-mkdesigns-home-designs-green-prefab-pioneer-michelle

[76] This is according to the National Association of Realtors, as reported in a 2012 article published by *The Huffington Post*. Accessed February 24, 2017. http://www.huffingtonpost.com/2012/10/22/downsizing-for-retirement_n_1961961.html

[77] Tiny house villages have been developed as a self-built and community-managed alternative to tent camps. See a 2017 article on tiny house villages on the website of the *Tent City Urbanism* website. Accessed February 23, 2017. http://www.tentcityurbanism.com/2016/12/2016-in-review-next-wave-of-villages.html

Fig.4. 10 The poster for the FYI TV series Tiny House Nation (left), a chart showing the growth of single-family houses between 1973-2010 (top right), an internet article discusses the impact of growing size of homes on energy efficiency (bottom right).

The *California Health and Safety Code* (17958.1) defines efficiency dwelling units (for no more than two persons) as having a minimum floor area of 150 sq. ft. *California Residential Code* makes this provision more stringent: an efficiency dwelling unit must be at least 220 sq. ft. (not including a mandatory closet and bathroom).[78] Still, even the biggest of the tiny houses (the ones that comply with these standards) are at least 10 times smaller than an average American home. The median house was 2,467 sq. ft. in 2015. The 1,525-square-foot home considered median in 1973 is, today, considered a small house.[79] It would be a considerable achievement to return to those standards, if one has to pursue the American dream of owning a detached cottage. As it often happens, the (tiny-house) counter-reaction to spatial and financial gluttony was extreme, yet extreme is also the unaffordability of available houses, even the small ones.

[78] Although the 2016 *California Residential Code* includes a state amendment which imposes a minimum size of an efficiency dwelling unit to 220 sq. ft., excluding a separate closet and bathroom (R304.5), the ICC model residential code only specifies the size of habitable rooms. This used to be 120 sq. ft. (for one room at least) and is now 70 sq. ft. regardless the number of rooms (R304.1) According to the ICC model code, a habitable space can consist of a 70-square-foot room and a bathroom.

[79] This data is based on statistics provided by the U.S. Census Bureau as reported in a 2016 article published on the American Enterprise Institute website. Accessed February 23, 2017. http://www.aei.org/publication/new-us-homes-today-are-1000-square-feet-larger-than-in-1973-and-living-space-per-person-has-nearly-doubled/

While tiny houses are seen by many as a sustainable alternative to scarce (and still unaffordable) low-income housing, for many others they are an embodiment of the romantic 'Walden' dream.[80] Not surprisingly, this fringe phenomenon attracted enough attention among viewers and potential homeowners to justify the launch of more TV shows. In 2014, HGTV released the *Tiny House, Big Living*, and FYI TV launched the *Tiny House Nation*.

A locally-rooted, and hence less 'spectacular' yet highly admirable counter-reaction to generic prefabricated green homes (and romanticized green tiny trailers) has been explored by Rural Studio, a design-built program based at the University of Auburn and founded by Samuel Mockbee and D.K. Ruth in 1993. While Frampton had no place for such minor masterworks as the 2001 *Corrugated Cardboard Pod*, or the 2002 *Lucy Carpet House*, these projects respect (and explore) cultural, economic, and environmental constraints without neglecting the aesthetic dimension of architecture. In 2005 Rural Studio launched an affordable-housing program which continues today. The main premise of *the 20K Home* is to provide a locally-built alternative to the generic homes found in trailer parks. Far from spectacular, Rural Studio projects are both pragmatic and delightfully inventive. What makes them unique is the recognition of the fact that true sustainability is local rather than universal, and that the financial architecture of the house must be equally designed locally rather than speculated upon globally. To be sustainable, home architecture must be financially-sound.[81]

In the last decade, architects have explored sustainability in many different ways; with or without concern for green metrics. From a LEED-certified (tiny) prefabricated green *Porch Houses* designed in 2010 by the highly successful Texas-based studio Lake|Flato, through the 2012 modern version of an earthship, the *Edgeland House* by Bercy Chen Studio, to the 2015 *Wing House* by David Hertz. The range of houses awarded with the AIA/COTE Top Ten also confirms that sustainability does not entail a specific aesthetic.[82] No longer only an expression of an alternative culture (as it was in the 1970s), in the 1990s the green

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[80] Henry David Thoreau lived near Walden Pond in a 150-square-foot cabin while writing *Walden* in the 1840s.

[81] As explained by Rural Studio: "The $20,000 budget has origins from the 502c Direct loan program." The design of the house complies both with the local building code and the FHA requirements to expand financing opportunities for future 20K Home owners. See the Rural Studio blog. Accessed February 22, 2017. http://20khouse.ruralstudioblogs.org/post/3662915518/fha

[82] Except for Kappe's *Z6*, seven other houses won the award. Among them there were three private residences: *Yin Yang House* by Brooks+Scarpa (2011, Top Ten 2013); *Solar Umbrella House* Pugh + Scarpa (2005, Top Ten 2006); *Wine Creek Road Home* by Siegel & Strain Architects (2002, Top Ten 2003); and four 'demonstration' projects: *A New Norris House*, designed by the University of Tennessee College of Architecture & Design (2011, Top Ten 2013); *OS House* by Johnsen Schmaling Architects (2010, Top Ten 2011); *Special No. 9 House* by John C. Williams Architects and KieranTimberlake (2008, Top Ten 2010); and *Factor 10 House* by Esherick Homsey Dodge & Davis (2003, Top Ten 2004).

architecture got absorbed by the market. By the mid-2000s, it was elegant enough to be featured on the sleek pages of *Dwell Magazine*. It was marketable enough to be effectively flipped on TV. Despite the crisis, in 2007 *This Old House* 'turned green',[83] and in 2008 HGTV launched the new series entitled *Green House*, eventually renamed *Smart House* in 2013. In fact, when in 2008 Michelle Kaufman built a prefab green house on the grounds of the Chicago Museum of Science and Industry, it was part of the "Smart Home: Green + Wired" exhibition. Smart is the new green.

Consumed by the media, the greening of architecture is slowly being incorporated into mandatory building codes. The first green building standards code was introduced in California in 2008 and was spurred by a series of state (and federal) acts addressing, again, energy independence, and now also global warming. In 2006, once more first in the nation, California enacted the *Global Warming Solutions Act* (Assembly Bill 32) which requires the state "to reduce its GHG emissions to 1990 levels by 2020 — a reduction of approximately 15 percent below emissions expected under a 'business as usual' scenario."[84] The 2005 *Energy Policy Act*, the *Energy Independence and Security Act* of 2007 (EISA, Public Law 110-140), and the *American Recovery and Reinvestment Act* of 2009 (ARRA) introduced more stringent standards, appliance efficiency rebates, provisions for energy-efficient home tax incentives, weatherization assistance programs, and incentivized states to adopt energy codes. According to the Alliance Commission on National Energy Efficiency Policy it was "The most recent catalyst for the widespread adoption of building energy codes across states," as ARRA "technically required states to adopt codes (2009 IECC and ASHRAE 90.1 -2007) prior to receiving stimulus funding through State Energy Program (SEP)" (2013, 9).

Since obtaining a private-label green building certificate posed a financial challenge and brought few advantages to smaller residential developers and homeowners, these groups were initially excluded from the mandatory compliance with LEED standards that was imposed onto federal and commercial buildings in many state building codes. Eventually, in response to the objectives set in the 2006 *Global Warming Solutions Act*, California Building Standards Commission developed the *Green Building Standards Code*

[83] This eco-friendly season was dedicated to an Austin craftsman bungalow. One of the episodes was entitled: "Where Green Building Was Born." (Austin's Energy Green Building Program introduced in the early 1990s was the first rating system in the U.S.) See *This Old House: Season 26, The Austin House* (2007). Accessed February 13, 2017. https://www.thisoldhouse.com/watch/austin-house

[84] See the website of the California EPA, Air Resource Board. Accessed February 24, 2017. http://www.arb.ca.gov/cc/ab32/ab32.htm

Fig.4. 11 The cover of the first edition of the California Green Building Standards Code, CalGreen (left), the cover of the first International Green Construction model code (right).

(CalGreen), and in 2008 published it as Part 11 of the *California Code of* Regulations, Title 24 (Fig.4. 11).[85] Initially a voluntary option, in 2010 the measures became mandatory for almost all types of new constructions. As explained in the *Guide to the 2016 Green Building Standards Code*, the main objectives of the *CalGreen Code* are to: "(1) reduce GHG from buildings; (2) promote environmentally responsible, cost-effective, healthier places to live and work; (3) reduce energy and water consumption" (ICC 2017, viii). In a somewhat awkward language article 101.2 states: "The purpose of the *CalGreen* code is to improve public health, safety and general welfare by enhancing the design and construction of buildings through the use of building concepts having a reduced negative impact or positive environmental impact and encouraging sustainable construction practices" (2). Even in this environmentally-driven code, the goal is again to improve human health, safety, and welfare. The well-being of the environment is merely a step towards it.

[85] As explained in the *Guide to the 2016 California Green Building Standards Code*, the governor vetoed the initial legislation, and specified that state should not rely on private entities to set the standards (ICC 2017, viii).

Fig.4. 12 An article by GreenBuilder Resilient Housing featuring "super shelters" (right), the White House note reporting the Resilience through Codes initiative (left).

Ultimately, in 2012, ICC introduced a new overlay code, the *International Green Construction Code* (IgCC) to standardize the minimum requirements for sustainable construction (Fig.4. 11).[86] With this latest addition, ICC recognized the work done by, among others, USGBC and the state of California as sufficient to prepare policy makers, the market, and general public to accept an additional layer of restrictions in all types of construction.[87] Although, only 6 states and local governments in 4 other states had adopted the IgCC in early 2015, by October 2016 IgCC was adopted by local jurisdictions in 6 additional states. The greening of building codes is under way. [88] The green apparatus is in place, yet, there will be other side-effects to be addressed. In fact, in 2016 the Obama Administration launched a public-private initiative meant to "increase Community Resilience through Building Codes and Standards" (Fig.4. 12). The press

[86] See the IgCC webpage. Accessed February 24, 2017. http://www.iccsafe.org/codes-tech-support/codes/2015-i-codes/igcc/

[87] Noteworthy, USGBC whose interest is to maintain LEED certifications on the market, responded by recognizing *CalGreen* requirements towards LEED points, to both maintain its position, and mark a clear distinction between the *CalGreen* baseline and USGBC ambition to set the highest standards.

[88] See "International Codes - Adoption by State (October 2016)." Retrieved February 24, 2017. http://www.iccsafe.org/gr/Documents/stateadoptions.pdf

note explained that the purpose was to: "highlight the critical role of building codes in furthering community resilience and the importance of incorporating resilience and the future impacts of climate change in the codes and standards development process."[89] The next set of practices to be standardized will have to focus on the prevention of climate-change-triggered damage, in other words on resilient construction which, if we continue on the current path, should provide yet another managerial solution to a problem that we have failed to prevent.

Twenty years after the *Kyoto Protocol*, environmentalists continue to fight against the politics supporting the economy of extractionism and denounce the impact of free trade and unconstraint economic growth on natural ecosystems and social ecologies.[90] Although critics of growth-based economy are in the minority, they persist, and return to the same questions in moments of acute crisis. In 2007, at the height of a period of apparent economic prosperity, just before the collapse of the financial market, and forty years after the original publication of Daly's *Steady-State Economics*, Mark Anielski asked again: "Why do economists, financial analysts, politicians and media fixate on growth measures (such as the GDP or gross domestic product) as the key indicator of human progress?" and "What is driving our more-growth, more-consumption obsession?"[91] At the same time, the ecological economist Peter Victor was completing his book *Managing without Growth: Slower by Design, Not Disaster* (2008) in which he explained how growth only recently became the main economic objective of government policies, and why developed countries should be transitioning out of it. Among other things, he emphasized (after Daly) that the absolute throughput of materials and energy had to be reduced, that decoupling of economic growth from environmental impact did not work, and that technology (and relative efficiency) should not be perceived as the ultimate solution to social and environmental dilemmas. In 2010 in *Prosperity without Growth* Tim Jackson also questioned economic growth and the meaning of technological progress: "Our technologies,

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[89] See the White House website (Obama archives). Accessed February 25, 2017. https://obamawhitehouse.archives.gov/the-press-office/2016/05/10/fact-sheet-obama-administration-announces-public-and-private-sector

[90] For example, 350.or founded by Bill Kibben organizes climate-focused campaigns against fossil fuel projects and promotes community-owned low-carbon initiatives. Earth First! provides "media from the frontline of ecological resistance," publishing news and resources regarding direct action "in defense of living systems around the world." These, and many other organizations (i.e. Greenpeace), have been actively involved in actions against such project as the Keystone XL tar sands pipeline and the Dakota Access fracked oil pipeline in 2016. All of the mentioned organizations were actively involved in such events as the BP Oil Spill. According to the National Oceanic and Atmospheric Administration, the 2010 BP's Deepwater Horizon Oil Spill injured ecosystems, and was the largest offshore oil spill in U.S. history. Examples of environmental impact of free trade agreements were reported in the previously mentioned document co-authored by Sierra Club: *NAFTA: 20 Years of Costs to Communities and the Environment*, see note 14 above.

[91] These are some of the questions that open *The Economics of Happiness*, in which Mark Anielski presented an alternative economic model called Genuine Wealth (1).

our economy and our social aspirations are all badly aligned with any meaningful expression of prosperity." (2)

Eventually, in 2011 in *The End of Growth* Richard Heinberg returned to the 1972 *Limits to Growth*: "The authors […] concluded that the end of growth would probably arrive between 2010 and 2050," and added: "Growth scenario study has been re-run repeatedly in the years since the original publication, using more sophisticated software and updated input data. The results have been similar each time" (2011, 6). While many have tried to discredit the message, a plausible future was written in the 1972 report, just not in form a spectacular apocalypse out of Mike Davis's *Ecology of Fear*. A 2016 Los Angeles Times article reported that house prices in the Los Angeles area have reached the record levels of 2007 and will continue to rise beyond the previous peak as they 'normally' do.[92] As Heinberg explains: "we have created monetary and financial systems that require growth" (6).

When talking about the misinterpretation of the concept of sustainable development set out in the *Brundtland Report*, Peter Victor quoted Jim MacNeill: "Only in a Humpty Dumpty world of Orwellian doublespeak could the concept be read in the way that some suggest (2006)."[93] While many important standards and policies continue to be introduced,[94] and Paris agreement was signed in 2015, climate continues to change.[95] In the meantime, we *advertise* sustainability in terms of net-zero, carbon-free technologies, and smart cities which continue to grow and consume. Governments fine-tune green building standards, concentrating on incentives for efficient technological artifacts, and guaranteeing demand among potential consumers by regulating the minute details of private lives. With the introduction of mandatory green building standards, the spirit of sustainable morality has finally

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[92] In the article Dana Kuhn (Corky McMillin Center for Real Estate at San Diego State University) explains: "The peak value in any given cycle has always exceeded the peak value in the previous cycle. So, there was no question in my mind — even during the depths of the downturn — that we would get back to peak [price levels] because we always have. It's only a question of how long it takes to get there. Of course, it took quite a long time this time because [the recession] was so bad. The only question is how many more years of increases beyond that peak can you expect? I don't know anyone who can tell us that." See "Why home prices in Southern California keep climbing," Los Angeles Times (Peltz 2016). Accessed February 25, 2017. http://www.latimes.com/business/la-fi-qa-home-prices-20160713-snap-story.html

[93] Jim MacNeill was Secretary General of the WCED (Brundtland Commission) and one of the main authors of *Our Common Future*. This statement was quoted in a lecture given by Victor in 2013 at the York University. Accessed February 24, 2017. https://www.youtube.com/watch?v=pZI2RDNvd6M

[94] Among them the first *National Standards for Mercury Pollution from Power Plants*, published by EPA in 2011, and the *Air Pollution Standards for Oil and Natural Gas*, updated by EPA in 2012.

[95] According to the National Hurricane Center, the 2012 Hurricane Sandy was "expected to rank as the second-costliest cyclone on record, after Hurricane Katrina of 2005, and will probably be the sixth-costliest cyclone when adjusting for inflation, population and wealth normalization factors." See "Tropical Cyclone Report Hurricane Sandy" (2013, 13). Retrieved February 25, 2017. http://www.nhc.noaa.gov/data/tcr/AL182012_Sandy.pdf

conquered the last uncharted territory: *oikos*. And if, as Christopher Hight says, "Ecology is the central administrative knowledge for the ordering of things within an age of biopower" (2014, 94), the household is the smallest arena for *miniaturized instruments of coercion* (Guattari 1984, 263). As such it is a perfectly standardized market for green products.

***

The subprime mortgage crisis deeply affected the housing industry, and indirectly undermined the validity of the premises behind green construction. Since the architecture of the financial market that fueled the real-estate boom lacked sufficient safety mechanisms, the eventual crisis generated a massive wave of mortgage defaults causing a socio-economic catastrophe and leaving behind thousands of abandoned houses. Some clearly superfluous, many desperately needed but no longer financially accessible to their previous owners. Although most of it happened without them, architects helped design and build many and too big houses driven by financial rather than vital needs, and in this contradicted the basic ecological premises of green building standards – care for the environment, and restraint in the use of natural resources.

They also misplaced their energies when they tried to contribute a technological solution to a financial emergency. By again focusing on prefabrication, they hoped to come up with a cheaper, and this time also environmentally-friendly solution. While some again turned towards the automobile industry, promoting homes on wheels, they did it hoping to minimize the financial and environmental unsustainability of available houses by scaling them down to a minimum. While tiny houses promoted lightness and mobility, Rural Studio focused on local resources – both in traditional design (or material) terms, and in relation to the financial mechanisms that make design accessible to who needs it. Although Rural Studio achieved a hard-to-match level of design excellence and (low-tech) environmental sophistication, the results were neither easy to replicate not particularly appealing to average middle-class homeowners whose homes, in any case, were rarely designed by an architect. The modern green prefab was however well received by the readers of design magazines such as Dwell. TV shows also promoted the green spirit, increasingly focusing on its smarter, wired face. All of them, magazines, readers, TV shows, and their viewers disregarded the impending collapse of the housing market, or better, they thrived on it as it lasted.

In the meantime, more state and federal energy-efficiency-driven legislation was enacted. California passed the first in the nation act which recognized global warming as an impending threat, and another valid reason to promote energy-efficiency-driven regulations. A series of federal acts further increased the stringency of efficiency standards, but as the housing boom transformed into a crisis, they increasingly coupled it with measures meant to stimulate economic recovery. The 2009 *American Recovery and Reinvestment Act* which authorized stimulus funding, made it conditional upon adoption of energy conservation codes. It was clear again that energy-related legislation was economically rather than environmentally driven, but the rise of the global warming as a new critical agenda made the motivations less evident. When in 2008 California adopted the first in the U.S. *Green Building Standards Code*, it too confirmed that the underlying motivations have not really changed. It was driven by resource security, and of course human health, safety and welfare, rather than a true concern for the environment.

With increasing climate-change-related disasters posing more and more risk to the housing stock, the code-makers are turning their attention towards resilience, and will, most likely, soon recommend and then impose another layer of regulations. In the

meantime, environmentalists and ecological economists continue to question the underlying premises behind our economic and social systems. While more and more people point out that we should be preparing for the end of economic growth, we continue to discuss how to attain sustainable development. What the green building standards have surely achieved is to finally bring this doublespeak home; into the American dwelling.

PART 2 – MECHANICS

(…) an old adage a posse ad esse non valet consequential. (I take this to mean: just because something can be, it does not follow that it should be.)

- George Parkin Grant, 1986

It simply is.[1]

- Jacques Ellul, 1954

[1] In *The Technological Society*, Jacques Ellul says: "A surgical operation which was formerly not feasible but can now be performed is not an object of choice. *It simply is.* Here we see the prime aspect of technical automatism. Technique itself, *ipso facto* and without indulgence or possible discussion, selects among the means to be employed" ([1954] Eng.: 1964, 80).

Introduction

Interactions between social, economic, and environmental ideas and programs have shaped the present-day building regulations. As demonstrated in the first part of this study, the gradual accumulation, or better, legitimization of different motivations determined the code-making circuits, and the character of the American house. The complicated system of codes formed slowly in response to changing socio-economic realities, but today it is applied as a rarely questioned, indivisible (although expandable) apparatus. Environmental concerns affected residential regulations late in comparison with the legislation which targeted territorial dynamics, and they were the last ones to be added to the existing *stack* of codes. While the greening of architecture was, in part, a reaction to the excessive economic growth, and its detrimental impact on the natural environment; the commercial potential of green building standards was quickly leveraged by the market. Incentivized in a number of stimulus acts, energy-efficient appliances, and green construction systems were ultimately promoted to boost the waning economy and improve energy security.

Most economists represent the circular flow of economy as a process suspended in a void (Fig.P2.1a). The consequence is that they either assume that it exists in an infinite land of bounty (Fig. Fig.P2.1b), or that somehow nature is a bottomless mine, a system subservient to economy (Fig.P2.1c). These unspoken assumptions underpin economic models, and since neoliberal economists have been promoting these

models as receipts for reality, they do eventually determine its shape. While such way of conceiving of the environment was understandable when economy was comparatively small, due to its exponential expansion (Fig.P2.1d), economy should now be drawn – as advocated by Herman Daly – in a *tight* box (Fig.P2.1e).[2] A partial realization of this fact has, of course, affected the measures promoted by the proponents of green economy and green building standards. Yet, as explained by Daly, what is required is not just relative efficiency (i.e. better technologies and recycling) but absolute limits imposed onto the flow of economy which is not a closed circular loop. Yet these limits have not been established, and we continue to focus on the relative efficiency of the interface that connects economy with the environment – technology.

George Parkin Grant wrote in *Technology and Justice*: "The very American neologism brings before us our novelty. When 'technology' is used to describe the actual means of making events happen, and not simply the systematic study of these means, the word reveals to us the fact that these new events happen because we westerners willed to develop a new and unique co-penetration of the arts and sciences, a co-penetration which has never before existed" (1986, 12). The events and ideas described in the first part gradually connected the knowing of nature – science of ecology, with the making of domestic architecture – art of building. Technology, as broadly defined by Grant, was omnipresent in this process, if not explicitly as artifacts, then implicitly either as science at their service,[3] or as technics in their support. Architecture absorbed certain ways of thinking about and acting upon the environment into its own "means of making events happen," creating a unique technological interface. Not only were these ideas incorporated into artifacts (appliances, equipment, construction materials and systems), but they were also reflected in the technics that support the social acceptance, diffusion, and use of these artifacts: technics of organization – from informal practices to bureaucratic management; coercion – unwritten norms and legislation; and incentivization – cultural motivation and financial incentives (Fig. P2.2). Therefore, as knowing and making

[2] The argument about the finite nature of the planet should be always made considering the human perspective, it does not assume an absolute finiteness, or its incapacity to regenerate at some point.

[3] Mumford dedicated an entire chapter to this issue in *The Pentagon of Power*, in the section entitled "Science as Technology" he said while talking about the seventeenth-century polymath: "Bacon brought science to earth." He linked science to technique recognizing in this union a way to fulfil "the immediate human desire for health, wealth, and power" (1970, 106). In *Science of the Modern World,* Whitehead wrote about Bacon's prophecy realized in the 19th century: "Science, conceived not so much in its principles as in its results, is an obvious storehouse of ideas for utilization. But, if we are to understand what happened during the century, the analogy of a mine is better than that of a storehouse. (…) One element in the new method is just the discovery of how to set about bridging the gap between the scientific ideas, and the ultimate product" ([1925] 1997, 96-7). George Parkin Grant observed that 'applied' (science) means 'folded towards" admitting: "Why that foldedness towards potentialities of new makings has been implicit in modern science since its origin is extremely difficult to understand, and indeed has not yet been understood" (1986, 14).

were merging, a particular paradigm of ecological knowledge and environmental awareness was also being embedded in the technics of coercion – laws, codes, and standards; and later on, technics of incentivization. The latter, while encouraging homeowners to purchase products to comply with green standards, also generate economic activity.

Chapter 5 - Quid pro Quo focuses on technological artifacts, and on the technics of incentivization used to promote them. In four sections, it explores the role of financial incentives in encouraging certain types of environmental solutions and products. The first sections return to the original critique of the pro-growth economy, and consumerism fueled by technological innovation. The objective here is to better understand how the impact of technology was theorized in the post-war period, how it affected the environmental action in the 1970s, and what alternative avenues were rejected by the market. The aim in the second section is to understand when and why governments choose market-driven technics of incentivization rather than those of coercion when they decide to intervene to correct a market failure, in this case its incapacity to recognize environmental limitations. The third section provides an overview of environmentally-driven incentives which are currently available in the state of California. The aim is to highlight the type of alternative solutions that are promoted, and to understand how specific financial instruments and channels of distribution influence the outcomes, but also how they reflect the original reasons for the adoption of financial incentives. The focus here is on the tension between environmental agendas and the energy-security discourse. The last section explores the paradoxes hidden in these technics, concentrating on the way building regulations support and *protect* solar technologies. While this last section also demonstrates that building regulations, and their own architecture, play an important role in promoting technological artifacts – a topic further explored in the next chapter, the main objective is to expose the dangerous consequences of a system that prefers, to use Illich's expression, an "overefficient" technological artifact to an efficient, yet less predictable tree.

The second and closing chapter of this part focuses on the core of the green apparatus, the legally-binding code of building regulations. Chapter 6 - Meta-Code investigates how the effects of the coercive methods encapsulated in the code are affected by the different aspects of its own architecture. It examines the *geography* of the rule-making network, the internal structure of the code, and the grammar of the language used to express particular regulations. The ambition is to understand how these so to speak *technicalities* affect the approach to sustainability in residential construction, and why they should matter to more than just the experts involved in the rule-making trade. In this chapter, each section investigates one particular aspect of the code architecture by means of an example of an environmentally-challenging

aspect of construction. The first section provides an overview of the different aspects of the architecture of the code on the example of the standards applied to materials used for insulation, specifically foam plastic. The aim is to examine the structure of the regulations, understand the mechanisms from which the rules originate, and think about their impact on the actual standards. The second section of this chapter, focuses on the rule-making matrix; addressing both the hierarchy of regulators, and the boundaries of their jurisdictions. The goal is to understand how the geography of the regulatory network impacts the regulated environmental dynamics. Since man-made geographic divisions fail to reflect the boundaries of watersheds, this section uses the regulations which target use of water as an example. The objective is to understand how the long-lasting disregard for natural boundaries affects the success of green building standards imposed by the code, and other overarching regulations it must obey. The third section of this chapter examines the multipart organization of the code, and the multi-layered structure of the individual parts. It uses air-related regulations to assess the purpose of different parts, and the reasons for internal cross-referencing. The aim is to understand how the structure of the code reflects and safeguards the agency of different authors and authorities. It highlights the extensive reliance on standards written by non-governmental associations, and points at political reasons behind the preference for adding new parts over amending the ones that already exist. The fourth and final section addresses the internal grammar of the regulations. It explores how the way in which standards are expressed shapes the way we tackle the previously addressed issues. It asks how one is allowed to insulate, provide shade, purify air, and treat water, and ultimately demonstrates that the range of accepted solutions does not include vegetation, and that this exclusion is deeply embedded in the regulatory language and its grammar. The ultimate goal in this final section is to highlight how the meta-code determines what is acceptable and emphasize the importance of the apparently insignificant inner workings of the regulatory apparatus for the way we practice sustainability and think about ecology.

FIG. P2.1 - ECONOMY & NATURAL ENVIRONMENT

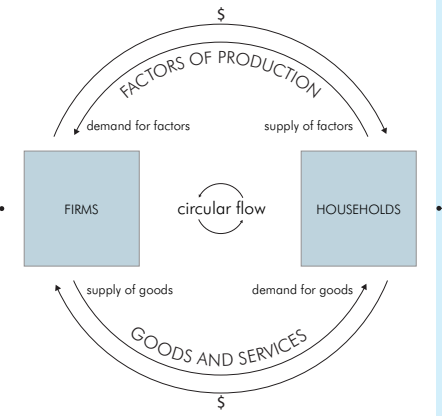


fig.P2.1a - THE CIRCULAR FLOW OF ECONOMY
conceived as an isolated system

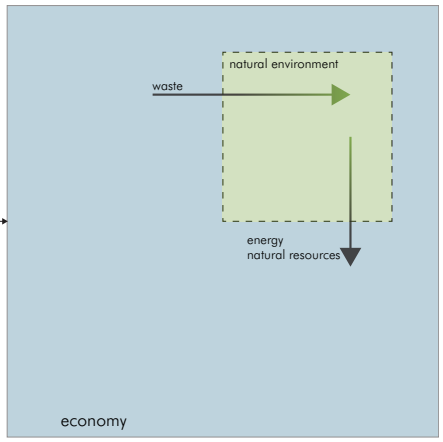


fig.P2.1c - NATURAL ENVIRONMENT
perceived as a subsystem
subservient to the ECONOMY *

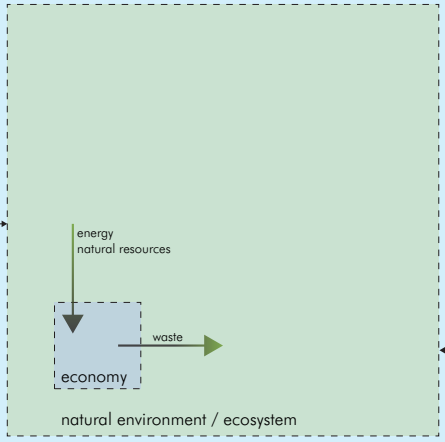


fig.P2.1b - SMALL ECONOMY *
conceived as an independent system
in an infinite NATURAL ENVIRONMENT

'empty world'

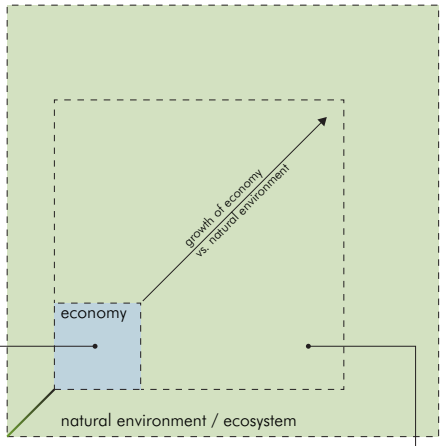
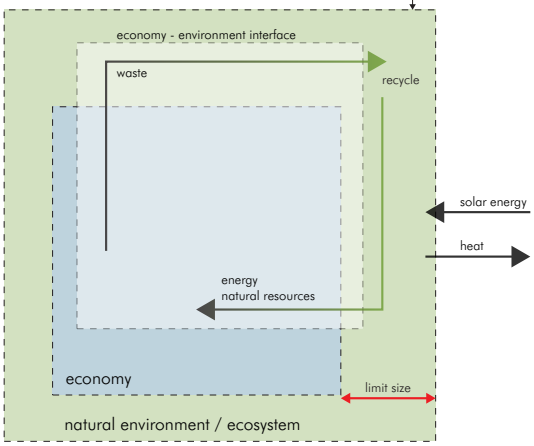


fig.P2.1d - GROWTH OF THE ECONOMY
in relation to the
NATURAL ENVIRONMENT

'full world'

fig.P2.1e - LARGE ECONOMY *
perceived as an open subsystem of
a finite natural environment



* drawn after Daly and Farley 2004

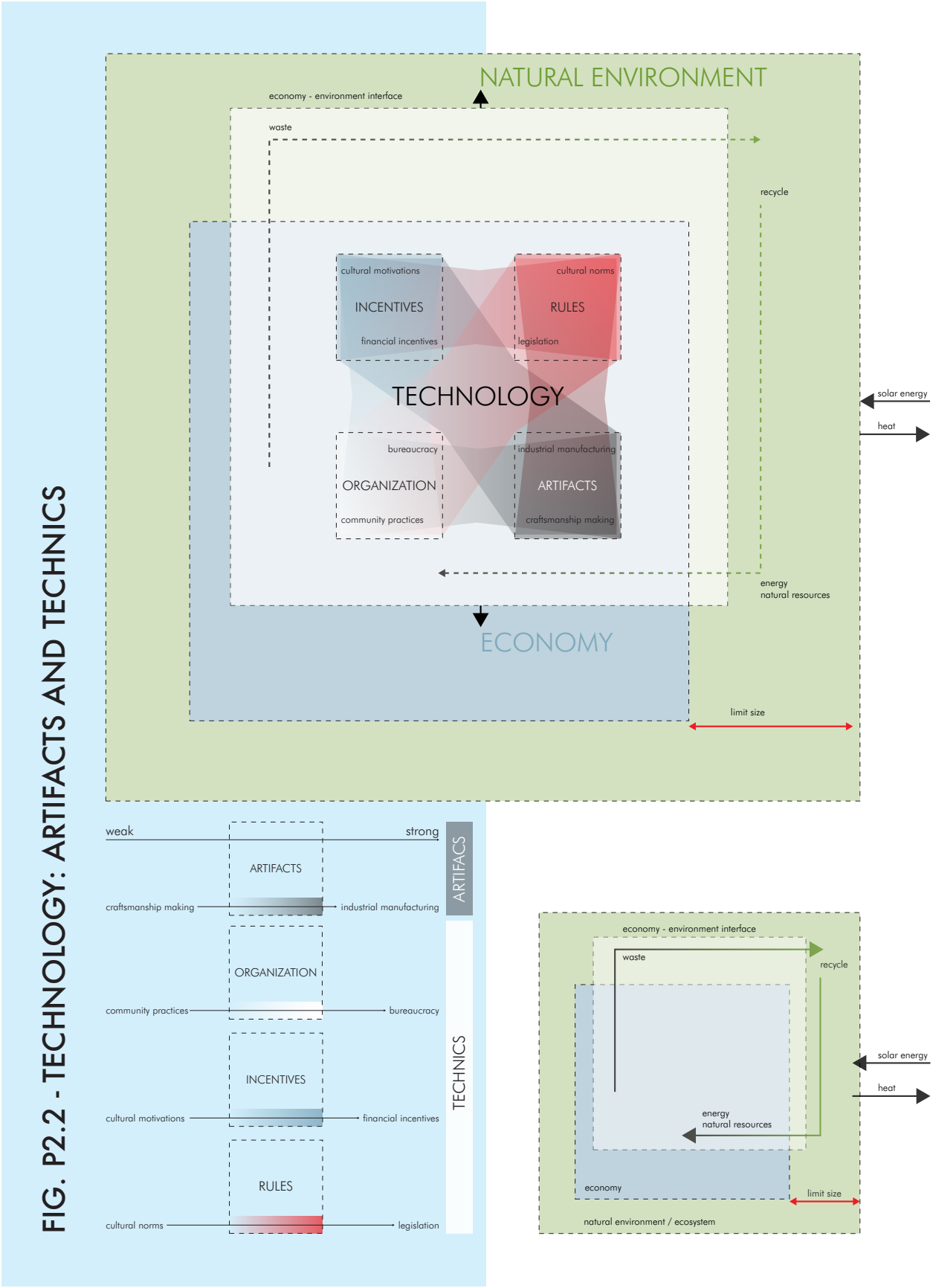


FIG. P2.2 - TECHNOLOGY: ARTIFACTS AND TECHNICS

Chapter 5 – *Quid pro Quo*: Technological Artifacts & Financial Incentives.

5.1. Artifacts and Technics.

This chapter focuses on financial incentives, a technique instrumental both in the diffusion of the supposedly *green* technological artifacts, and the promotion of unsustainable levels of consumerism and economic growth. The objective in this opening section is to return to the previously discussed environmental critique of growth-based economy, this time emphasizing the discourse that targeted the impact of technology as an engine of growth at the peak of the first environmental crisis. The goal is also to provide critical tools for the subsequent discussion of current market-driven approaches to sustainability by examining the ways of thinking about technology (its means and effects) that emerged after the war and influenced the subsequent critique of pro-growth economy.

While *The Limits to Growth* exposed the potential environmental consequences of relentless economic growth, the French radical socialists, Illich and Gorz exposed a hidden danger embedded in the report; they feared that any attempt to address the problem from within the market-driven ideology, without questioning consumerism and the role of technology and its "tools," would lead to a form of "ecofascisim." While Illich called for a complete subversion of the technological system which, according to him, determined ecologically unjust social hierarchies, the proponents of the Appropriate Technology movement adopted a less radical stance, hoping to develop an alternative approach by isolating themselves from the mainstream system rather than attempting to subvert it. Both efforts to reverse the negative impact of planned obsolescence and excessive consumerism failed to recognize that there could be only one "efficient ordering," one winning technology, or "technique" to use Ellul's terms. Neither distributed technological systems, nor apparently decentralized modes of control could revert this tendency. Eventually, even Mumford's initial trust in the machine gave way to an inevitable acknowledgment of its subservient role, and its dependence on the mechanisms of regimentation – technics of coercion and incentivization, in the production and promotion of consumer products.

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The Limits to Growth enjoyed instant fame and received fierce criticisms after its publication in the 1970s,[1] yet not one more poignant than the one voiced by André Gorz. While most critics attacked the authors, pointing at imprecise assumptions, approximate modeling methods, or inaccurate predictions,[2] out of hopeful incredulity or calculated interest to silence this ecological debate, Gorz agreed with the report, and criticized the ones who commissioned it, the leaders of the Club of Rome.[3] With well-founded pessimism, Gorz saw in the report a pragmatic attempt to simply prepare the economy for an epochal shift, rather than a willingness to admit the limits and voluntarily surrender to some form of an ecologically-imbued socialism. Potential common-sense remedies, such as durability and repair of products, or recovery and recycling of resources, contradicted the basic premises of capitalist system dependent on planned obsolescence and relentless technological innovation. Rapid deterioration of goods next to artificially-stimulated scarcities and consumer needs were at the very heart of the growth-based economy. Any form of counter-ideology formulated by the leaders of the pro-growth economy was perceived by Gorz, and earlier by Ivan Illich, as an even greater peril, a form of "ecofascism" which posed a threat to both social and psychological environment.[4]

The basic mechanics of the growth-based economic system depend, to a large extend, on technology, or to use the term preferred by Illich, on "tools."[5] For Illich, tools were both material objects and immaterial technics for regulating, organizing, and incentivizing their consumption, "all rationally designed devices,

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[1] See notes 8 and 9 in Chapter 3.1.

[2] As mentioned by the author of the *End of Growth* Richard Heinberg in 2011, if not the exact results, at least the overall tendencies have been reconfirmed in many subsequent studies. The most recent, is the previously referenced report *Limits Revisited* commissioned by the U.K.-based All-Party Parliamentary Group (APPG) on Limits to Growth (Jackson and Webster 2016). The main conclusion of this report is that not only the overall patterns and trends were correctly predicted in the original research and that according to many cited studies we are on the "standard run," but also that some of the most pressing environmental issues – "planetary boundaries" - that we face, were not even mentioned in the *Limits to Growth (10)*. The question, however, is how these new findings will be used by those who commissioned the report this time round, or better, whether any government has enough power to change these trends.

[3] The leaders "so large, they are obliged to have a vision. Like everything, they can buy it." See "Socialism or Ecofascism," in *Ecology as Politics* (Gorz 1975, 79).

[4] Illich warned: "A programmatic antigrowth elite would be highly undesirable. By pushing people to accept limits to industrial output without questioning the basic industrial structure of modern society, it would inevitable provide more power to the growth-optimizing bureaucrats (…)" (1973, 107). Gorz, on the other hand, asked: "When the Meadows report looks forward to tripling worldwide industrial production, while recommending zero growth in industrialized countries, doesn't it imply this neo-imperialist vision of the future?" (1975, 85)

[5] For a discussion of Illich's term "tools," see *Tools for Conviviality* (1973, 20).

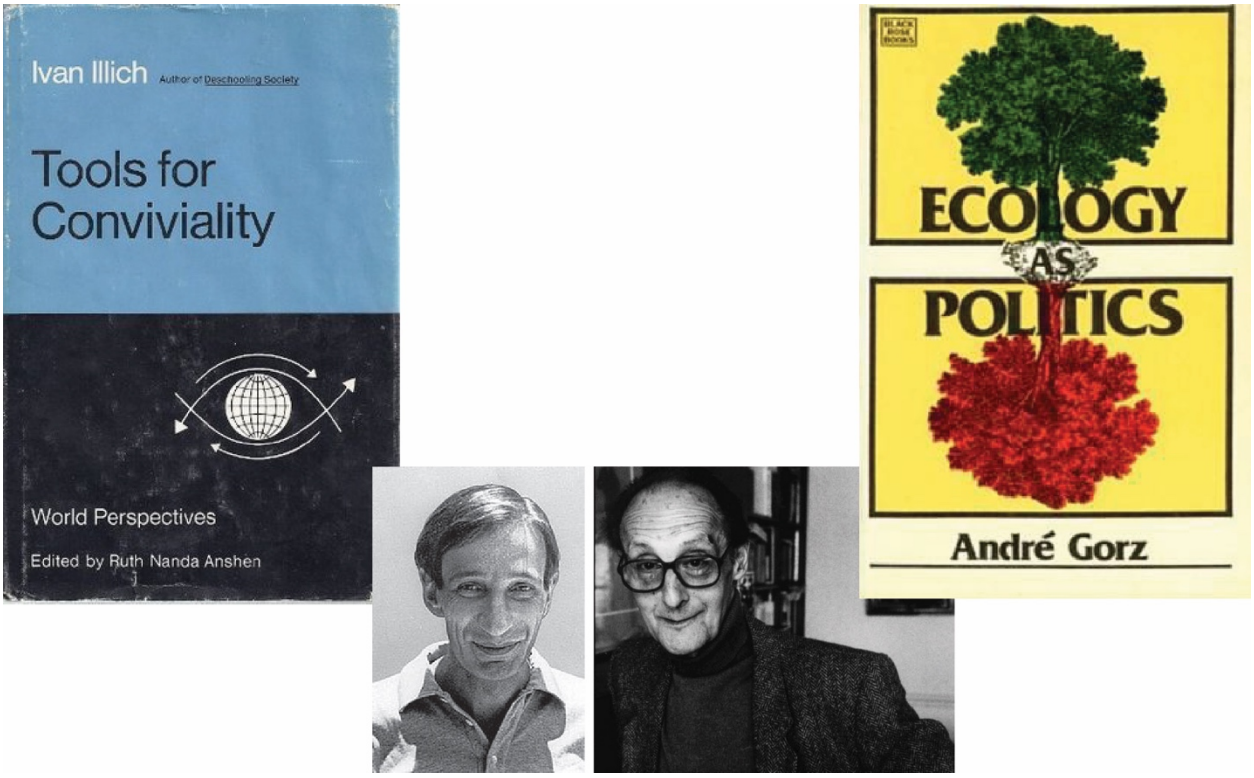

Fig.5. 1 The cover of Tools for Conviviality (left), Ivan Illich (bottom left), Andre Gorz (bottom right), the cover of his book Ecology as Politics (right).

be it artifacts or rules" (1973, 20). Returning to Grant's definition of 'technology,' they were material and immaterial "means of making events happen." In *Ecology as Politics*, Gorz poignantly observed: "Technology is the matrix in which the distribution of power, the social relations of production, and the hierarchical division of labor are embedded. Societal choices are continually being imposed upon us under the guise of technical choices" (1975, 18-9). Both argued that those choices were not optimal or without an alternative. Illich, and Gorz after him, called for a "reversal" of tools, from "manipulatory" to "convivial," criticizing "the radical monopoly" of certain products which impose compulsory consumption, and emphasizing "autonomous and creative intercourse among persons, and the intercourse of persons with the environment" (1973, 11). A radical anarchist, Illich saw an urgent need to inform, involve, and equip people with political and legal tools for a total reversal towards a more autonomous and environmentally-respectful use of tools as means rather than ultimate ends. Others, driven by less radical but eventually just as utopian ideals, searched for ecological alternatives through adjustment rather than subversion of the socio-political regime (Fig.5. 1).

Fig.5. 2 The cover of Schumacher's book Small is Beautiful (left), the cover of 1971 The Last Whole Earth Catalog, and a page from the same issue entitled "access to tools" (right).

Publicized by E.F. Schumacher in his 1973 book *Small is Beautiful* (Fig.5. 2),[6] the Appropriate Technology movement (AT) applied its ecologically-driven ideas in isolated counterculture communes in the wealthy California and exported them as an "appropriate" or "intermediate" option to developing countries aspiring to reach Western standards without losing their autonomy. Yet, regardless good intentions and many successful applications, in most cases the AT advocates fell victim to a series of fallacies.[7] Firstly, by believing that one can isolate a community from the dominant global system and its technics without bringing about atrophy. Secondly, by assuming that small size always guarantees autonomy and reduced

[6] Schumacher's book was previously mentioned in the context of early ecological economics in Chapter 3.1.

[7] In a 1980 book entitled *Paper Heroes* Witold Rybczynski tells a story of the successes and failures of the AT movement, both as a defining feature of the California young counterculture and the environmental movement of the late 1960s and early 70s, and in the context of the international aid programs meant to assist developing countries.

environmental impact.[8] Thirdly, by hoping to define once and for all what the appropriate technologies and scales are. As Schumacher himself pointed out (but nuances often get forgotten), there can never be a final solution; the "idolatry of giantism" was not to be replaced by an "idolatry of smallness."[9] Fourth, by concentrating on technological artifacts, and underestimating the importance of institutional structures and information strategies.[10] Last but not least, the AT proponents failed to acknowledge that labor-intensive, do-it-yourself solutions can only temporarily compete with the totalizing efficiency of the ready-made alternatives offered by the mainstream market. *Appropriateness* is not permanent, for many AT followers the interest in passive solar heating faded away when energy prices fell again at the end of the oil crisis. Soon, AT heroes, at least in the wealthy West, were to become "paper heroes," and the alternative communities brought up on *The Whole Earth Catalogues* (Fig.5. 2)read in Fuller's (and Steve Bear's) domes which populated *Drop Cities* gradually declined. Eventually, the young appropriate technologists grew up, gave up their autonomy, and accepted the Mumfordian "magnificent bribe" – instant gratifications of an apparently effortless lifestyle offered by the modern "megatechnics" – as an *appropriate* bargain.[11] In a truly Western spirit, some will still occasionally consult an issue of the *Catalogue* to enjoy a *do-it-yourself* Sunday, before returning to their fully-wired *smart* home on Monday. After all, as Fuller once joyfully stated: "It's all technology."[12] He surely hoped to affect more than our Sundays.

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[8] An example of this fallacy can be found in the rhizomatic patterns of post-Fordian landscapes. Decentralized control, and fragmentation which brought some of the anticipated autonomy to smaller communities also resulted in previously underestimated environmental consequences, i.e. due to extensive networks of storage and transport infrastructure. In Drosscape, Alan Berger concludes: "Flexible modes of production create more waste landscape" (2006, 54). Paradoxically, this not only affects the natural environment but also social relations.

[9] In an essay included in *Small is Beautiful*, entitled "A question of Size," he said: "What I wish to emphasize is the duality of the human requirement when it comes to the question of size: there is no *single* answer. (…) Yet people find it most difficult to keep two seemingly opposite necessities of truth in their minds at the same time" (1973, 65-6).

[10] In *Paper Heroes*, Rybczynski emphasizes these structural issues when discussing examples of AT programs introduced in India, Pakistan, Mexico, and the U.S. ([1980] 1991, 148-9).

[11] In an essay entitled "Authoritarian and Democratic Technics," Mumford briefly discussed the perils hidden in the subtle power mechanisms embedded in the present-day technics and based on a democratic distribution of consumer goods and an economy of abundance: "Under democratic-authoritarian social contract, each member of the community may claim every material advantage, every intellectual and emotional stimulus he may desire (…). But on one condition: that one must not merely ask for nothing that the system does not provide, but likewise agree to take everything offered, duly processed and fabricated, homogenized and equalized, in the precise quantities that the system, rather than the person, requires." (1964, 6) The same argument was further explored in his tour de force *The Pentagon of Power*, where he says: "On megatechnic terms complete withdrawal is heresy and treason, if not evidence of unsound mind. The arch-enemy of the Affluent Economy would not be Karl Marx but Henry Thoreau" (1970, 330).

[12] Quoted by Rybczynski in *Paper Heroes* ([1980] 1991, 99).

Often categorized as a pessimist and a technological determinist,[13] Jacques Ellul believed that there could be only one "technique" simultaneously at work – the one that offers maximum efficiency. In *The Technological Society,* he wrote: "Technique has only one principle: efficient ordering" ([1954] 1964, 110).[14] As such, it autonomously self-directs itself towards the most *appropriate* arrangement. Since, when using the term 'technique,' Ellul intended a phenomenon sustained by immaterial technics and material artifacts, it is fundamental to note that the efficiency of one artifact (or system of artifacts) does neither guarantee nor obstruct an "efficient ordering" of the overall arrangement. The most diffused construction method used by the U.S. single family housing construction industry – the stick frame – provides a simple example. The fact that this in itself quite outdated construction method persists, means that all the technics that support it are "efficiently ordered." Ellul was correct when he said that "financial capitalism checks technical progress that produces no profit" (81). Although in itself the stick frame could be perceived as a "reverse salient" – an outdated part of a larger system – the momentum of the entire industry is such that no radical innovation has so far managed to replace it. It has been conservatively improved for decades,[15] and the stick frame *scaffold* functions in relative harmony with the most advanced smart technologies, and mortgage products. While it does not mean that the homeownership system, or houses themselves are efficient, the industry seems "efficiently ordered" to generate profit.

Sadly, it's hard to agree with Ellul when he says: "Capitalism, in spite of all its power, will be crushed by

[13] Many of Ellul's claims convey a strong sense of pessimism: "It is useless to hope for modification of a system like this - so complex and precisely adjusted that no single part can be modified by itself." ([1954] 1964, 116). Although many of his observations overlap with those found in Ellul's book, Lewis Mumford referred to Ellul as a fatalist refusing, with typical trust in humanity, to accept that the current trends cannot be reversed (1970, 291). In an essay entitled "Technological Momentum," Thomas Hughes also (and somewhat defensively) distanced himself from his determinism (1994, 103). George Parkin Grant positioned Ellul's book among the greatest commentaries on advanced societies. In a review of *The Technological Society*, Grant praised it by saying: "Not to have read this book is to choose to remain socially myopic when somebody offers you free the proper spectacles." See "The Civilization of Technique," originally published in 1966, republished in *The George Grant Reader* (1998, 398). Langdon Winner engaged with Ellul's ideas at length in *Autonomous Technology* (1977), his own commentary on the modern society. In the chapter entitled "Complexity and the Loss of Agency," Winner agrees with Ellul's observations on the autonomy of technology, but he adopts a more contemporary explanation, one informed by the science of complexity: "The idea of autonomous technology in the grand sense that Ellul ultimately suggests can be taken as an attempt to fill another kind of gap in our understanding. Which? I am convinced it is this: *the gap between complex phenomena that are part of our everyday experience and the ability to make such phenomena intelligible and coherent*" (1977, 282).

[14] For Ellul's exposition of his ideas about technological autonomy and its self-directing movement towards the greatest efficiency, see the chapter entitled "Automatism of Technical Choice" ([1954] 1964, 79)

[15] It might be excessive to refer to the very core of the housing industry – the structural frame - as a "reverse salient" but it is true that innovation in this area has fallen behind in comparison to other aspects of the housing industry, such as environmental-management technologies, or financing mechanisms. Hughes's concept of "reverse salient" is explained in "Evolution of Large Technological Systems" (Bijker et al 1987, 73).

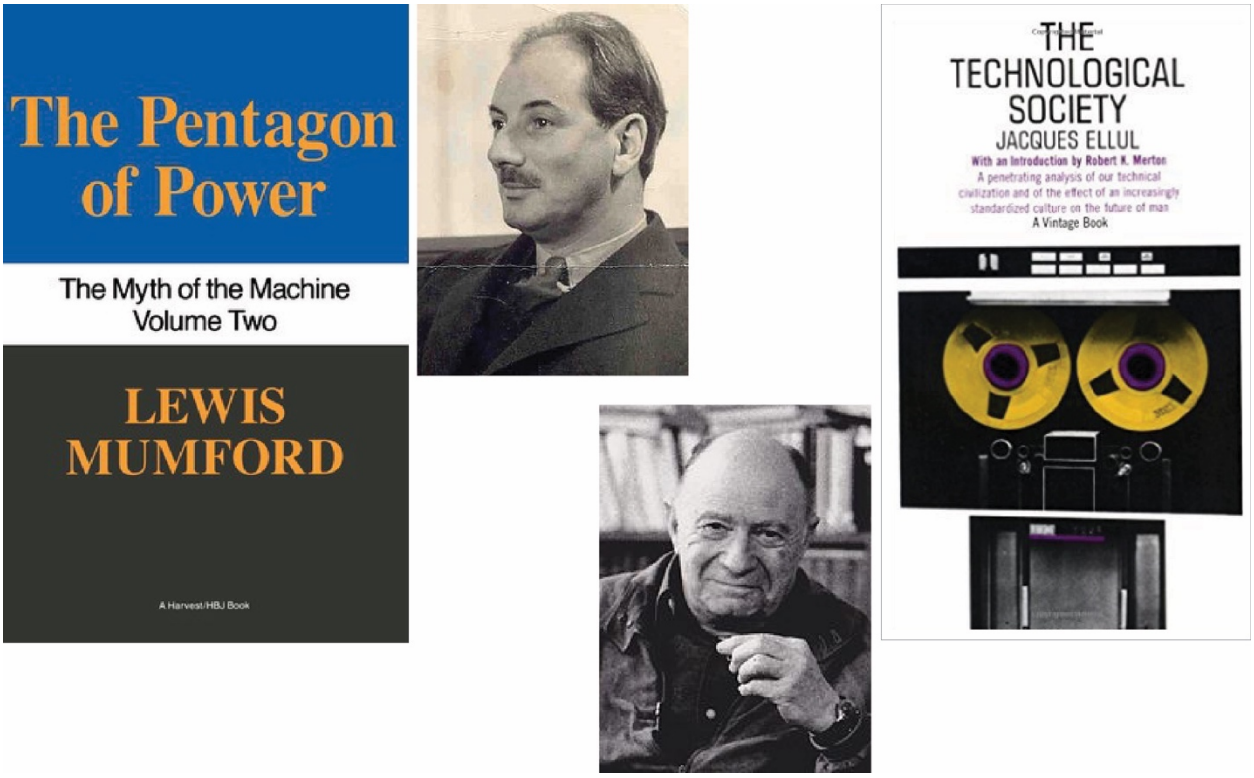

Fig.5. 3 The cover of The Pentagon of Power (top left), Lewis Mumford (top left), Jacques Ellul (bottom right), his book The Technological Society (right).

this automatism" (Ellul [1954] 1964, 82). On the contrary, technique and its automatism have been so far absorbed by it. Ellul was however right (although possibly for wrong reasons) when he claimed that decentralization and technical progress could not co-exist (194). This might initially seem wrong: on daily basis, we witness how many technical advancements are held back by insufficient profitability while many of us are immersed in decentralized systems powered by solar panels scattered across private roofs. Yet, technical progress continues (although selectively), because those decentralized, and apparently democratic, systems are themselves embedded in, and dependent on larger, yet hardly intelligible, centralized systems. These systems while not "directed and planned" (Ellul [1954] 1964, 217), guarantee if not an optimal, at least, to use Herbert Simon's term, "satisficing" performance. It is that *cunning* nature of capitalism, which Ellul probably underestimated, but Gorz anticipated in 1975 (79), that assures that technical progress persists in a way that is profitable and grants us an illusion of autonomy while assuring coherent functioning of the entire arrangement. Most importantly, as Mumford pointed out: "the center now lies in the system itself, invisible but omnipresent" (1964, 5). And if, as Winner said in "Do Artifacts

Have Politics?": "The things we call 'technologies' are ways of building order in our world,"[16] no actor (possibly with the exception of ones like the atomic bomb) has sufficient power to affect that order. Even if at times, groups of identifiable actors join forces to alter a particular trend.[17]

While Ellul was clearly pessimistic about the "technique" he described in the 1950s, Mumford embraced the "machine" in the 1930s,[18] but lost some of this optimism when he returned to the topic thirty years later. This change in attitude was inevitable considering the historical events that occurred in between; the Nazi regime and the atomic bomb are the two most significant incarnations of the monstrous 'megamachine'. Yet, the shift was also due to the fact that in his earlier writings he decoupled the *young* machine (technological artifact), from the more *mature* mechanisms (or technics to use previously

[16] A version of this essay was originally published in a 1980 issue of *Daedalus*, it was then included in *The Social Shaping of Technology* (edited by MacKenzie and Wajcman), from where this quote is taken ([1985] 1999, 31), and eventually in Winner's book *The Whale and the Reactor* (1986).

[17] The idea of technological determinism was strongly contested in the 1980s by a school of scholars who focused on the importance of social shaping of technology. Two volumes that represent this approach are: *The Social Construction of Technological Systems*, edited by Wiebe E. Bijker, Thomas Hughes, and Tevor J. Pinch (based on a series of workshops held in 1984, and published in 1987), and *The Social Shaping of Technology*, edited by Donald MacKenzie and Judy Wajcman ([1985] 1999). The Social Construction of Technology (SCOT) is a method that analyses technological artifacts as context dependent, culturally constructed and interpreted phenomena. Related to the SCOT method, the Actor Network Theory developed by Bruno Latour and Michel Callon attempted to go a step further, giving equal agency to human and non-human actors that together shape technological networks. This way of describing socio-technical systems is very clear in the following statement made by Callon in an essay entitled "Society in the Making," a story of the electric car in France of the 1970s: "So it was the Renault engineers, in alliance with the contaminating catalyst and aided by the increasing weakness of the protest movements, who completely rehabilitated the traditional motorcar, (…)" (Bijker et al 1987, 91). (While the ANT method was an important step towards a more complete vision, materialism of Deleuze and Guattari in their own writings and in the work of Manuel De Landa seems to offer a more powerful set of thinking tools as it recognizes the agency of organic and inorganic material and energetic processes as they form a powerful continuum.) In his studies, Thomas Hughes also argues that technological development is not only shaped by science but also by economic decisions (and regulatory frameworks) which in turn are socially (and politically) determined. However, his approach is more balanced than that used in the ANT as it considers agents and relations as part of complex systems and avoids a form of personification of artifacts (non-sentient entities) as actors, or technology as a deity. While less radical that Ellul's determinism, he believes that certain assemblages originally shaped by the social and natural environment "gather enough momentum" to eventually start shaping them (1994, 108). In the essay "Technological Momentum," he observes: "The social constructivists have a key to understanding the behavior of young systems; technical determinists come into their own with the mature ones" (112). In fact, using the social lens helps understand social dynamics and cultural factors that affect the formation and shape of artifacts and systems. Steven Moore and Barbara Wilson applied this method in a very effective way in their analysis of sociotechnical building codes in *Questioning Architectural Judgment*, in particular in the chapter entitled "Coding Disability: A Case Study of Frame Integration" which describes the social dynamics that led to the passage of Americans with Disabilities Act (ADA) in 1990 (2014, 154). It is, however, crucial to remember, as pointed out by George Parkin Grant, the importance of the fundamental presuppositions and paradigms of knowledge embedded in social decisions and in artifacts shaped by them (1986, 22). In "The Social Construction of Facts and Artifacts," Pinch and Bijker recognize this limitation in the following passage: "(…), the SCOT method of describing technological artifacts by focusing on the meanings given to them by relevant social groups seems to suggest a way forward. Obviously, the sociocultural and political situation of a social group shapes its norms and values, which in turn influence the meaning given to an artifact" (Bijker et al 1987, 46). The method describes the immediate "how" but not the distant "why."

[18] Although in *Technics and Civilization*, he recognized: "the machine is ambivalent. It is both an instrument of liberation and one of repression" ([1934] 2010, 283).

employed terms) of regimentation. In *Technics and Civilization*, Mumford wrote: "If mechanical thinking and ingenious experiment produced the machine, regimentation gave it a soil to grow in: the social process worked hand in hand with the new ideology and the new technics. Long before the peoples of the Western World turned to the machine, mechanism as an element in social life had come into existence" ([1934] 2010, 41). If Ellul was pessimistic *tout court,* it is because he always saw this two-headed *monster* as one indivisible entity, the machine and regimentation together formed "technique." As he said, while symptomatic of it, "machine represents only a small part of technique" which integrates it into the society (1964, 4).[19] In *The Pentagon of Power*, Mumford came closer to Ellul by giving this assemblage of regimes and artifacts a telling name: "megatechnics."

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Ivan Illich and André Gorz agreed with the gloomy prognosis, but openly criticized the hypocritical premises behind *The Limits to Growth.* By pointing out that any solution suggested by the market itself will inevitably reaffirm the current economic system, which depends on an artificially-stimulated demand for consumer products, they foretold the future of green technologies. While Illich advocated for a complete reversal of "tools" – a radical change in the way technology was owned and used, the members of the Appropriate Technology movement concentrated on small, isolated, community-driven action. While they failed to recognize the limitations of isolation and smallness and overlooked the totalizing efficiency and attractiveness of the solutions offered by the mainstream market, Illich underestimated the capacity of the omnipresent technology to impose one "efficient ordering." Small, distributed technological systems, and decentralized (only apparently democratic) modes of control serve the automatism that drives technology. Contrarily to Ellul's prediction, this technological automatism did not manage to crash capitalism. Quite the opposite, it was absorbed by it together with the artifacts produced by the machine that gave so much hope to the young Mumford. It is thanks to various forms of regimentation, both voluntary and coercive, that technological artifacts penetrate the society to maintain this automatic, if not autonomous, arrangement. Similarly, it is through incentives and regulations that green technological artifacts continue to support this same system despite the paradoxical fact that they are simultaneously promoted as a solution against it; an instrument meant to correct the market's incapacity to recognize environmental limits to relentless growth and consumption.

[19] While Ellul speaks of machines as a sub-set of technique, Felix Guattari takes the concept of machine "far beyond the technical machine." This 'reconstruction' of the concept carried out in "Machinic Heterogenesis," posthumously published in *Chaosmosis,* involves a conceptual opening of the concept of machine as material apparatus (artifact) onto a series of components – a "functional ensemble" which associates it with man. What stands out in this "machinic assemblage" is a transversal force which relates all these components into a dynamic continuum (material, cognitive, affective, social) - the abstract machine ([1992] 1995, 34-5). In this sense, our relationship with the machine-artifact depends directly on technique, but eventually on the abstract machine that defines the relationship according to "constellations of Universes of value" as they evolve over time and as they monopolize it. Guattari concludes by asking: "How does this machinic heterogenesis, which differentiates each color of being - (…) - end up being reduced to the capitalistic homogenesis of generalized equivalence, which leads to all values being valued by the same thing, all appropriative territories being related to the same economic instrument of power, and all existential riches succumbing to clutches of exchange value?" (55)

5.2. Incentivize to Convince or Legislate to Coerce?

This section concentrates on the instruments used by authorities to address the market's failure to mitigate unsustainable building practices. The objective is to understand why and when policy makers decide to use incentives rather than regulations, and how use of a market instrument to address a market failure affects the results.

One of the principal reasons for the market's incapacity to minimize the environmental impact of building practices is their economic inconvenience. Governments intervene to correct this market failure either by using traditional command-and-control measures (regulations) or economic instruments. Financial incentives are adopted when economic costs are too high to be simply imposed onto the end users, and the threats are not immediate enough to trigger fear – a prerequisite for acceptance of expensive coercive measures. While incentives are supposed to support measures that are economically inconvenient, it appears that they often promote those products that are accepted by customers since they help them economize on resource use. This is partly an indirect consequence of promoting products which provide limited, yet convenient and guaranteed results, instead of specifying a more ambitious performance target without defining the means. While this approach is understandable in case of end-user incentives – it is hard to expect households to innovate – the result is that the *safe winners* are products that best serve the market which produced them. They are technological artifacts which improve relative efficiency while stimulating consumption.

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In a 2008 paper, Carl Circo, an expert in construction law, discussed the economic reasons for which governments should intervene to correct unsustainable construction practices, and promote green building methods.[20] After having reviewed a series of optimistic studies which argued for economic advantages of green building standards, he pointed out: "It is one thing to conclude that savings in operations justify increased construction costs to improve energy efficiency during a building's useful life, but it is a far different matter to prove the business case for the whole range of eco-friendly building practices that the sustainability movement advocates" (2008, 737). He asked then whether the industry could be depended on to deliver this promise, or the government should intervene to correct the market failure[21] in order to reach, what he defined as, a non-controversial objective: a more efficient use of raw materials and energy, and a decrease in pollution (744). While according to this author it was justifiable

[20] See "Using Mandates and Incentives to Promote Sustainable Construction and Green Building Projects in the Private Sector: A Call for More State Land Use Policy Initiatives" (Circo 2008). This article was published when the first (but only voluntary) version of *Green Building Standards* Code (*CalGreen*) was being introduced in California.

[21] As explained in a 2011 Congressional Research Service (CRS) report entitled *Energy Tax Policy: Historical Perspectives on and Current Status of Energy Tax Expenditures*, market failures result from inefficient allocation of resources: "Market failures can result from the presence of externalities, the existence of principal-agent problems or information inefficiencies, or from a failure to adequately address national security concerns" (Sherlock 2011, 10).

Fig.5. 4 An advertisement of GRID Alternatives emphasizing their role in the reduction of greenhouse gas emissions (top left), types of financial incentives (bottom left), a negative externality: emissions from a power-generating plant (right).

for the government to intervene (and as discussed in the previous chapter, authorities have been intervening since then in various ways),[22] there was a variety of methods that policy makers could choose from: "For example, in some cases economic instruments designed to correct market failures will be more appropriate than command-and-control regulations" (750). Despite the fact that "taxing activities associated with negative externalities may enhance economic efficiency, [while] subsidizing the alternative activity is not necessarily economically efficient,"[23] the latter option – that of incentivizing and hence using economic instruments – has become an increasingly popular means (Fig.5. 4). Before examining what is currently promoted through financial incentives (which is the topic of the next section in this chapter), it is worth asking when and why policy makers use technics of incentivization instead of

[22] Circo states: "Given the current police power jurisprudence, with the possible exception of theorists who advocate reversing decades of established precedent, few authorities would question the legal justification for regulations that promote green buildings" (2008, 746). It is noteworthy that as governments change it is the reversal of established precedents rather than promotion of green standards that some consider justifiable.

[23] This observation made in the previously-mentioned 2011 CRS report (10) is further explained as follows: "Taxing an activity that imposes negative externalities reduces the amount of the activity in equilibrium, as a corrective tax leads market participants to consider the full internal and external costs of the activity when making consumption or production choices" (27).

directly mandating green building standards. The question asked in the previously mentioned paper is: "Why should the government fund subsidies to encourage private investors to follow green building standards that advance legitimate state interests in a clean, efficient, and sustainable built environment any more than government should pay for sound structural engineering, safe electrical design, and sanitary plumbing for private sector building" (762)?

Although limits of what can be imposed by law are being pushed as the public absorbs more and more environmental standards in front of concrete threats and apparent risks,[24] economic cost of green building standards remains of paramount concern. The end users will only accept that much financial responsibility for the consequences of modernization. Financial incentives are, in fact, adopted when economic costs can no longer (or not yet) be shifted onto the consumers. This happens mainly when the threats are not perceived as concrete and immediate. Since the acceptance of laws is most commonly driven by fear, incentives are adopted when the threat is not considered imminent enough to be feared. Although in *World at Risk* Ulrich Beck talks about the "fear business" in relation to personal security, it is evident that "the tightening of laws, a seemingly rational 'totalitarianism of defense against threats'" affects all domains of life, and next to fear of terrorism, the tightening is accepted out of fear of, for example, an ecological catastrophe. Real and "staged" risks drive us to exchange freedom for security and make us *buy into* certain ideologies ([2007] 2009, 9-10). Although green standards are promoted as an antidote against real risks associated with climate change, most environmental threats (e.g. loss of biodiversity) appear so distant that they are not feared enough to trigger acceptance of tightened rules. Even those that are perceived as directly affecting human life (i.e. water scarcity) and are feared are often not addressed since they do not appear imminent. Green building standards are a *young* and contested agenda, and the connection between environmental protection and human welfare is not considered to be direct or immediate enough. Most people prefer to address it later, rather than now.[25] It is in part for these reasons that green standards are subsidized. Yet, it remains an open question whether they really subsidize what is urgently needed (for the environment) but financially inconvenient for the customers and the market.

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[24] Although this process varies across states, Green Building Standards Codes and Energy Codes in California are becoming increasingly stringent. The City of Santa Monica has recently mandated that all new single-family construction must be zero-net energy (ZNE). See a recent post on the city website: "Santa Monica City Council Votes in the World's First Zero Net Energy Building Requirement; Implementation Begins in 2017." Accessed April 8, 2017. https://newsroom.smgov.net/2016/10/27/santa-monica-city-council-votes-in-the-world-s-first-zero-net-energy-building-requirement-implementation-begins-in-2017

[25] The problem of "discounting the future" as explained by Pearce in his 1989 book *Blueprint for a Green Economy* is mentioned in Chapter 4.1.

Buying into the ideology acquires a literal meaning when instead of being forced to embrace a new standard, homeowners follow it voluntarily, but rather than reducing consumption, they buy partly-subsidized energy-efficient appliances. The fact that consumers do *buy into* buying their freedom is a fact on which policy makers capitalize when they choose to convince the public using economic instruments rather than legislating to coerce. Incentives serves a multiple purpose. Sustainable incentives are a paradoxical "tool," to use Illich's term, which simultaneously protects against, and promotes unsustainable consumption. This approach emerged in the 1990s (as discussed in Chapter 4.1) when economist successfully promoted the idea that a market failure is best fixed with market instruments. Similarly, to cap-and-trade, end-user incentives are a market's proper instrument. They can supposedly correct a market failure, in this case negative environmental externalities of economic growth, while enhancing market performance, and stimulate nothing else but the same growth by promoting green products. Subsidizing alternative green solutions that can be commercialized is then a preferred technic as it brings this important additional advantage. Moreover, unlike punitive taxes on negative actions, subsidies which promote positive alternatives will also make future prescriptive mandates easier to absorb if not simply unnecessary.[26] Once absorbed by the market and accepted by consumers, the winning alternative naturally becomes a standard, if not a norm. Often, there is no longer a need to impose it using coercive measures. Sadly, David Pearce was accurate when he pronounced this pragmatic judgment: "If environmental improvement is to be achieved, it will require policies that use selfishness rather than opposing it".[27] Policy makers have literally incentivized this selfishness by providing subsidies for solutions that do not require a renegotiation of the way of life.[28] The current economic system cannot subsidize restraint. Instead, it rewards efficient waste. In this lies its cunningness.[29]

A challenging question, however, persists: Which existing (but economically inconvenient) alternative

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[26] In a paper entitled "Energy Efficiency Tax Incentives in the Context of Tax Reform," Steven Nadel provides an example: "Ultimately the efficiency levels originally covered by the 2005 incentives became the basis for new minimum efficiency standards adopted by DOE in 2012" (Nadel 2012, 3).

[27] For a brief discussion of David Pearce's position, see Chapter 4.1 where the same statement is also mentioned (1992, 7).

[28] In reference to a comment made by the U.S. President George H. W. Bush, and previously mentioned in Chapter 4.1. During the 1992 Rio Earth, G.H. Bush famously said that the American way of life was not negotiable.

[29] In the above-mentioned paper, Nadel reports a following forecast: "by 2050, energy efficiency measures and practices could reduce U.S. energy use by 42-59 percent relative to current projections, and in the process, save consumers and businesses billions of dollars, raise gross domestic product in 2050 by $100-200 billion, and support 1.3-1.9 million jobs in 2050" (2012, 8). It's telling that the statement concentrates on 'relative' not absolute reductions, savings of 'dollars,' growth of 'domestic product,' and increase in 'job' numbers. One hopes that it is considered explicit, but the forecast makes no mention of environmental effects.

should be subsidized? If one decides not to curb individual freedom, and instead of taxing the negative effects, incentivizes a positive solution, one has to define what this positive alternative is. Yet, defining an artifact is more challenging than describing performance. The definition must not repress innovation so that the market can develop competitive solutions in the future, and at the same time it must prevent misuse of public funds (Sherlock 2011, 27-8). The former risk occurs when the alternative solution is defined too precisely, the latter when the definition is too broad. While it was possible to create a market for pollution and allow industries to search for innovative ways to reduce it by broadly describing performative objectives (maximum levels of emissions), it would be more difficult (if not absurd) to introduce a similar system in households hoping to spur an open-ended innovation among individual homeowners. It would be also difficult although not impossible to track. The short life of the Appropriate Technology movement in California proves that lasting technological inventions requires more than enthusiasm and ingenuity. Their penetration into the society depends on *politics*, *publicity*, and on simple *horse power*, they must guarantee *productivity* and *profit*. They depend on a "pentagon of power."[30] Since this pentagon of power is only accessible to large organizations, rather than end users with full-time jobs, the incentivized solutions tend to be defined precisely. Rather than incentivizing environmental innovation by setting performance standards, the end-user subsidies inevitably support the diffusion of specific technological artifacts, easy to buy and use consumer products.

At the expense of further innovation, subsidies are directed towards *safe winners*. Policy makers incentivize use of those technologies that have been recognized as valid by a broad constituency, once, what Bryan Pfaffenberger defined as the "technological drama" has been enacted and a general consensus has been reached.[31] While the most ambitious voluntary rating systems (e.g. Living Building Challenge) go beyond operational efficiency, achieving such ambitious standards outside a small niche market has been so far perceived as too demanding by the mainstream construction industry. Although policy-makers should be directing public funds towards financial incentives which promote those more ambitious measures that cannot be imposed as mandatory due to their excessive cost, as it will become

[30] In reference to Mumford's "pentagon of power" in the homonymous book (1970).

[31] In an essay entitled "Technological Dramas," Bryan Pfaffenberger defines the process of creation, interpretation, appropriation, and assimilation of technological artifacts and systems as a form of recursive discourse in which often unrelated actors gradually form common frames of meaning to achieve their cultural, social, and political goals (1992, 285-6). It is when these initial 'dramas' gradually get forgotten, and a technological artifact becomes an unquestioned part of daily routines, that it reaches its "greatest social penetration" (309). A relatively innocuous case is when we ignore "how the refrigerator got its hum." (A story told in a homonymous essay by Ruth Schwarz Cowan published in the first edition of *The Social Shaping of Technology (1985)*).

evident soon, most incentives still focus on operational efficiency of appliances. This is in part because many homeowners are still struggling to recognize the benefits of the basic operational efficiency.[32] It is also, if not mainly, because these technological artifacts are not distributed *for free* (they are only partially subsidized), and end users are only willing to spend money on those appliances which fulfill their proper economic objectives, rather than bigger environmental goals.[33] Although renewable-energy sources and energy-efficient appliances are in themselves positive developments – to paraphrase Daly, the policy makers are this time intervening at the right end with the right policy tool – they are insufficient if not balanced by a measure functionally equivalent to Daly's "depletion quota."[34] Yet this would require curbing consumption which is not what a market instruments such as a financial incentive are made for. As stated in the above-mentioned report on energy tax policy: "Subsidizing renewable energy, (…), reduces the average price of energy, which increases demand and ultimately consumption" (Sherlock 2011, 10). In fact, as household appliances continue to be more and more efficient, houses have grown bigger and more technology-dependent. We have been consuming, wasting, and polluting more.

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In front of the market's incapacity to address the environmental impact of construction, governments have the choice to intervene by either adopting prescriptive and prohibitive command-and-control measures, or by using economic instruments. Financial incentives are adopted since the economic costs of green building standards, and sustainability in general, are too high to be shifted onto customers who do not perceive the environmental threats immediate enough to accept more costly regulations. While the basic premise behind the use of incentives is to promote those measures that are critical for the environment but are too expensive for the end users, most incentives still reward "selfishness;" they promote products that are accepted by customers because they help them reduce operational costs. Although it would be difficult (although not impossible) to impose performative targets on end users, policy makers do not offer financial incentives for reaching environmental objectives but directly specify concrete means with which to achieve them. The main reason for this is that incentives are a market-building tool, they stimulate consumption to promote growth and efficient functioning of an economy that needs a boost rather than another burden.

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[32] Although it is financially beneficial to the end users to invest in cost effective appliances, several issues prevent it. The 2011 CRS report on energy tax policy mentioned principal-agent problems, which occur "when the ultimate consumer of energy does not make equipment purchasing decisions," lack of information, and high initial costs (Sherlock 2011, 11).

[33] While in general critical of these incentives, Circo admits that: "in some cases, modest temporary incentives may be appropriate to hasten acceptance in the marketplace of these proven practices" (2008, 779). Steven Nadel points out a negative aspect, the increased risk of "free riders" – "consumers and businesses who would have installed the efficiency measures even without a tax credit" (2012, iii).

[34] For a mention of Daly's "depletion quotas" versus pollution taxes, see note 13 in Chapter 4.1.

5.3. Incentives: Building the (Green) Market.

The currently available incentives are the topic of this section. The objective here is to verify the exact alternative solutions that authorities subsidize, and to understand the importance of the tools and distribution channels that are used in this process, both in relation to their impact on the results, and for a better understanding of the underlying agendas.

In the first part, two databases are explored. Firstly, the Funding Wizard, a source of information about funding for "sustainable projects" available in California. Secondly, the Database of State Incentives for Renewables & Efficiency, the most comprehensive source that exclusively lists energy-efficiency and renewable-energy financing programs. While the first source indicates the predominance of energy-related programs, the second (chosen as a consequence of this initial finding) confirms the prevalence of active technological solutions. In the second part, tools and distribution channels are discussed. The former with the aim of understanding the consequences of using, for example, tax credits versus simple rebates, in economic, environmental, and social terms. While the quick overview of the main channels of distribution of funding confirms the complete exclusion of architects from the process, the emphasis here is on the connection with the underlying motivations. These are explored in the last part of this section, where national energy security and the recent economic crisis are contrasted with environmental concerns, such as climate change as reasons for adoption of incentives after the oil embargo, and more recently the economic crisis. Eventually, the focus on energy productivity and various assessment metrics are discussed to further emphasize the underlying and still prevailing agendas.

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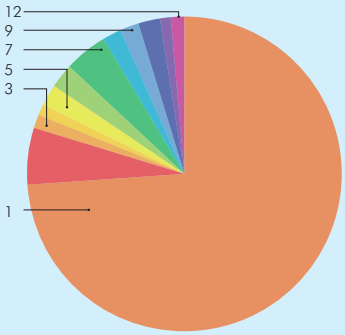
As of early March 2017, the Funding Wizard, which is a searchable database supported by the Environmental Protection Agency, listed more than 600 funding programs for "sustainable projects" available in the state of California.[35] More than 300 of these programs were applicable to the residential sector. The database categorizes programs according to various aspects of sustainability (Fig.5. 5). Energy-oriented funding was available through 243 programs in the residential sector (392).[36] Other aspects of sustainability were addressed with the following frequency: Transportation: 9 (31), Air Quality and Climate: 6 (24), Water: 4 (12), Agriculture and Forestry: 1 (12), Public Health: 1 (7), Waste Management: 0 (10), Community Development and Land Use: 1 (8), Natural Resources: 0 (8), Business and Commerce: 0 (13), Education and Outreach: 0 (5). Energy-related projects were clearly the most subsidized ones, yet after having examined the remaining 23 non-energy-related residential incentives, it was discovered that

[35] "The Funding Wizard lists grants, rebates and incentives for sustainable projects. The service is supported by the Air Resources Board, part of the California Environmental Protection Agency. Most funding is available to selected residents (based on income), depending on geographic location or the power and water utility that serves it. Accessed March 8, 2017. https://fundingwizard.arb.ca.gov/

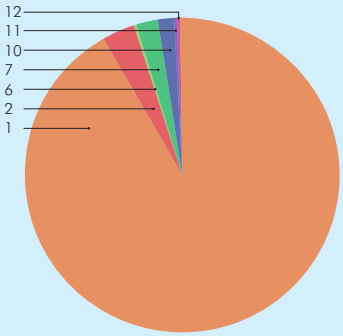
[36] The total number in all sectors is provided in brackets.

FIG. 5.5 - FINANCIAL INCENTIVES: FUNDING WIZARD

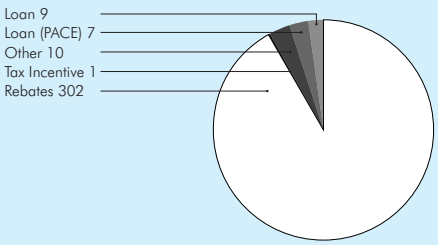
ALL APPLICANTS: CATEGORY



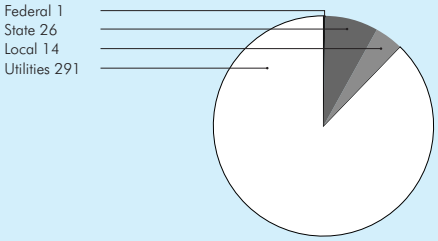
RESIDENTIAL: CATEGORY



RESIDENTIAL: FINANCING TOOL TYPE



RESIDENTIAL: FUNDING ENTITY



CATEGORY	All Applicants	Residential/Individual
1 Energy	**392**	**243**
Appliances		
Equipment		
Heating & Cooling		
Lighting		
Building Envelope		
Whole Building Systems		
Services		
Demand Response		
2 Transportation	**31**	**9**
Clean Air Vehicle		
Public Transportation		
Alternative Fueling/Charging Stations		
Vehicle Retrofits		
Infrastructure		
Demand Reduction		
3 Natural Resources	**8**	
Habitat Restoration		
Land Conservation		
Wildelife Research and Preservation		
Recreation		
4 Education and Outreach	**5**	
Environmental Education		
Scholarships or Internships		
Teacher Training		
5 Business and Commerce	**13**	
Small Business		
Economic Development		
Special Technical Service		
6 Agriculture and Forestry	**12**	**1**
Organic Farming		
Resource Conservation & Development		
Urban Forestry		
Agriculture Conservation		
Forestry		
Technical Assistance, Information Services		
7 Air Quality and Climate	**24**	**6**
Air Quality Improvement		
Air Pollution Control		
Greenhouse Gas Emission Reduction		
California Climate Investments (GGRF)		
Disadvantaged Communities		
Climage Change Mitigation		
Climate Action Planning		
Climate Adaptation		
8 Waste Management	**10**	
Recycling and Composting		
Source Reduction and Reuse		
Pollution Prevention		
Hazardous Waste Recycling		
9 Other	**10**	
10 Water	**12**	**4**
Water Conservation		
Wastewater Treatment		
Water Pollution Control		
Coastal Water Quality		
Water Recycling		
Community Water Supply Services		
11 Community Development & Land Use	**8**	**1**
Green Building		
Land Acquisition, Falciities, Construction		
Planning and Technical Assistance		
Infrastructure		
Transit-Oriented Development		
Affordable Housing		
Economic Development		
Infill Development		
12 Public Health	**7**	**1**
Environmental Health		
Community Health		

the majority of them also, even if indirectly, targeted energy efficiency. In the Transportation category, out of 9 available programs, 7 were energy-efficiency-related as they subsidized clean energy vehicles and charging stations. The remaining 2 (vehicle retrofits) related to Air Quality and Climate. Under Air Quality and Climate, 5 (out of 6) were energy-related (clean energy vehicles and efficient appliances), and one referred to Water (conservation through turf replacement). Under Water, out of 4 options, 1 targeted energy as well (efficient appliances), and the remaining 3 concentrated on water conservation (efficient appliances and turf replacement). The only program listed under Agriculture and Forestry was energy-related as well since it offered "shade trees" as part of a packet of energy-efficiency rebates. The only Public Health incentive available to residential and individual applicants also clearly related to energy, it was a weatherization program. The only incentive listed under Community Development and Land Use related to energy and water conservation as well. Only 4 programs related exclusively to water conservation, and 2 to air pollution (although they were still indirectly promoting clean energy vehicles which also pollute less). Vegetation was mentioned in 3 programs, in each case serving another purpose, either water conservation through turf replacement, or energy conservation through planting of shade trees.

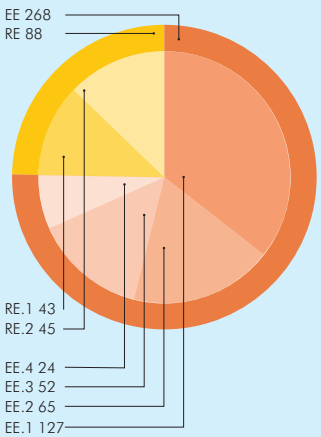
Since energy was the prevailing agenda, another internet source, the Database of State Incentives for Renewables & Efficiency (DSIRE), considered the most comprehensive national database dedicated to energy efficiency (EE) and renewable energy (RE) financing programs, was used to understand the specific types of energy-related solutions that were incentivized.[37] DSIRE listed 214 programs in California, 114 of which were applicable to the residential sector (Fig.5. 6). While 30 of them related to regulatory policies, 84 were financial incentives available to end users.[38] Most of the DSIRE programs included RE incentives: the database listed 10 different methods for generation of renewable energy 88 times, including 43 incentives for solar photovoltaics, and 16 related to solar water heating equipment. Most programs also contained multiple EE incentives: the DSIRE database mentioned 23 different energy-efficiency-related technological artifacts 268 times, 127 of these incentives related to various types of heating, cooling, and ventilating equipment (HVAC), 65 were insulation materials and construction systems, 52 household appliances, and other 24 related specifically to artificial lighting. Daylighting and solar passive heating

[37] "Established in 1995, DSIRE is operated by the N.C. Clean Energy Technology Center at N.C. State University and is funded by the U.S. Department of Energy." See the website. Accessed March 8, 2017. http://www.dsireusa.org/

[38] Similar results were obtained using the search system offered by the Department of Energy (DOE) which employs the same categories as the DSIRE.[38] It listed 104 programs applicable to the residential sector in the state of California.

FIG. 5.6 - FINANCIAL INCENTIVES: DSIRE

RESIDENTIAL: CATEGORY



ENERGY EFFICENCY / EE

CATEGORY		Total Count
EE.1 Heating, Cooling & Ventilating Devices	Heat Pumps	25
	Air conditioners	24
	Water Heaters	20
	Pool Pumps	18
	Ceiling Fan	8
	Furnaces	7
	Motor VFDs	6
	Geothermal Heat Pumps	6
	Fuel Cells using Renewable Fuels	5
	Motors (Pool)	3
	Programmable Thermostats	3
	Fuel Cells using Non-Renewable Fuels	2
	Total	127
EE.2 Construction Materials & Systems	Building Insulation	21
	Windows	18
	Duct/Air sealing	12
	Roofs / Reflective Roofs	11
	Caulking/Weather-stripping	3
	Total	65
EE.3 Household Appliances	Clothes Washers	20
	Refrigerators/Freezers	20
	Dishwasher	12
	Total	52
EE.4 Lighting	Lighting / LED Lighting	21
	Lighting Controls/Sensors	2
	Daylighting****	1
	Total	24
	Total	268

RENEWABLE ENERGY / RE

CATEGORY		Total Count
RE.1	Solar Photovoltaics	43
RE.2 Everything BUT Solar PV	Solar Water Heat	16
	Solar Space Heat	7
	Wind (Small)	5
	Solar Thermal Electric	5
	Biomass	4
	Solar Pool Heating	3
	Geothermal Electric	2
	Solar Thermal Process Heat	2
	Solar - Passive****	1
	Total	45
	Total	88

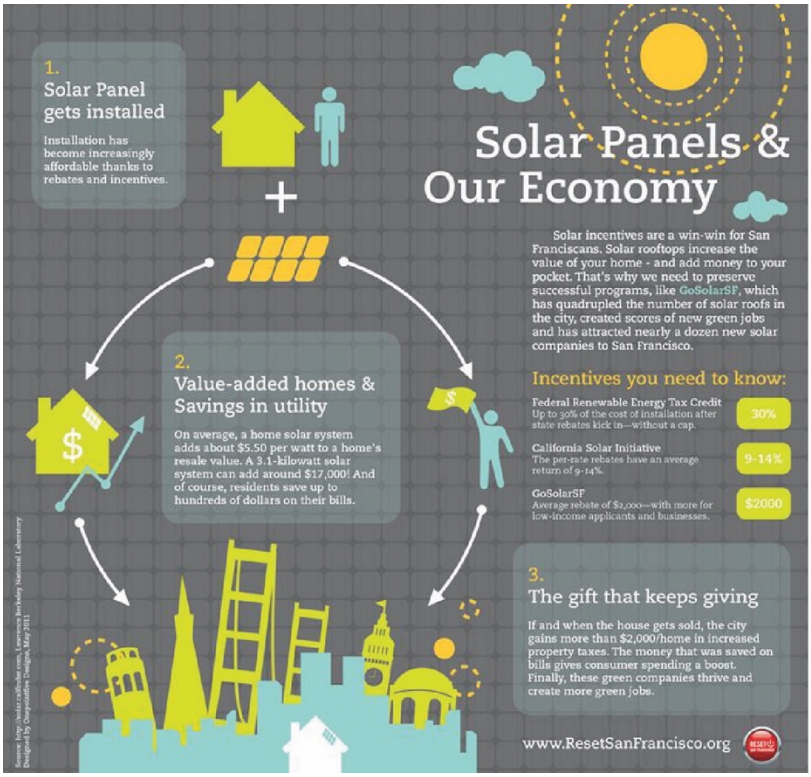


Fig.5. 7 Benefits of solar incentives for the economy as promoted by the City of San Francisco (left), logos of the consulted databases: DSIRE and Funding Wizard (right).

were each mentioned one single time. While the initial overview of the funding programs listed on the Funding Wizard website indicated that most financial incentives supported energy-related projects, the above analysis of energy-related funding listed on the DSIRE site confirmed that promoted methods were either energy-efficient (EE) technological artifacts such as household appliances, HVAC equipment, materials and construction system, or renewable-energy (RE) generation devices, predominantly solar panels (Fig.5. 7). With a single exception, passive methods were not subsidized. It is impossible to receive a rebate to pay an architect for environmentally-driven design ingenuity.

While assessment of the effectiveness of environmental programs is very difficult, what influences it next to the choice of targeted issues and promoted solutions, are the tools and channels used to distribute funding.[39] The energy-efficiency and renewable-energy (EE/RE) programs employ a variety of financing tools which not only influence the results in terms of the primary environmental goals, but also rise questions regarding social equity. The majority of previously-described programs use rebates and tax-

[39] Assessment metrics are discussed at the end of this section (Kubert and Sinclair 2011, 8).

based incentives.[40] Among the 84 residential programs listed on the DSIRE website, 66 offered rebates which are the simplest financing tool as they provide direct cash subsidies. Unlike tax credits and exemptions, which are only accessible to middle and upper-income taxpayers,[41] rebates do not depend on income. The simplicity and apparent fairness of rebates are positive points, but they also have social drawbacks. As explained in a report prepared for NREL: "(…) uniform rebate levels can create an economically inefficient level of support, over-subsidizing some purchasers of EE/RE equipment and under-supporting others" (Kubert and Sinclair 2011, 29). The *Weatherization Program* run by the Department of Energy is one of few programs designed to help low-income households to retrofit their existing homes and pay energy bills free of charge. Based on an energy audit, authorized contractors install insulation, seal ducts, mitigate air infiltration, and repair or replace heating and cooling systems in order to improve operational efficiency (Cunningham 2016, 9). In many cases federal, state, and utility-distributed subsidies can be combined to improve the diffusion of promoted solutions.

The effectiveness of incentives is assessed both in terms of their environmental and market performance. A common drawback of all direct tools (i.e. rebates) is that while they do guarantee a purchase, they do not always guarantee environmental performance. This is particularly true when it comes to generation of renewable energy, "a solar PV system could be installed on a roof where there is excessive shading from adjacent trees" (29). Performance-based incentives and feed-in-tariffs address this issue by modifying the way RE funds are distributed. In both cases subsidies and revenues are guaranteed but they are proportional to generated energy.[42] An important market-related issue recognized in the previously-mentioned NREL report is that "the rebates will not help to build a market if potential customers face other significant barriers" (28-9). While the expression "build a market" is in itself noteworthy – it confirms the principal agenda behind the incentives, the point here is that many additional mechanisms support incentives to ensure that regulatory or organizational issues do not create impediments. While

[40] Various forms of loans are also offered. For a detailed description of financing tools see the report prepared for NREL and entitled *State Support for Clean Energy Deployment: Lessons Learned for Potential Future Policy*, section entitled "Financing Tools" (Kubert and Sinclair 2011, 25-55).

[41] For an analysis of socially-discriminative effects of tax-based tools, see the CRS report entitled *Residential Energy Tax Credits: Overview and Analysis* (Crandall-Hollick and Sherlock 2016, 9).

[42] As explained in the above-mentioned NREL report, Performance-based Incentives (PBIs) "encourage good RE system siting, the use of equipment that meets performance specifications, quality installations, and ongoing maintenance." This tool is more appropriate for commercial use, where up-front financing is more easily available. Some programs allow residential customers to apply for expected PBI (EPBI), "a lump-sum rebate adjusted for estimated system performance" (30). Feed-in Tariffs (FITs) "require utilities to purchase electricity from renewable electricity system owners at long-term, fixed rates approved by regulatory commission." (32)

some of these "technology-friendly policies" address systemic issues related to utility companies,[43] others directly affect builders and homeowners. Non-financial incentives are, for example, used to grant priority in building permit issuance, or even additional zoning rights. An example of a regulatory incentive that was until recently implemented through the Los Angeles zoning code was the green building floor area bonus.[44] Paradoxically, it allowed homeowners to build a bigger house as long as it followed the basic LEED green building standards. As anticipated later in this chapter and discussed in the following one, building standards and codes are also used to support the diffusion of incentivized technologies through prohibitive measures (i.e. to prevent excessive shading from adjacent trees). Codes are meant to assure performance, but they indirectly also help build the market.

Due to the overwhelming prevalence of energy-related subsidies, funding for the residential incentives is mainly channeled through the Departments of Energy (DOE).[45] The DOE funding is distributed through two programs to local water and power utilities which eventually distribute it to their customers in form of simple cash rebates or direct assistance. The *State Energy Program* (originally authorized by *Energy Policy and Conservation Act* of 1975) provides funding to states which then distribute them to local utilities (Cunningham 2016, 14). The previously-mentioned *Weatherization Assistance Program* (enabled through *Energy Conservation and Production Act* of 1976) provides direct local grants to utilities and authorized contractors.[46] The second channel is provided by the Department of the Treasury which is responsible for tax-based incentives (21). The original Energy Efficiency Tax incentives (authorized by *Energy Tax Act* of 1978) provided 15% tax credit for residential energy conservation measures and renewable energy investments between 1977 and 1985, but as previously mentioned, it had little overall effect.[47] Legislation passed in 1992 (*EPACT92*) rendered residential EE/RE subsidies nontaxable.[48] The most comprehensive set of measures was introduced in 2005 (*EPACT 2005*) in form of energy efficiency and renewable energy tax

[43] According to the same NREL report, these are: 1) Renewable Portfolio Standards; 2) Interconnection Standards (connection of distributed generators to utility distribution lines); and 3) Net Metering (methods in which distributed generators are compensated for surplus energy they feed into the distribution grid) (77-82).

[44] This bonus was eliminated as part of the anti-mansionization measures by Ordinance No. 184,802 which went into effect in March 2017. Retrieved April 13, 2017. https://planning.lacity.org/ordinances/docs/R1VariationZones/SingleFamily.pdf

[45] The Department of Housing and Urban Development, and the Department of Health and Human Services also run their own programs. For a complete overview of these programs, see the CRS Report entitled *Renewable Energy and Energy Efficiency Incentives: A Summary of Federal Programs* (Cunningham 2016).

[46] A similar program is run by the Department Of Health And Human Services as *Low Income Home Energy Assistance Program* (Cunningham 2016, 35).

[47] See note 26 in Chapter 3.1.

[48] This incentive is called *Residential Energy Conservation Subsidy Exclusion* §136 (Cunningham 2016, 21).

credits.[49] These provisions were renewed and expanded as part of President Obama's *Stimulus Package* (*ARRA 2009*), and were available until 2016. To illustrate their scale: "Research by ACEEE and ASE (2011) estimates that about 90 percent of windows sold in 2010 and 2011 qualified for the tax credit, a level that indicates a high number of free riders" (Nadel 2012, 6).[50] The ARRA tax credits for energy-efficiency have expired, the market has been built. The tax credits for solar technologies are still available and scheduled to expire in 2021. The assumption probably is that by then the solar market will be fully built as well. Not surprisingly, the Department of Housing and Urban Development (HUD) which in part supplanted the Federal Housing Administration also provides funding. The specter of mortgage defaults caused by high energy bills continues to drive various forms of regulatory and financial initiatives underwritten by the federal government. As mentioned before, financial risks associated with operational energy efficiency (or rather inefficiency) were already explicitly inscribed into the FHA *Standards* in 1958.[51] Incentives are now available through the HUD which offers *Energy Efficient Mortgages* through FHA and VA lending program, and *FHA PowerSaver Loans*.[52] The above-described channels delegate distribution of funds to utilities, authorized contractors, and lenders. Architects are once again absent.

If the financial incentives described so far were not concerned with a more broadly-understood environmental protection, it is simply because protection of the environment was not the primary agenda

[49] EPACT 2005 authorized two tax credits. The first one was the *Residential Energy Efficiency Tax Credit* §25C. As explained in the 2016 CRS report on EE/RE incentives, it offered: "A 10% credit for energy efficiency improvements to the building envelope of existing homes and for the purchase of high-efficiency heating, cooling, and water-heating equipment" (Cunningham 2016, 21). The second one was the *Residential Renewable Energy Tax Credit* §25D. The 30% credit applied to the following types of equipment: solar water heat; photovoltaics; wind; fuel cells; geothermal heat pumps; other solar electric technologies (22). In 2007 the congress passed another tax credit named *Energy-Efficient New Homes Tax Credit for Home Builders* §45L (authorized by Tax Technical Corrections Act). As explained in the same report, it "provided tax credits of up to $2,000 for builders of all new energy efficient homes, including manufactured homes constructed in accordance with the Federal Manufactured Homes Construction and Safety Standards" (23).

[50] The 2011 CRS report, also points out the increase in tax expenditures after 2009: "In 2007 the revenue losses for residential energy efficiency, the largest of the efficiency tax provisions enacted under EPACT05, were estimated to be $0.3 billion, or 3% of all energy tax expenditures. By 2010, estimated revenue losses for residential energy tax provisions had increased to $1.9 billion, or 22% of all energy tax expenditures" (Sherlock 2011, 19).

[51] The 1958 edition of the FHA *Minimum Property Standards for Properties of One or Two Living Units* addressed energy efficiency and defined allowable heat losses. See note 72 in Chapter 2.4. However, as mentioned in Chapter 2.2, financial risks associated with building performance in general was already inscribed into the precursor of the FHA mortgage issuance standards, the 1922 *Recommended Minimum Requirements for Small Dwelling Construction* (Hover's Department of Commerce's Bureau of Standards).

[52] HUD's *Energy Efficient Mortgages* (EEMs) was introduced in the late 1980s and authorized in 1992. As explained in the above-mentioned CRS report, *FHA PowerSaver Loan Program* (no statutory authority, developed by HUD in 2009) applies to: "energy efficient improvements, including installation of insulation, duct sealing, replacement doors and windows, HVAC systems, water heaters, home automations systems and controls (e.g., smart thermostats), solar panels, solar thermal hot water systems, small wind power, and geothermal systems" (34).

Fig.5. 8 A construction worker insulating an existing house (top left), the logo of the Weatherization Assistance Program launched after the oil embargo (bottom left), every-day effects of the embargo (right).

behind the diffusion of these incentives. While obviously welcomed and supported by the environmentalists, the technics of incentivization developed in the 1970s were first and foremost a response to a threat to the national energy security (Fig.5. 8). As explained in the 2011 CRS report, "Since the 1970s, energy policy in the United States has attempted to achieve two broad objectives. First, policy makers have sought to reduce oil import dependence and enhance national security through a variety of domestic energy investment and production tax subsidies. Second, environmental concerns have led to subsidization of a variety of renewable and energy efficiency technologies via the tax code" (Sherlock 2011, Summary). The preponderance of energetic security over environmental concerns is evident in the fact that the first energy tax incentives introduced after the 1973 oil embargo supported national oil and gas industries, rather than renewable energy sources. Not only did environmental concerns not trigger the introduction of these credits but it is also unlikely that at that time policy makers considered them a market failure to be addressed using financial instruments such as tax credits. This approach was adopted in the 1990s, while environmental concerns started to be addressed using *old-fashioned* command-and-

control instruments in the 1960s and 1970s.[53]

Energy productivity was paramount, while the conservative voices of Ezra J. Mishan and Herman Daly were hardly heard. The author of the same CRS report explains: "In the late 1970s nearly all revenue losses associated with energy tax provisions were the result of two tax preferences given to the oil and gas industry." This situation gradually changed as cheap oil and gas became more difficult to extract, and global warming turned from a concern into a national security threat: "By 2010, revenue losses associated with tax incentives for renewables exceeded revenue losses associated with fossil fuels" (Sherlock 2011, Summary). While energy conservation and efficiency were initially promoted mainly to help reduce dependence on foreign sources of energy, they gradually acquired more environmental significance and gained more impetus when reduction of greenhouse gas emissions became a more widely-discussed concern. But even then, the promotion of renewable energy sources was only in part environmentally-driven. The environmental discourse was co-opted to support efforts driven by the initial agenda, the difficulty to extract oil cheaply meant that new sources of energy were not greener, they were simply urgently needed.

The result of all these efforts has been a clear increase in energy productivity since the 1970s: "U.S. economic output expanded more than three times since 1970 while demand for energy grew [my emphasis] *only* 50%" (Alliance Commission 2013, 4). Unfortunately, environmental gains have been less clear. The absolute energy consumption has obviously not decreased, and the reduction in per capita use is so low that it is only significant considering the tripled size of economy.[54] The 2011 NREL report estimates that the rate of saving is more than three times lower than the rate of growth in energy demand (9). The picture becomes even more troubling when one considers outsourcing of industrial production. Externalities are clearly *external* to energetic security concerns if heavy industries polluting a

[53] See Chapter 2.5 for a brief account of the first wave of environmental policy-making triggered by Carson's *Silent Spring*, and Chapter 3.1 for the policies enacted after the establishment of the Environmental Protection Agency.

[54] The previously-referenced report entitled *The History of Energy Productivity* specifies: "In 1970 Americans consumed the energy equivalent of about 2,700 gallons of gasoline per person for all uses of energy. That rate of consumption extrapolated to our current economy would have come to the equivalent of about 5,400 gallons per person. Instead, 2010 consumption was the equivalent of 2,500 gallons per person." (Alliance Commission 2013, 4) According to the U.S. Census Bureau, the U.S. population was 203.1 million in 1970, and 308.7 million in 2010. Considering the per capita consumption provided above, the absolute consumption of energy by all Americans in 1970 was 548,370 gallons (2,700 x 203.1million), and 771,750 gallons in 2010 (2,500 x 308.7million). The absolute use of energy increased by 40%. The Alliance report mentions an even higher increase in demand: 50%. While this is positive considering that economy increased three-folds, it is still clearly negative considering global warming (among other less publicized issues).

foreign country are considered a sign of increased productivity.[55] When national security encounters environmental concerns system boundaries acquire an uncanny significance. As Ulrich Beck taught us, "there is a systematic 'attraction' between extreme poverty and extreme risk." ([1986] 1992, 41) Yet, while poverty is more likely to accept the risks inherent in modernization, ultimately risk has no boundaries, it has become global: "Nuclear contamination, (…), is egalitarian and in that sense 'democratic.' Nitrates in the groundwater do not stop at the general director's water faucet."[56] A reflux of negative externalities is eventually inevitable.

According to the consulted NREL report, the Department of Energy uses five performance metrics to evaluate the effectiveness of the initiatives funded through its *State Energy Program*. It considers energy saved or generated; GHG emissions reduction; energy cost savings; funds leveraged; and job creation (Kubert and Sinclair 2011, 8). According to the same report, in 2011 the cost of renewable-energy incentives that support the diffusion of solar panels still exceeded the average cost of procuring conventional energy supply in most regions, although it might have been below the price at peak hours, when energy is very expensive during hot summer afternoons (20-1). On the positive side, however: "An evaluation of the California Solar Initiative estimated that each megawatt of grid-connected solar installed with program support through 2008 represents an estimated annual CO_2 reduction of 885 tons" (22). The author of a 2012 ACEE working paper estimates that the results are clearly positive in case of energy-efficiency incentives: "Federal cost of $0.02-2.33 per million Btu of energy saved is far less than the approximately $10 per million Btu we now pay for energy" (Nadel 2012, 13). While by simply using common-sense measures, we could clearly conserve a lot of energy, costly repairs receive no incentives in the U.S.,[57] and 'passive' methods cannot be credited for leveraging funds or creating jobs (not counting unpaid housework required to actively manage passive systems). Equally, as mentioned further below, no tree can absorb as much CO_2 as a *megawatt of solar.* Incentives do not spread sustainability, they assist the market on its path towards the most "efficient ordering." Technology, its technics and artifacts are

[55] Outsourcing of heavy industries is mentioned as one of the factors that drive energy productivity in the above-quoted report (4).

[56] While Ulrich Beck's first extensive discussion of democratization of risk can be found in *Risk Society* ([1986] Eng.: 1992), this statement comes from *Ecological Enlightenment* ([1991] Eng.: 1995, 27).

[57] In September 2016, a surprising news made headlines internationally. The Swedish government decided to offer tax breaks for repairs in order to reduce waste due to planned obsolescence built into most household appliances and create jobs for unskilled workers. See, for example, the following article published on September 19, 2016 by The Guardian: "Waste not want not: Sweden to give tax breaks for repairs." Accessed April 13, 2017. https://www.theguardian.com/world/2016/sep/19/waste-not-want-not-sweden-tax-breaks-repairs

used to propagate the paradox of sustainable growth.

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An overview of two databases of financing programs, the EPA-supported Funding Wizard, and the nationwide DSIRE which focuses on energy efficiency and renewable-energy generation confirms that most incentives promote active technological solutions. Form-based strategies are clearly not subsidized. The initial search also revealed that most funding available for sustainable projects in the residential sector focuses on energy. The analysis of financing tools exposed limitations of different options; among them: social issues in relation to tax-based instruments, environmental unpredictability of simple rebates, and market uncertainties due to external regulatory obstacles. Funding is managed by a number of federal departments and state agencies, which eventually delegate distribution of subsidies to utilities, authorized contractors, and lenders. Architects are once again excluded from this process. As discussed in the previous chapters, their methods are too inconvenient for merchant builders, too unpredictable for the mortgage underwriters, and too inefficient for energy experts. Both, after the oil embargo, and recently after the subprime mortgage crisis, national energy security and economic recovery were the principal reasons for the adoption of incentives. Environmental concerns were co-opted by the authorities to promote their policies. Increasingly, global warming (considered a real threat to national security) has supplanted other environmental issues as a reason for green subsidies. The interdependency between energy security and greenhouse gas emissions has provided another, yet fundamental reason for this success. The impossibility of conservative measures to, for example, create jobs is, by contrast, the cause of their failure.

5.4. Green Artifacts and Technics: Side-effects.

In this closing section, the focus is on the ecological side effects of the above discussed system which favors technological artifacts and emphasizes isolated aspects of sustainability. The objective is to illustrate how the "ecofascism" that Gorz feared in the 1970s has found its embodiment in the green technologies and green standards, and how it affects our relationship with the environment. When the first energy incentives were being introduced, Ralph Knowles promoted his idea of an adaptive solar envelope. Yet, his form-driven strategy was too inconvenient, unpredictable, and inefficient to compete with the productive capacity of the solar technology. With the advent of solar panels, solar access – once considered a right – became a commodity, the envelope – once an environmental interface – turned into an engine of profit for the market, and generator of meaning for most architects. The efficiency of solar technologies transformed the solar project into a flat device, and to a large extent reduced sustainability to a one-dimensional discourse focused on energy efficiency and carbon emissions. As described below, both zoning and building codes contain articles which protect solar technologies and structures, referring to state acts which explicitly protect them from a range of potential obstacles: from homeowner associations to shade cast by trees. A popular internet source confirms that carbon math is on the side of solar panels rather than trees. Despite numerous ecosystem services that they provide, and regardless many invaluable qualities that they represent, trees cannot compete with the "overefficient" solar panels.

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Shortly after the 1973 oil crisis, when the first energy tax incentives were being introduced, Ralph Knowles published *Energy and Form* (1974). Result of more than a decade-long research developed with his

Fig.5. 9 A model of Knowles's solar envelopes in an urban context (left), the form of envelopes reflecting different street orientation (right).

students, the book suggested an alternative path towards conservation of non-renewable energy and use of renewable sources through control of built form and command of spatial techniques, rather than active mechanical equipment. It also constituted the basis for his *Solar Envelope* project which, Knowles hoped, would provide the foundations for an alternative regulatory instrument for urban zoning (Fig.5. 9). Knowles's solar envelope was not just meant to norm the right to solar access, it was supposed to generate the form of urban fabric in response to the cyclic rhythms of the sun. Unfortunately, urban form responds better to the rhythms of the market. With little concern for environmental dynamics, extrusion-based zoning envelopes have persisted maximizing potential profits for the real-estate market. In the meantime, conservation of energy has been delegated to expensive technological artifacts – the engine of another market. Not without limitations in the era of increasing urban densities which limit access to daylight,[58] the idea of an adaptive solar envelope has gradually lost to that of the productive solar roof

[58] Access to daylight and the need to build densely are two conflicting interests. Ralph Knowles returned to the topic of solar envelope in a 2003 paper entitled "The Solar Envelope: Its Meaning for Energy and Buildings," in which he defined maximum urban densities that allow for the application of his solar envelope concept.

and the technology of the solar panel, leaving the envelope to the real-estate market. The media and the market managed to convince average homeowners that their house was sustainable if its daily operations were powered with solar panels, and water came out of an efficient faucet.[59] Unfortunately, it is not just lack of knowledge or hypocrisy. The above discussion of available financial incentives demonstrates that a house which actually consumes less energy due to spatial solutions will not receive a tax write-off while the one that promises to cover a predicted consumption with an array of solar panels will. Until recently, that house could even expand and consume more resources: as mentioned above, the Los Angeles Zoning Code contained a green building bonus applicable to most single-family residential areas. This non-financial incentive offered an additional 20 percent of the maximum residential floor area if the new construction was in substantial compliance with the basic requirements for the LEED for Homes program.[60] In part, it meant installing solar panels.

Once a welfare concern, the right to solar access became a quantifiable commodity. Although the efficiency of solar technologies gradually improves, shade remains a crucial problem. This immaterial yet very concrete issue once limited the application of Knowles's passive solar method in dense urban environments. It continues to pose a challenge to active solar technologies as economy directly couples solar exposure of flat surfaces with energy productivity, and financial profits. Not surprisingly, *Google Project Sunroof* (similarly to many municipal tools for solar potential assessment) work in plan – they are quasi two-dimensional in nature (Fig.5. 10).[61] As solar technologies improve, they continue to decouple the three-dimensional form from environmental performance, liberating the economic potential of building volumes. They depend on shade as productivity and profitability rely on unobstructed sunlit surfaces. Yet, the power of active technologies is manifested not only in their disconnection from spatial form, but also in their spatial mobility. (This was once proven when industrial production was freed from the energy provided by streams and rivers.) Unlike Knowles's solar envelope, the solar panel is not only

[59] Although very progressive, even the California climate action expresses the same market-driven emphasis on operational efficiency. See the official website. Accessed April 14, 2017. http://www.californiaznehomes.com/#!about/cdtl Also, as a recent article published by Greentech Media reports, while the homes become more efficient, the average household consumption has been increasing due to the size and equipment of homes. Accessed April 14, 2017. http://www.greentechmedia.com/articles/read/The-Growing-Size-of-New-US-Homes-is-Offsetting-Residential-Efficiency-Gains

[60] See note 47 above.

[61] *Project Sunroof* analyses roof exposure using Google maps, and computes hours of usable sunlight per year, and square feet available for solar panels. It couples this data with projected savings. According to Google's own website: "Project Sunroof puts Google's expansive data in mapping and computing resources to use, helping calculate the best solar plan for you." See the website. Accessed April 13, 2017. https://www.google.com/get/sunroof#p=0

Fig.5. 10 Google Project Sunroof.

flat, but it can also be located elsewhere, it can be installed on the roof of the adjacent building that deprives the house of its solar access. If one feared that, like many recent experiments in architecture which explore the ecological potential of adaptive patterns in a parametric manner, the *solar trend* also risked being consumed as a 'surface effect,' the risk is no longer there. As long as a sunlit flat surface can be provided somewhere else, not only the volume is free to deliver profit, but also the surface, once an environmental mediator, is again a flat medium perfectly poised to express cultural meaning. It is free to express itself.

As incentives coupled with regulations focus almost one-dimensionally on operational energy efficiency, and greenhouse gas emissions, flatness acquires yet another meaning. These immaterial devices create a 'radical monopoly,' they detract attention from other issues, distant places and longer time scales, and fail to clearly communicate ecological trade-offs of the current concentration on low-carbon, and net-zero

energy strategies.[62] When Ivan Illich criticized the selectiveness with which environmentalists approached the crisis by saying: "One-dimensional dispute is futile" (1973, 49), he probably did not expect that not only the search for solution would not open up to include multi-dimensional agendas, but that it would be further reduced to few, most tangible threats, addressed using, what he feared most, the "overefficient tools" (51). Surely, codes and available incentives are not what defines the dimensions of ecological awareness among architects, but most homes are built without one. They are built 'by right', most of the time in compliance with prescriptive standards and in response to financial incentives which replace environmentally responsive design with technological artifacts.

It is worth asking then whether this green apparatus formed by coercive measures and financial rewards represents a positive non-zero-sum game that benefits both the net-zero-energy economy and the natural environment. Can one assume that parameters are clear and, to use the game theory terminology, the 'pay-off' table can be easily drawn up and filled in with quantifiable data, and that under the reign of *green economy*, both economy and the environment are winners? Certainly, Los Angeles Zoning Code promotes a series of integrated methods for conservation of energy. In order to mitigate urban temperatures and reduce energy consumption, Section 12.42, for example, requires a tree planting plan which contains a proposal for shading of walls of structures.[63] However, this and other municipal codes also list numerous exceptions from various requirements for solar energy technologies and support structures. None of the codes associates the term *solar* with the word *envelope*. The envelope is a shell that dissipates energy, and solar panels are one of the technological artifacts that are there to fix it. Definitely Banham's 'technological scaffold' has acquired notable legislative immunity since he first thought of the house as an ensemble of technological gadgetry in the stunning essay "A Home is not a House" (1965).

A reference to a minor, yet striking provision appears in the *Green Building Standards Code*. Similarly, to the zoning code, the *CALGreen Code* imposes tree planting as a measure against the heat island effect. Numerous (each reasonable on its own) exceptions are, however, listed: "Tree selection and placement

[62] The goal of the progressive state of California is as follows: "All new residential construction in California will be zero net energy by 2020." See the website of this initiative. Accessed April 13, 2017. http://www.californiaznehomes.com/ As mentioned before, Santa Monica was the first to pass a net-zero-energy ordinance. See note 27 above. The city is already facing the issue of shade. The question is: if a plot of land zoned residential does not receive enough daylight to be powered with solar panels, how can the house fulfill the goals of the Zero-Net-Energy Residential Action Plan?

[63] Los Angeles Zoning Code is part of the Municipal Code: Chapter I, General Provisions and Zoning / Article 2, Specific Planning – Zoning, Comprehensive Zoning Plan (City of Los Angeles, 2017).

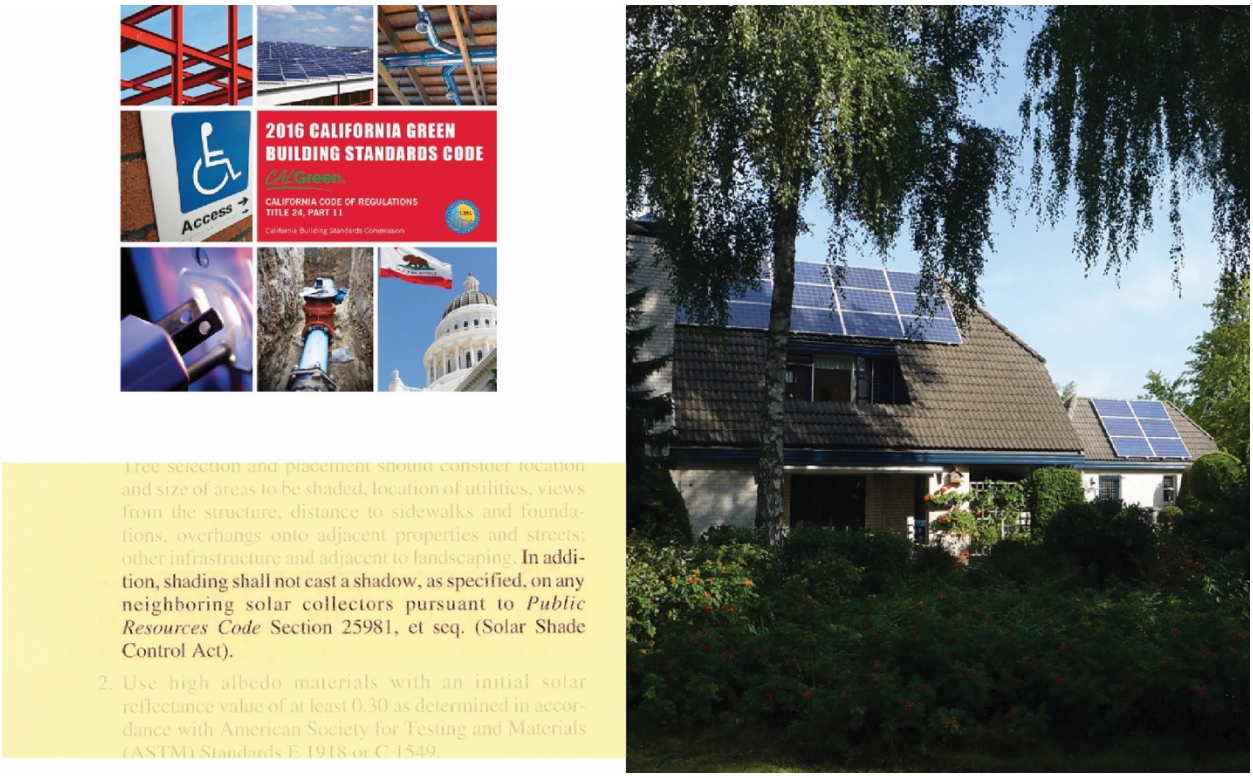

Fig.5. 11 The cover of the California Green Building Standards Code (top left), the reference to the Solar Shade Control Act included in the same code (bottom left), a solar panel (and a house) shaded by a tree (right).

should consider location and size of areas to be shaded, location of utilities, views from the structure, distance to sidewalks and foundations, overhangs onto adjacent properties and streets; other infrastructure and adjacent to landscaping." One notable exemption affects the *rights* of trees, and reads: "In addition, shading shall not cast a shadow, as specified, on any neighboring solar collectors pursuant to Public Resources Code Section 25981, et seq. (*Solar Shade Control Act*)" (Fig.5. 11) The *Solar Shade Control Act* of 1978 reads: "25982. After the installation of a solar collector, a person owning or in control of another property shall not allow a tree or shrub to be placed or, if placed, to grow on that property so as to cast a shadow greater than 10 percent of the collector absorption area upon that solar collector surface at any one time between the hours of 10 a.m. and 2 p.m., local standard time."[64] Even in California, this means solar elevation angles as low as 28.5 degrees on January 21 at 10am. One feels

[64] The *Solar Shade Control Act* is available online. See the website of the California Legislative Information. Accessed April 15, 2017. https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=PRC&division=15.&title=&part=&chapter=12.&article= See also the report entitled *California's Solar Shade Control Act: A Review of the Statutes and Relevant Cases* (Anders et al 2014) where the provisions included in the Act are explained (Anders et al 2010).

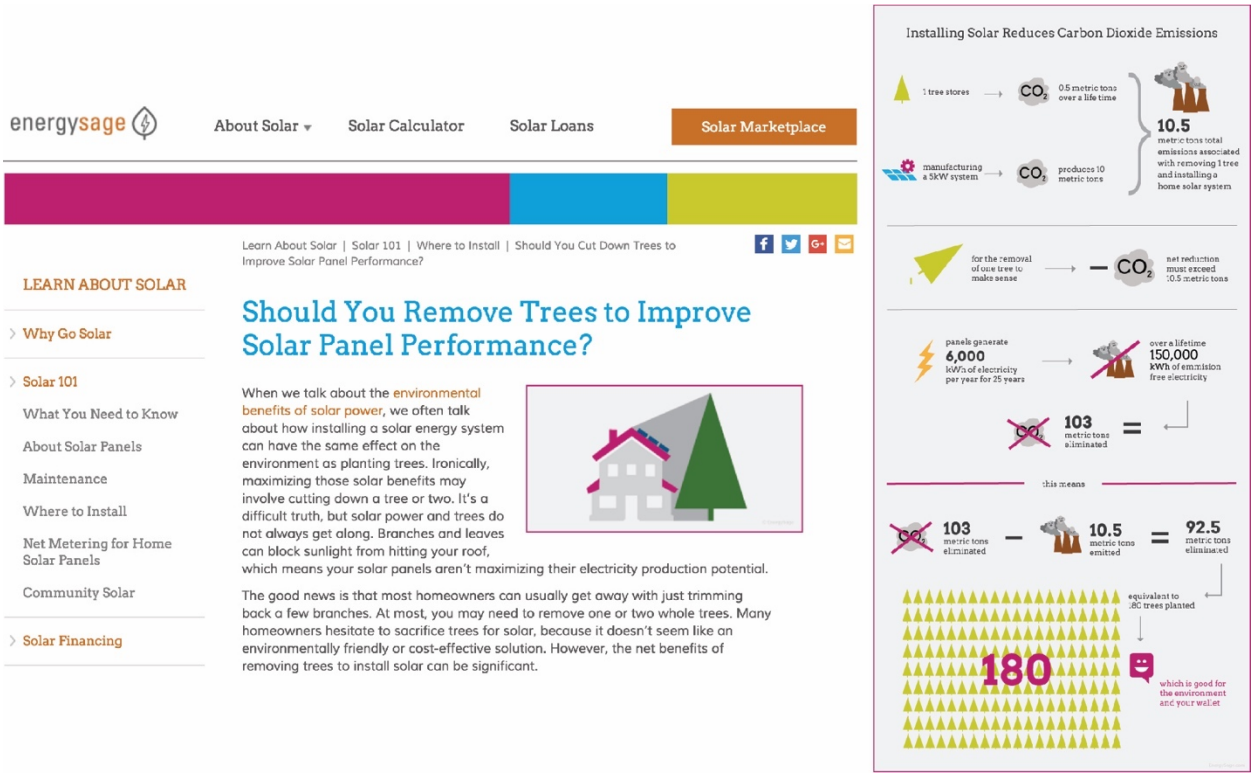

Fig.5. 12 An article published on EnergySage discussing the removal of trees when installing solar panels (left), a diagram comparing benefits from trees and solar panels (right).

urged to ask what a neighborhood would look like if trees that fall into this range were consistently prohibited in the future. Would ornamental bushes replace them to protect solar panels? And if the common interest developments (CIDs), criticized for exasperating social divisions and urban injustice (and rightly so), seem perfectly poised to restrict the special rights granted by codes to solar panels, this option has been ruled out from the very outset. Among its many important provisions related to the right to sunlight, another piece of California state legislation from 1978, the *Solar Rights Act* (AB 3250) famously protects solar technologies against the private covenants, conditions, and restrictions that regulate these exclusive developments by simply ruling them void.[65]

In "Thinking about Technology" Grant observed: " The coming to be of technology has required changes in what we think is good, what we think good is, how we conceive sanity and madness, justice and

[65] A report prepared by the University of San Diego and entitled *California's Solar Rights Act: A Review of the Statutes and Relevant Cases* (Anders et al 2014), explains the provisions included in the Act (i.e. right to a solar easement), and describes how the Act prevents CIDs from denying the residents the right to install solar energy system. (See Chapter 4.1 for a brief mention of CIDs in relation to green building standards.)

injustice, rationality and irrationality, beauty and ugliness" (1986, 32). Those who doubt whether it is right (good or beautiful) to remove a tree to gain solar power can be quickly reassured that the carbon math is clearly on the side of the solar technology: the environment will gain more from a solar panel than from a tree. An article entitled “Should You Cut Down Trees to Improve Solar Panel Performance?” and found on EnergySage website provides a version of this math and resolutely concludes: “We recognize that there are other factors to be considered, too. First, you may have to pay to remove your tree. There are other less quantifiable factors to consider as well. The trees in question could house wildlife, shade your home during the summer, or provide aesthetic or other ‘quality of life’ benefits. How these costs affect the equation is a function of your [I emphasize] *personal preferences* and may or may not change the outcome" (Fig.5. 12).[66] The statement expresses a common sense, yet as Grant again points out: “it is a common sense from within the very technology we are attempting to represent” (1986, 32). Or otherwise, as Ellul explained: "When everything has been measured and calculated mathematically so that the method which has been decided upon is satisfactory from the rational point of view, and when, from the practical point of view, the method is manifestly the most efficient of those hitherto employed or those in competition with it, then the technical movement becomes self-directing. I call this process automatism” ([1954] 1964, 79-80). It may well be that distributed solar power embodies the future of “the one best way” (79), and that an individual tree is not efficient enough to be given precedence over a solar panel, and hence does not deserve to be supported with tax money. Yet, a question persists: what are the environmental, bio-ethical, and cultural repercussions and limitations of this bio-economic attitude that prefers an “overefficient tool” to nature? A tool by many claimed democratic just because it

[66] A shorter version of this article is now available online under a slightly changed title: “Should you remove trees to improve solar panel performance?” Accessed April 13, 2017. https://www.energysage.com/solar/101/should-you-remove-trees-for-solar-panel-performance/

is distributed.[67]

According to ecologists, trees represent an incredibly versatile technology (although not an artifact of human making). The list of functions they perform and services that they deliver is long. Trees improve air quality by absorbing particulates and pollutants, remove carbon dioxide, prevent soil erosion, purify storm water, provide habitat, limit noise, and regulate microclimate. Although large patches of urban forest are required to substantially reduce the urban heat island effect, trees reduce temperatures by shading buildings and paved surfaces. Keeping impervious surfaces cooler reduces the amount of energy used for indoor cooling in summer and consequently minimizes the amount of heat emitted by the mechanical systems. Studies demonstrate that trees can reduce use of energy for cooling up to 40% when positioned considering local winds, temperatures and sun path. Even if the capacity of trees to store carbon is not comparable to that of a solar panel (which does not store it but indirectly minimizes its release), trees emit oxygen which the solar panels cannot yet do. According to the American Forestry Association an average-sized tree releases enough oxygen for a family of four (Gartland 2008). Trees are also capable of trapping particulates and capturing other air pollutants such as nitrogen oxides, sulphur oxides, particulate matter and ozone. Trees use solar energy to evaporate water which brings a double benefit: while reducing the amount of energy which would heat up surfaces, they improve air moisture levels. Among other benefits, they also protect humans from ultraviolet light. During a rainstorm, they reduce storm water run-off as they capture substantial amounts of water and process it through evapotranspiration. They have a significant influence on the soil properties and the organisms which occupy the rhizosphere (Craul 1992). Soil properties and soil organisms help maintain a balanced water cycle and contribute to the decomposition of organic litter which constitutes the main source of soil

[67] In "Authoritarian and Democratic Technics" Mumford makes a series of statements that help decide whether distributed solar technologies can be considered a democratic technic. He first identifies the characteristics of the two technics: "The tension between small-scale association and large-scale organization, between personal autonomy and institutional regulation, between remote control and diffused local intervention, has now created a critical situation." He then states: "two technologies have recurrently existed side by side: one authoritarian, the other democratic, the first system-centered, immensely powerful, but inherently unstable, the other man-centered, relatively weak, but resourceful and durable." Finally, he clarifies: "What I would call democratic technics is the small-scale method of production, resting mainly on human skill and animal energy but always, even when employing machines, remaining under the active direction of the craftsman (…)" (1964, 2). Although small-scale, distributed, and in part controlled by homeowners, solar panels depend on technological know-how that is controlled by few large corporations, they must be installed by "certified" contractors, and in most cases, they 'feed' the energy into the municipal grid (first, because storing energy is still very expensive, second, because that is how homeowners receive some of the incentives). Eventually, yes, they provide some autonomy and control. Most importantly, they are potentially democratic while many other systems are not compatible with democracy at all. This is what Winner points out in "Do Artifacts Have Politics?" when he speculates about the political nature of artifacts and refers to Mumford's assertion. He briefly discusses solar energy pointing at the fact that its decentralized nature might be more "compatible with" democratic systems rather than democracy *tout court*. (MacKenzie and Wajcman [1985] 1999, 33-4).

nitrogen, indispensable for plant growth and health. Trees play a key function in the overall urban metabolism and support biodiversity by providing habitat and nutrients for other organisms. Individual trees do not provide stable habitats, but they can form connective corridors and provide stepping stones for animals. Together they form a dynamic patch mosaic system.

The reason for listing so many complicated details (already drastically simplified here) is that these facts cannot be omitted to fully comprehend the ecological trade-offs of the solar-panel-centered culture. Yet, they probably will not revert its automatic progress. It is also true that even if scientists were able to assess the exact value of the ecosystem services rendered by trees using bio-economic methods, not everything can be expressed as a quantity to be then listed in a pay-off table and assessed using the federal assessment metrics. The presence of vegetation, especially in residential neighborhoods, fosters a sense of extended community of living beings, and intensifies our involvement with the ultimate otherness - the world of plants. Clearly, these aspects are hard to quantify, as David Pearce pointed out, they are not something that economists "work with."[68] Maybe, after all, it is better this way. Otherwise, the risk of, what Gorz called "ecofascism," and Beck referred to as "ecocracy" ([2007] 2009, 83) would be even greater. And while Illich warned that: "The re-establishment of an ecological balance depends on the ability of society to counteract the progressive materialization of values" (1973, 51), for now "There is nothing left to do but wonder at a mechanism that functions so well and, apparently, so tirelessly" (Ellul [1954] 1964, 82).

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Ralph Knowles's solar envelope represents one of many form-based energy-conservation strategies which failed to compete with technological artifacts developed by the green market and promoted with federal incentives since the first oil crisis. The increasing popularity and efficiency of solar technologies transformed solar access from a right into an asset. It freed the envelope to act as an engine of profit, and a scaffold for the production of meaning. The flatness of solar panels not only impoverished the solar project but also turned a multi-faceted environmental cause into a one-dimensional discourse focused on global warming, which while scientifically recognized as a real and important threat, is one of many environmental issues that should be addressed. Yet, since addressing global warming also helps increase energy security, it became a priority. The result of this concentration on renewable energy and greenhouse gas emissions is reflected in provisions included in zoning codes, building regulations, and state acts. In fact, since the 1970s, coercive measures have been used to protect the incentivized solar technologies against, among other issues, the peculiar rules that govern common interest developments, and against nature

[68] As mentioned in Chapter 4.1, Pearce wrote: "Economists do not deny that 'other' values exist. They make no claim to be working with other values, only economic values - i.e. preference-based valuation. Intrinsic and economic values may therefore co-exist. Practical issues do of course arise, since someone still has to say what the intrinsic values are and how they trade-off against other values (e.g. the rights of trees to exist and the rights of people to a livelihood)" (1992, 7)

itself, regardless the numerous services and delights that the later offers. The scope of the next chapter is to understand how the very structure and form of regulations help the market-driven and product-oriented strategies while precluding other possible roads towards a greater balance between the natural and anthropic processes.

Chapter 6 – *The Meta-Code:* Structure & Form of Regulations.

6.1. The Rule: Who Protects the (Interior) Environment? Focus: Materials.

The aim of the previous chapter was to discuss how technological artifacts developed by the green market and promoted with federal incentives shape the common understanding of sustainability. The objective was to demonstrate the penetration of market goals into public funding mechanisms meant to mitigate the environmental impact of residential construction. This chapter concentrates on the core of the apparatus – the form of regulations and their structure. The goal is to understand the indirect impact of the rules that govern the regulations, on the environment.

In this introductory section, a sample selection of regulations extracted from the *California Building Standards Code* – those containing the term 'interior' – is used to transversally examine the text and identify an issue complex enough to quickly highlight the most critical aspects of the internal architecture of this regulatory text. A brief analysis of the chosen topic – plastic foams used to *isolate* the 'interior' from the external environment – helps introduce the issues addressed more in detail in the remaining sections of this chapter: 1) the geography of the rule-making network, and its distributed agency; 2) the multiple parts of the code, and their role; and 3) the form of particular regulations, and their impact. It also serves as a means to contrast and compare the original objectives of the code with the current environmental concerns.

While the basic purpose of the building code – protection of public health, safety, and welfare – is encapsulated in the few key sections which describe "habitable rooms," the sections that define the specific means for protecting their "interior" offer a way to understand how specific aspects of the code directly and indirectly influence environmental impact of residential construction. In this section, a series of prescriptions from the *Residential Code,* which norm the use of an insulation material, help emphasize the tension between the original goals of the code-makers (i.e. safety - protection from fire), the environmental issues currently in

the center of public attention (i.e. energy efficiency), and less well-publicized yet fundamental environmental problems (i.e. toxicity). Different foam plastic insulation products are examined to understand their environmentally-related characteristics, and the *Green Building Standards Code* is consulted to verify its role in mitigating the negative environmental impact of this product permitted elsewhere in the code.

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Protecting the Habitable Interior. Clearly, the *Residential Building Code*[1] regulates construction of dwellings. The most obvious reasons for constructing dwellings – protection from various hazards and natural elements – is precisely what the code concentrates on. As stated in the *2016 Residential Code*, its purpose is to guarantee that a dwelling unit satisfies certain standards of health, safety, and well-being:

> **1.1.2 Purpose.** The purpose of this code is to establish the minimum requirements to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, stability, access to persons with disabilities, sanitation, adequate lighting and ventilation, and energy conservation; safety to life and property from fire and other hazards attributed to the built environment; and to provide safety to fire fighters and emergency responders during emergency operations (CBSC 2016a, 3).

According to the code, a "dwelling unit" revolves around a more strictly-regulated interior core consisting of "habitable spaces."[2] The term 'habitable' appears in 30 sections of the code, and those sections which define the main attributes of "habitable rooms" reflect the core values embedded in the code. Section R303 specifies how habitable interiors should be illuminated, ventilated, and heated to satisfy basic *health* and *comfort* requirements. Sections R304 and R305 determine the minimum room dimensions to assure general *welfare*. *Safety* in case of emergency is regulated in sections R310 and R311 which define means of escape and egress.

Numerous more specific sections define material and spatial attributes of the elements that demarcate the habitable interiors. A quick analysis of how the term 'interior' is used in relation to various objectives of the code can, by consequence, provide a preliminary way to think about how the building code and its

[1] Unless otherwise specified, all mentioned codes are part of the *California Building Standards Code*, Title 24 of the *California Code of Regulations*.

[2] According to the *2016 California Residential Building Code* a dwelling unit is: "A single unit providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation" (CBSC 2016a, 33), while a habitable space is: "A space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered habitable spaces" (34).

inner rules directly regulate, and indirectly affect the environmental impact of the act of building. It also helps understand how other regulations, standards, and laws embedded in it or referred to, indirectly contribute to shaping the agendas promoted by the code. This type of reading is clearly partial, yet, it is also transversal due to the many ways in which the term is used. Not only is it a noun that denotes the inside of a building or room, but it is also a common adjective used to indicate the relative position of objects in space, independently of scale. The distinction between, for example, the interior and exterior face of a wall of course matters a great deal when it comes to protecting the core of a dwelling unit - its interior. The term 'interior' appears in 147 sections. By the time one reaches page 668 of the *Residential Code* the interior of a habitable room is structurally stable, accessible, protected against fires, floods, termites, speculation, and weather. After 152 more pages of the *Energy Code*, and 184 of the *Green Building Standards Code*, it is also energy-efficient, and environmentally well-tempered.

Thermal Barrier Against the Insulation. Two cross-referenced sections trigger particular curiosity as their purpose appears paradoxical: they seem to be protecting the interior environment from the very means which protect it from the natural elements. The first section is part of a larger set of prescriptions which regulate interior wall covering, and reads:

> R702.3.4 Insulating concrete form walls. Foam plastics for insulating concrete form walls constructed in accordance with Sections R404.1.2 and R608 on the interior of habitable spaces shall be protected in accordance with Section R316.4 (CBSC 2016a, 397).

Section 316.4, to which the above section R702.3.4 refers, is part of a set of prescriptions which concentrate on the use of one family of products only - foam plastics. It specifies how this type of insulation should be protected, and indirectly explains why it needs such protection:

> R316.4 Thermal barrier. Unless otherwise allowed in Section R316.5, foam plastic shall be separated from the interior of a building by an approved thermal barrier of not less than 1/2-inch (12.7 mm) gypsum wallboard, 23/32-inch (18.2 mm) wood structural panel or a material that is tested in accordance with and meets the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275 (104).

If in linguistic doubt, the term 'thermal barrier' refers to fire resistance, not protection from excessive heat. A half an inch of gypsum or less than an inch-thick space of wood will generate a 15-min time between the person in the habitable interior, and the flames in the plastic foam. Foam is obviously highly

flammable, but aren't flame retardants there to provide a sufficient thermal barrier? A quick search on the website of The Home Depot (one of the leading U.S. home improvement retailers) might not explain why use of plastic foam is so tightly-regulated in the building code, but it does explain other reasons for which foam should be separated from the habitable interior, or better, why both the interior and the exterior environment should be protected from it.

Foam Plastic Insulation. Most rigid foam insulation products available on the Home Depot website appear *benign*, and only those with a deep interest in environmental issues know the hidden risks of common EPS and XPS boards.[3] Not only do they apparently decompose in a dangerous way when in contact with seawater,[4] but the brominated flame retardant HBCD that they contain has been banned by many countries, and was listed on the Stockholm Convention on Persistent Organic Pollutants (POPs) (Fig.6. 1).[5] Still, the risks embedded in other products advertised on the Home Depot website are more immediately visible. While apparently non-toxic after it has cured, the *Touch 'n Foam 2-Component Spray Foam* (Fig.6. 2) comes with a long safety data sheet – a clear warning that hazards exceed accepted levels of risk. Harmful, sensitizing, and irritant prior to, and during application, the components of this polyurethane foam are also hazardous to aquatic life.[6] Once cured and eventually disposed of, polyurethane is difficult

[3] EPS and XPS insulations are so commonly used that most people don't question them. A representative safety data sheet (SDS) for an EPS insulation board produced by the Insulation Corporation of America and called Expanded Polystyrene ICA-Lite Insulation Board reads: "Effects of Chronic Exposure: No significant health hazard is expected to result under conditions of normal occupational use of this material." Yet, the same SDS specifies: "Carcinogenicity: The degradation component styrene is listed as a possible carcinogen." Under "Section 12 – Ecological Information" one also reads: "Non-biodegradable, insoluble in water, low potential for bioaccumulation. Not expected to harm ecosystems through its applied use." Unfortunately, the harmlessness of applied use ends when EPS must be disposed of. Under "Section 13 – Disposal Considerations" we read: Reuse or dispose via sanitary landfill or adequate incinerator (…). Do not discharge into waterways or sewer system." Retrieved July 9, 2017. https://insulationcorp.com/wp-content/uploads/2016/05/ICA-LITE-SDS.pdf

[4] A 2009 article posted on the website of the American Chemical Society, and entitled: "Plastics in oceans decompose, release hazardous chemicals, surprising new study says" reports that, contrarily to previous believes plastics (including polystyrene used in insulation boards) is not indestructible. It does (and quite quickly) decompose when in contact with seawater, and it becomes toxic. But we will most likely continue using it until the quantity of released toxic substances is such that it can no longer be ignored. Accessed July 9, 2017. https://www.acs.org/content/acs/en/pressroom/newsreleases/2009/august/plastics-in-oceans-decompose-release-hazardous-chemicals-surprising-new-study-says.html

[5] In 2014, HBCD was added to the Annex A (Elimination) of the Stockholm POPs treaty. The Annex A specifies: "Parties must take measures to eliminate the production and use of the chemicals listed under Annex A. Specific exemptions for use or production are listed in the Annex and apply only to Parties that register for them." Paradoxically, the exemptions refer to EPS and XPS insulation. (The Convention has not been ratified by the U.S.) See the website of the Convention. Accessed July 10, 2017. http://chm.pops.int/Convention/ThePOPs/ListingofPOPs/tabid/2509/Default.aspx

[6] See the Safety Data Sheet. Retrieved July 9, 2017. http://www.homedepot.com/catalog/pdfImages/e0/e0226efa-b0c9-434e-a8bc-698c64cef9fc.pdf The product is advertised on the Home Depot website. Accessed July 9, 2017. http://www.homedepot.com/p/Touch-n-Foam-15-Board-Foot-Polyurethane-2-Component-Spray-Foam-Kit-4006002506/204352574

Fig.6. 1 HBCD added to the Annex A (Elimination) of the Stockholm POPs treaty in 2014 (left), an article posted on the website of the American Chemical Society discussing decomposition of plastics in seawater (bottom right), plastic waste washed up on a beach (top right).

to decompose in landfill, it releases poisonous gases when incinerated, and its chemical recycling is risky due to by-products.[7] Unlike steel, aluminum, or glass, plastics cannot be physically recycled forever. Its fibers gradually shorten, become unusable, and eventually end up in landfills. The distance between a landfill and ground water is often a short leach. Another highly-efficient option available through Home Depot; *R-Matte Plus-3/Thermasheath-3* (Fig.6. 2), is "composed of environmentally sound, closed cell, polyisocyanurate foam."[8] While it remains unclear what environmental soundness stands for, polyisocyanurate (abbreviated as polyiso or PIR), does offer the greatest R-value per inch. It is also often listed as an alternative to EPS and XPS since it does not use brominated flame retardant HBCD. However,

[7] For more detail, see for example: "Recycling and Disposal Methods for Polyurethane Foam Wastes," a paper written by Wneqing Yang, Qingyin Dong, Shili Liu, Henghua Xie, Lili Liu, Jinhui Li, and published in *Procedia Environmental Sciences* (Vol. 16, 2012, pp. 167-175). Retrieved July 9, 2017. https://doi.org/10.1016/j.proenv.2012.10.023

[8] See the Home Depot website. Accessed July 9, 2017. http://www.homedepot.com/p/Thermasheath-Rmax-Thermasheath-3-2-in-x-4-ft-x-8-ft-R-13-1-Polyisocyanurate-Rigid-Foam-Insulation-Board-613010/100573703

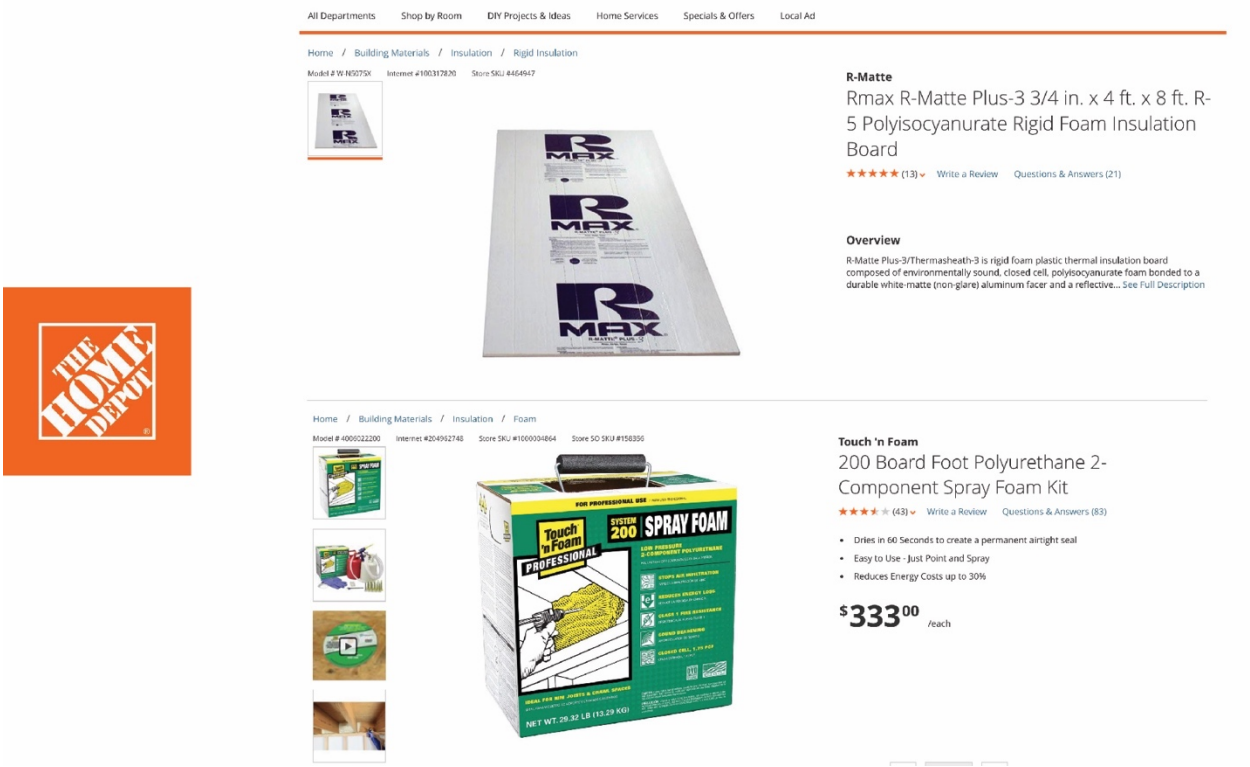

Fig.6. 2 Some of the insulation materials available from Home Depot: Touch 'n Foam 2-Component Spray Foam (bottom), R-Matte Plus-3/Thermasheath-3 (top).

the chlorinated flame retardant TCPP typically used in polyiso panels as a replacement[9] is by many considered equally risky (just less understood and tested), while the EPA is investigating the hazards associated with other ingredients used in this material.[10] To put it simply, the composition of this highly energy-efficient foam rises doubts, and since it is similar to polyurethane, its end-of-life is most likely far

[9] The product sheet does not state what flame retardant is used in the *R-Matte Plus-3/Thermasheath-3* polyiso. It does advertise that its blowing agents are HFC-free. See the specifications. Retrieved July 9, 2017. http://www.homedepot.com/catalog/pdfImages/7c/7ccf79ef-2268-485a-af2b-ecec9322e675.pdf

[10] TCPP is another halogenated flame retardant scrutinized by governments and third-party organizations but not banned yet (Prior to 2013, USGBC's LEED awarded pilot points for not using materials that contain them). For a short overview of halogenated fire retardants see, for example, an article posted by the U.K.-based GreenSpec on their website: "Halogenated flame retardants." Accessed July 10, 2017. http://www.greenspec.co.uk/building-design/halogenated-flame-retardants-environment-health/ As mentioned above HBCD was added to the Stockholm POPs treaty, it is banned in Japan, European Union (2015), and several U.S. states but the not by the U.S. federal government. In 2014, the U.S. Environmental Protection Agency released a report entitled "flame retardant alternatives for Hexabromocyclododecane (HBCD)." In this report, polymeric flame retardant (PFR) is listed as an alternative to HBCD although it is little-known, and polyiso and polyurethane are listed as alternatives to EPS / XPS insulation. Not only do they use TCPP as a flame retardant, but the EPA report also lists other hazards and unknowns related to those alternatives (EPA 2014, 5-9, and 5-12). This brings up an important problem: difficulty to track and test hundreds of new materials that are considered *innocent until proved guilty*. Retrieved July 10, 2017. https://www.epa.gov/sites/production/files/2014-06/documents/hbcd_report.pdf

from being "environmentally sound."[11] One more product; *UltraLight Foam Tile Backer Board* draws attention as its description is directly followed by a warning. This lightweight, waterproof, and vapor-retardant material cuts easily with a utility knife, and is dust-free, it seems perfect, except for the endnote: "California residents: see Proposition 65." The Proposition 65 reads: "WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm."[12] While Home Depot website does not provide a safety data sheet for this product, the one found on the manufacturer's website explains that similarly to the previously-mentioned materials, this foam and its principal ingredient (styrene, oligomers) are also noxious. Under Section 12 – Ecological Information, we read: "Ecotoxicity: Harmful to aquatic life with long lasting effects."[13] Being a type of EPS, it most likely also contains brominated flame retardant HBCD, but it is not clearly stated by the manufacturer. Yet, according to the *Residential Code*, as long as one acts "in accordance with the code and the manufacturer's instructions,"[14] one will stay safe, healthy, and generally well. A double bind?

Unwarranted Eco-Toxicity. The plastic foam is here to protect humans from extreme elements. Although some studies point out that it is redundant and environmentally unsound,[15] both the flame retardants in the foam, and section R316.4 of the building code protect the interior (and humans in it) from the flames. Or, could it be that section R316.4 protects the interior from the flame retardants? In any case, no article in the *Residential Building Code* protects the exterior environment from the weatherproofing foam, ecotoxicity of its ingredients, and simply from its sheer (non-biodegradable) bulk. But, after all, according

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[11] The product safety data sheet for *R-Matte Plus-3/Thermasheath-3* demonstrates that this material has not been fully tested and certified. It does not provide information about toxicity and ecological impact. Retrieved July 9, 2017. https://static1.squarespace.com/static/57a39be0579fb3a3a8540f56/t/583efbb415d5dbc227433ce8/1480522677057/Rmax+Thermasheath-3+SDS.pdf An environmental product declaration (EPD) was released by the Polyisocyanurate Insulation Manufacturers Association (PIMA) in 2015. In a 2015 web article entitled "Polyiso Impacts Are High, but Performance May Make Up for Them," BuildingGreen questioned its objectivity. Accessed July 9, 2017. https://www-buildinggreen-com.ezp-prod1.hul.harvard.edu/news-analysis/polyiso-impacts-are-high-performance-may-make-them

[12] See the Home Depot website. Accessed July 9, 2017. http://www.homedepot.com/p/DUROCK-UltraLight-5-ft-x-3-ft-x-1-2-in-Foam-Tile-Backer-Board-170036/206343173 and

[13] See the safety data sheet available on the manufacturer's website. Retrieved July 9, 2017. https://www.usg.com/content/dam/USG_Marketing_Communications/united_states/sds/usg-durock-ultralight-foam-tile-backer-board-sds-en-14000040003.pdf

[14] This is an expression commonly used in the code. For example: "R316.5.2 Roofing. The thermal barrier specified in Section R316.4 is not required where the foam plastic in a roof assembly or under a roof covering is installed in accordance with the code and the manufacturer's instructions" (CBSC 2016a, 104).

[15] In a paper entitled "Flame retardants in building insulation: a case for re-evaluating building codes" one reads: "Changing the building codes could prevent health and environmental harm from the toxicity of these substances without a reduction in fire safety. Plastic foam insulations that are protected by a thermal barrier should be exempted from the Steiner Tunnel test and the need to use flame retardants. This change would align US codes with code regulations in Sweden and Norway and ensure the fire safety as well as improve health and environmental impacts" (Babrauskas et al 2012, 738).

to section 1.1.2, the code is here "to safeguard the public health, safety and general welfare." Product of a nation-wide effort undertaken in the green 1990s, the *Residential Code* might be more uniform and modernized but it still reflects the original triple-purpose of code making: public health, safety, and welfare. Its anthropocentricity appears socially just but it is also ecologically (both socially and environmentally) short-sighted. One hopes that due to its sustainable agenda, the *Green Building Standards Code (*the *CALGreen Code)* will extend the boundary of the protected bubble beyond the walls of the interior of one's habitable room, into a larger, exterior environment. Yet, its objectives again revolve around man and his well-being. The code recognizes the importance of the natural environment, but it fundamentally describes it as a means, not an end in itself:

> 101.2 Purpose. The purpose of this code is to improve public health, safety and general welfare by enhancing the design and construction of buildings through the use of building concepts having a reduced negative impact or positive environmental impact and encouraging sustainable construction practices (…) (CBSC 2016e, 1).

After a quick search for 'foam,' one finds the following prescription:

> A5.205.3.2. Installation of urea formaldehyde foam insulation. Urea formaldehyde foam insulation may be applied or installed only if: 1. It is installed in exterior side walls; and 2. A four-mil-thick plastic polyethylene vapor barrier or equivalent plastic sheathing vapor barrier is installed between the urea formaldehyde foam insulation and the interior space in all applications (141).[16]

The *greenest* part of the *California Building Standards Code* not only does not restrict the use of a number of commonly-specified, but considered dangerous foams discussed above (of course it would be an internal contradiction to prohibit them – after all the *CALGreen Code* is just another part of the same code), but it also names and regulates a foam whose murky *interior matter* was judged unsafe and banned by many jurisdictions decades ago, in the 1980s. Many, since then, have claimed that the precaution was

[16] Here only a voluntary standard suggested for health facilities, yet, the exact same prescription applies to all *interiors* in Section 110.8 (b) of the *Energy Code* (CBSC 2016d, 43).

Fig.6. 3 Three reasons to regulate insulation: fire safety (top left), energy efficiency (middle left), and environmental impact (bottom left), a construction worker installing an insulation panel (right).

excessive, and similar products exist today under new names (with reduced formaldehyde offgassing).[17] Reflecting this lack of clarity, the *California Code of Regulations* prohibits the sale of urea formaldehyde foam insulation in California, but a series of rather hard to follow exceptions (subject to compliance with certain standards) after all makes it marketable.[18] Once sellable, it must be regulated. By regulating it, the code internalizes it. Better, it interiorizes it. By norming it, it normalizes it.

Who Protects the Exterior? As specified in Section R316.3 of the *Residential Code* (CBSC 2016a, 104), a third-party fire standard, *ASTM E 84*, protects the foam from flames by imposing a certain level of

[17] For a list of similar products, see an article posted on BuildingGreen on October 30, 2013, and entitled: "Formaldehyde-Based Foam Insulation Back from the Dead." Accessed July 10, 2017. https://www.buildinggreen.com/blog/formaldehyde-based-foam-insulation-back-dead On the other hand, some sources claim that the precaution was excessive, on February 4,2014 a Canadian building inspection company Carson Dunlop published an article entitled "Urea formaldehyde foam insulation," in which they claim: "UFFI is one of the most thoroughly investigated, and most innocuous building products we have used." Accessed on July 10, 2017. http://www.carsondunlop.com/resources/articles/urea-formaldehyde-foam-insulation/

[18] See California Code of Regulations; Title 26. Toxics; Division 20. State Energy Resources Conservation and Development Commission (Title 20); § 20-1553. Urea Formaldehyde Foam Field Applied. Accessed July 7, 2017. https://govt.westlaw.com/calregs/Document/I9741A460D44F11DEB97CF67CD0B99467?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)

flammability, and hence use of flame retardants. In reference to another national standard, *NFPA 275*, the previously-cited section R316.4 imposes a half-an-inch layer of gypsum board to prevent flames (and toxins) from entering the interior. The article A5.205.3.2 contained in the *CALGreen Code* protects it from urea formaldehyde foam (prohibited by the state of California) by imposing an extra layer of an apparently harmless polyethylene barrier. No article or jurisdiction protects the exterior from either of them – from brominated flame retardants, urea formaldehyde, EPS, XPS, polyiso, polyurethane, or from tons of polyethylene that we dump into the oceans and landfills each year. Even if the *interior* of the habitable room in which one resides seems oppressively small, as long as one stays in, it is safe and healthy according to the *California Building Standards Code*. Yet, the interface that separates the interior from the environment is a cunny space that protects and harms at the same time. Not only does the code fail to protect our health from a multitude of poorly understood materials, but it does little to protect the environment from them (Error! Reference source not found.). It is clearly beyond its scope to regulate the market – it can only regulate how what is sold is applied. Building code is as green as the economy that created it, The Home Depot might be able to do more for the environment than the code.

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A brief analysis of the way in which foam plastic insulation is regulated in the building code helps illustrate the complex relationship (and conflicts) between the original, anthropocentric goals of the code-makers (in this case: fire safety), the current sustainable agendas (here: energy efficiency), and above all, the less well-known environmental perils hidden in the unintentional side-effects of the older regulations (here: toxicity). The objective in this section was also to provide an introduction to three issues further explored in detail in the remaining sections of this chapter: 1) the multiple originating authorities which together shape the code; 2) the multi-layered nature of the code; and 3) the importance of the way in which individual regulations are expressed.

As it will be further explored in the next section, the complicated origins of the regulations deeply affect the outcomes. Although each code has an author, many sections refer to previously developed third-party standards, are amended by local governments, and must be read in conjunction with laws and regulations imposed by higher-level authorities. In case of foam plastic, a standard-setting organization establishes fire-safety criteria, another one decides which flame retardant should be added to foam in order to meet them, and yet another agency determines what additional thermal barrier will protect the interior environment in case the previous standard proves insufficient. Another third-party body sets standards of energy efficiency, and criteria of environmental safety are established by yet another, most likely federal, agency. Each of them addresses an isolated issue, and environmental impact is treated as one of many parallel problems, rather than an overarching concern. As it will become apparent in the next section, the complex geography of rule-making becomes even more problematic when the regulated issue has its own geographic identity.

6.2. The Matrix: Where are the Rule-Makers and What is Their Agency? Focus: Water.

While many issues contribute to the complicated nature of building regulations; one of them is the complex agency of authorities having jurisdiction. This section examines the rule-making network in relation to the geography of water brought in and out of households. In the United States, federal, state, county, and municipal authorities are granted the power to regulate different aspects of land use, construction, and domestic operations. In case of water-related regulations, man-made administrative and jurisdictional boundaries fail to reflect the boundaries of watersheds. Not only does this fact further complicate the mechanisms of rule-making and implementation, but it also fails to properly address some of the fundamental environmental issues. The supplies are regulated by the state while water sources are often located outside its boundaries. Stormwater is now regulated both as an alternative water source, and a perilous runoff, which involves both the scarcity-concerned states and municipalities, and the more environmentally-oriented federal government. Similarly, pollution from sanitary sewage is subject to federal control, but the sewers themselves are managed by municipal departments responsible for provision of basic services rather than the health of the common waters. They again concentrate on quantities of used water. Although federal and international acts have no jurisdiction over the supply *faucet*, they have the power to protect the environment by *plugging the ultimate drain:* denying the rivers and oceans as sink for waste.

While in this section the way water is regulated is discussed to understand the legislative matrix, the overview helps highlight how the distribution of powers shapes the tension between the initial objectives pursued by the code-makers (in this case: health - sanitation), the environmental issues currently in the center of public attention (i.e. water conservation), and less well-publicized yet fundamental environmental problems (among others: disrupted nutrient cycles).

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The Matrix. Water, more than any other aspect of the environment, is a matrix. It is the substance from which life originates, and on which it depends.[19] Human dwellings rely on a constant, and strictly-regulated provision of running water for personal hygiene, food preparation, climate control, fire protection, and gardening. A mirror reflection of the supply network takes care of domestic effluents in an equally invisible, and apparently effortless way. The *blue gold* becomes *black medium* as used water, bodily waste, and food left-overs are piped down the drain. Although a small percentage of rainwater is collected, most of it, instead of seeping into the ground, is *safely* piped away through another network of invisible drains to rivers, lakes, and oceans. Depending on whether it is called supply, sewage, runoff, flood, or excessive moisture; water assumes the role of resource or risk. Opportunities, hazards,

[19] The UN formally recognized water and sanitation as vital human rights very late, in the 2010 *Resolution 64/292.* Although the *Universal Declaration of Human Rights* proclaimed in 1948 protects the right to life (Article 3 reads: "Everyone has the right to life, liberty and security of person."), water, an obvious prerequisite for life, was not listed in the declaration deeply influenced by the "barbarous acts" of the World War II. See the website of the United Nations. Accessed October 15, 2017. http://www.un.org/en/universal-declaration-human-rights/ and http://www.un.org/waterforlifedecade/human_right_to_water.shtml

regulations, and regulators change accordingly. Since every aspect of water use and handling is regulated, and the geographies of these man-made hydrologic systems are vast and complex, it seems appropriate to examine the regulatory matrix (Fig.6. 4) in relation to water-related regulations. In urban areas located on the South West Coast, the sources of clean water, and the final destination of contaminated effluents are rarely located within the same watershed. Both treated wastewater, and polluted stormwater are piped to the ocean, while potable water is transported from distant places, affecting the ecology of other watersheds. Unlike natural hydrologic systems, water supply and drainage networks are wide open, and since they disregard the geography of water, the rules that govern them are also rarely a reflection of it.

Supplies. Although federal laws provide a framework for state and local regulations pertaining to the use and management of most resources,[20] no federal act norms the allocation of water supplies. The issue is regulated by state laws, and managed at state, regional, and municipal level. In California, as in the other arid states of the American South West, the regulatory compromise between riparian and appropriative rights[21] reflects an epic tale of appropriations, and acquisitions possible thanks to borderline legality, fraud, and graft.[22] No matter how the economic output of the Los Angeles region is accounted for to

[20] Federal acts rarely directly regulate construction and demolition of single-family houses. Most environmental acts apply to residential construction via state regulations and municipal ordinances, often only under certain circumstances, such as lot size, location, or level of hazard. Construction activities which affect habitat of endangered species are regulated by the *Endangered Species Act (ESA, 1973)*. Construction in proximity of protected waters is regulated by the *Clean Water Act* (CWA, 1973). Certain types of hazardous construction waste (which does not include sewage or sludge) are federally-regulated by the *Resource Conservation and Recovery Act* (RCRA, 1976). Several federal acts regulate toxic chemicals used in many construction materials, among them the *Toxic Substances Control Act (TSCA, 1976)*, and the *Resource Conservation and Recovery Act (RCRA, 1976)*. The limitations of the later acts become evident in emergencies such as the recent North California wildfires (October 2017), in which thousands of homes transformed into heaps of toxic ash. The toxicity trapped in construction materials (and in half-empty cans of paint that most people keep in their homes) is a dormant environmental peril that is yet to be properly addressed. See the New York Times article published on October 16, 2017 and entitled "Cleanup From California Fires Poses Environmental and Health Risks." Accessed October 23, 2017. https://www.nytimes.com/2017/10/16/us/california-fires-cleanup.html?emc=edit_ca_20171017&nl=california-today&nlid=69260130&te=1&_r=0

[21] In California, the water rights based on the riparian and appropriative doctrines. The former originates from the English common law and was adopted from the Eastern states. It is based on the adjacency of owned land to a source of water, gives a right to use a *reasonable* quantity, and prohibits diversion or storage of water. The later originates in the American West, where the right to use, divert, or store water was simply claimed by early settlers, gold miners, and entrepreneurs. Here prior appropriation secured the right to water regardless its distance from the land on which it is used, it also assures priority in case of drought, and did not limit the quantities of extracted water. Since the passage of the Water Commission Act of 1914, appropriation requires a permit. For a more detailed explanation, see the website of the California State Water Resources Control Board. Accessed November 12, 2017. https://www.waterboards.ca.gov/waterrights/board_info/water_rights_process.shtml

[22] For a fascinating account of the events that led to the construction of the Los Angeles aqueduct, Hoover Dam, and other water projects that turned the inhospitable West into the present powerhouse, see Marc Reisner's *Cadillac Desert (1993).* The potential profits and dreams were so big that both the local magnates, and the federal government participated in the frenzy. While the magnates invested to secure the value of their real-estate assets in Los Angeles (for example, by orchestrating the quasi-legal land takeovers necessary for the construction of the L.A. aqueduct), the federal government provided subsidies (51), and often the final word in disputes over water and land rights (83).

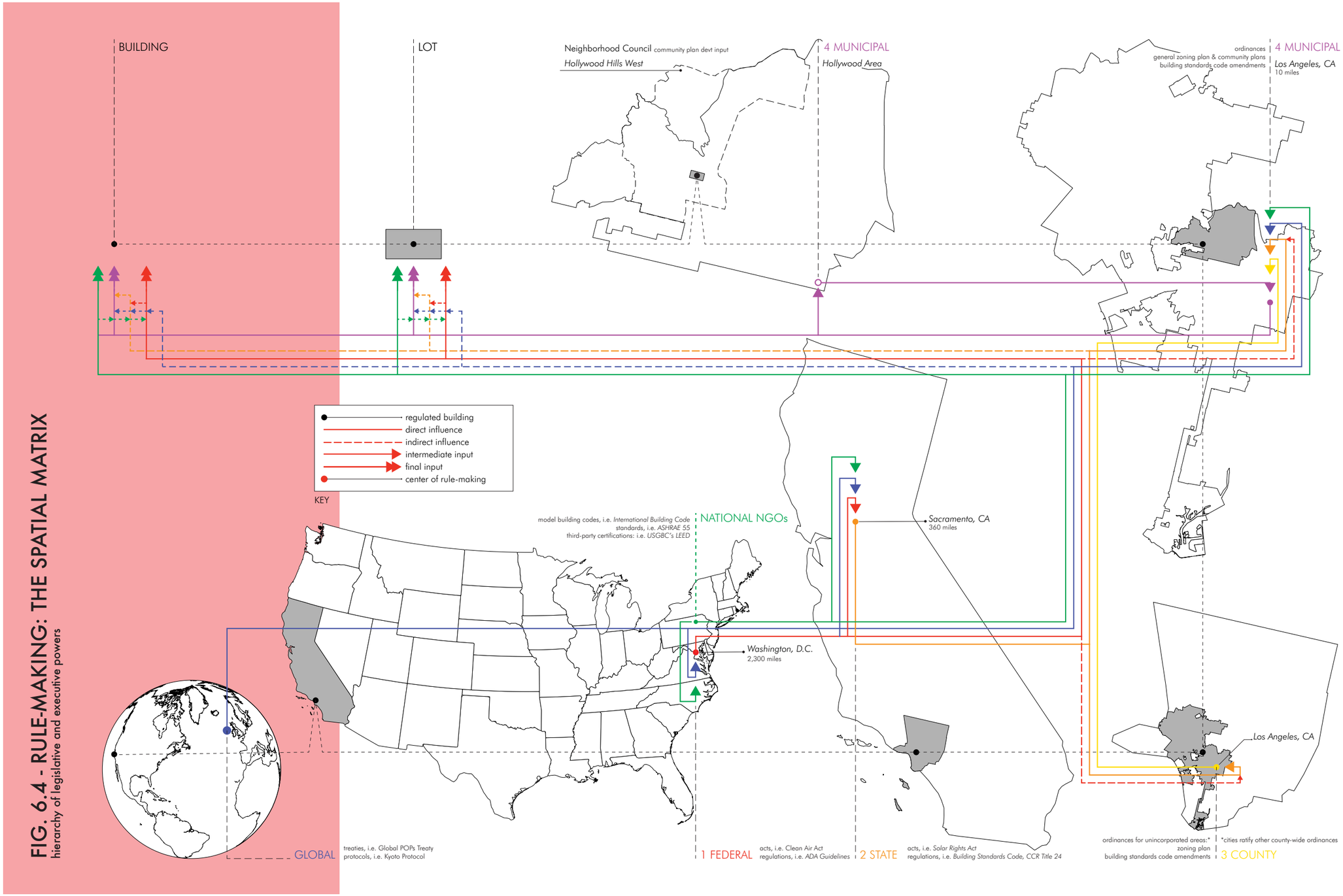

FIG. 6.4 - RULE-MAKING: THE SPATIAL MATRIX
hierarchy of legislative and executive powers

Fig.6. 5 Los Angeles Aqueduct (left), the Ballona Creek flood-protection channel which drains water from the L.A. basin to the ocean (right).

justify its water consumption,[23] the outcome is far from sustainable if one stands in the dusty Owen Valley, or the dry Colorado River delta.[24] While the question of water rights goes beyond the scope of this project, it is fundamental to remember that Los Angeles relies on water *grabbed* elsewhere. Only one-

[23] Los Angeles Basin's economic output accounts for half of the state's economy, ranks just after New York, but before, for example, Switzerland. California has the strongest economy in the nation, and the residents of California often point out that if they were an independent country, they would be the 6th largest economy in the world, comparable to the U.K. or France. For economic rankings, see the website of Center for Continuing Study of the California Economy. Retrieved November 11, 2017. http://www.ccsce.com/PDF/Numbers-July-2017-CA-Economy-Rankings-2016.pdf and http://www.ccsce.com/PDF/Numbers-July-2014-CA-Regional-Economy-Rankings-2013a.pdf

[24] Except for a small amount of water extracted from local wells (the average for the fiscal years 2011-2015 was 12%), and an even smaller amount of recycled water (2%), Los Angeles relies on three major sources of water. The municipally-owned and 240-mile-long Los Angeles Aqueduct (LAA) was inaugurated in 1913 and delivers water from the Owen Valley (29%). The 242-mile-long Colorado River Aqueduct was inaugurated in 1939, delivers water from the Colorado River, and originates at Lake Havasu. It is operated by the Metropolitan Water District (MWD). The most recent of the three, the California Aqueduct (part of the State Water Project) originates in the San Joaquin Valley and delivers water from Northern California and Sierra Nevada Mountains (total length of canals and pipes is approx. 700 miles). Its West Branch was inaugurated in 1973, Los Angeles provisions are supplied by MWD (57%, from Colorado River and California Aqueduct). Supplies from LAA have gradually diminished due to drought and environmental regulations which impose environmental mitigation (LAA provided only 7% of supplies in 2014). The deficit is compensated by water from the MWD sources, locally sourced water (greywater recycling, stormwater reuse), and drastic conservation measures. For details, see *Urban Water Management Plan* (LADWP 2015a, ES-21, ES-25).

tenth of water is extracted locally, and instead of replenishing ground water supplies, most of the rainfall is dumped into the ocean (Fig.6. 5). According to the Los Angeles County Flood Control District, "the same infrastructure that protects the region from largescale flooding pours out into the ocean roughly one-third of the region's total annual water demand" (LACDPW 2017, 2). While no federal act impedes such *waste* of rainwater; the state – driven by increasing water scarcity – has launched rainwater collection incentives, ordered municipalities to develop water management plans and adopt landscape ordinances, all in order to reduce runoff and improve infiltration.[25] As stated in the municipal *Stormwater Capture Master Plan* (LADWP 2015b, 19), in the highly impervious, almost *watertight* City of Los Angeles only 6% of incoming flow is captured. The annual incoming flow is estimated to be 831,000 acre-feet, an amount that exceeds the Los Angeles pLAn Water Demand Target for 2035 (estimated to be 551,000) by one-third (ES-23).[26] Yet, the projected 2,000 acre-feet captured in rain barrels, and a bioswale per household will not undo a

[25][25] In 1996, the Los Angeles municipality passed a landscape ordinance (Ord. No. 170,978) which is now part of the Zoning Code, Chapter I, Article 2 (Sections 12.40 – 12.43). Section 12.41 addresses water management but it is not applied to one-family dwellings. The more recent and ambitious ordinance, the *Irrigation Guidelines* is based on the state-authored "Model Water Efficient Landscape Ordinance" (implementation of the 2006 Assembly Bill 1881) and applies to single-family dwellings only if the landscaped area exceeds 2,500 sq. ft. when developer-built, and 5,000 sq. ft. when built by the home-owner (City of Los Angles 2011,3). Since a medium lot in Los Angeles is 7,500 sq. ft. (minimum size in R1 zone is 5,000 sq. ft.), it is rare for a home-owner to landscape 5,000 sq. ft. The 2016 edition of the *CALGreen Code* (Section 4.304. Outdoor Water Use) makes the ordinance mandatory for "new residential developments with an aggregate landscape area equal to or greater than 500 sq. ft." (CBSC 2016e, 25). The state uses all tools (local ordinances and state building code) to make the rules stricter and stricter.

[26] Of course, not all rainwater can be captured for human use. A large portion is reserved for 'environmental uses,' which ironically means both maintaining gardens for human enjoyment, and allowing it to flow into lakes, wetlands, and be used by plants and wildlife. Also, only approx. half of the water that is captured is recharged to aquifer, the remaining half infiltrates into soils separated from the aquifer by an impermeable layer (LADWP 2015b, ES-7). The Los Angeles pLAn (released in 2015) is a sustainable roadmap "made up of short term (by 2017) and longer term (by 2025 and 2035) targets in 14 categories that will advance our environment, economy and equity." For details, see the pLAn website. Accessed November 22, 2017. http://plan.lamayor.org/about-the-plan/

century of tropical gardening,[27] and real-estate speculation.[28] In fact, the Los Angeles Department of Water and Power is launching a new era of water projects, only that this time they will be less spectacular. Rather than impressive dams and aqueducts, it will take a lot of apparently fallow land for surface spreading, some surgical precision to position recharge wells, and a dose of unglamorous restraint to allow the rest of it to simply seep into the soil, at the risk of not being able to tap into it until in the distant future.[29]

Stormwater Discharge. If the geography of water regulations is getting closer to that of the watersheds, it is because in the face of water shortage, regions act like city-states to limit their reliance on imports. While it is the scarcity (rather than environmental benefits[30]) that drives the local authorities to consider capturing stormwater runoff worthwhile, it was the environmental concerns triggered by *Silent Spring* that made the federal government scrutinize the pollutants in the uncaptured portion of that same runoff. Unlike the *Safe Drinking Water Act* which regulates the levels of contaminants in drinking water,[31] the

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[27] In California, only 11% of water use is urban (in 2000 which was an average year, it was 8% in the wet 1998, and 13% in the dry 2001), 42% is agricultural (in 2000, 28% in 1998, 52% in 2001), and the remaining 47% (in 2000, 35% in 1998, 64% in 2001) is referred to as 'environmental', reserved for 'nature'. Since most farmland is concentrated in the central and northern parts of the state, Los Angeles water use is urban, on average in the period between 2011-2014, 66% use was residential (37% single family, 29% multi-family), 17% commercial, 14% governmental and non-revenue (i.e. firefighting, leakage), and only 3% industrial. (LADWP 2015a, ES-9). 40% of all water was used outdoors (ES-10). This is the reason for the efforts to reduce use of drinking water supplies for irrigation. While in the context of the state the percentage of urban water use is low comparing to that used in agriculture, Los Angeles attitude towards water seems against the California Constitution: it is unreasonable and wasteful (see Article X Water, Section 2). The city's almost tropical gardens appear as an offense against the dry farmland in the Owen Valley, or the disappearing Colorado River Delta in Mexico. For the statistics on water use in California, see the website of the California Department of Water Resources. Accessed November 13, 2017. http://www.water.ca.gov/swp/watersupply.cfm For the Constitution of California, see California Legislative Information website. Accessed November 12, 2017. http://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=CONS&division=&title=&part=&chapter=&article=X

[28] The 1936 *Flood Control Act* was a victory for the Los Angeles developers and realtors. It provided the legal basis and funding for the channelizing of the L.A. River (1938-1960). While the project made the city 'safer', and of course denser and wealthier, it isolated the river from its watershed. To mention a couple of side effects; it sent rain to the ocean rather than the aquifer, and it deprived soil of vital nutrients. Alternative solutions to the flood risk, most importantly the 1930 Olmsted-Bartholomew Plan, required too much prime land to be left intact, and hence disappeared from the desks of the officials of the Chamber of Commerce. For the story of the plan, and original document, see: *Eden by Design: The 1930 Olmsted-Bartholomew Plan for the Los Angeles* Region (Hise and Deverell, 2000).

[29] The LADWP estimates that the annual groundwater recharge can increase twofold by 2035 (68,000 acre-feet / year), thanks to the construction of new stormwater spreading facilities, and distributed stormwater infiltration methods (LADWP 2015b, ES-10). The city considers less than approx. a quarter of it (15,000 acre-feet / year) as a future source of supply. The rest is supposed to counteract the effects of over-consumption (LADWP 2015a, 7-29).

[30] The language of the official reports and plans reflects it. One of the chapters of the *Urban Water Management Plan* is entitled: "7.2 Additional Benefits of Watershed Management." The introduction reads: "Watershed management provides additional important benefits to the City, including increased water conservation, improved water quality, open space enhancements, wildlife habitat, flood control, and social/economic benefits" (LADWP 2015a, 7-5). Wildlife habitat is an additional benefit.

[31] The *Safe Drinking Water Act (SDWA, 1974)* protects human health by determining the maximum contaminant levels in the supplies of drinking water. Although the SDWA focuses on the quality of water at the supply end, it also indirectly protects ground water through a 2006 regulation commonly called the *Ground Water Rule*.

Clean Water Act (CWA, 1972) goes beyond the issue of human health as it regulates contaminants in all waste discharged into U.S waters.[32] Since 1987, it includes nonpoint sources of pollution such as urban runoff. Thanks to this amendment, discharging it now requires a permit, but the federal government delegates the task of issuing them to the states.[33] Since the geography of hybrid hydrologic systems (in part natural watersheds, and in part artificially created and managed stormwater drain systems) does not overlap with administrative areas, stormwater runoff is managed by parallel but cross-boundary authorities; water quality control boards, and flood control districts. Additionally, since the states (and various boards and districts) have no right to interfere with land-use control; they release permits but leave the mechanics to cities and counties.[34] To meet the requirements listed in the permit, the City of Los Angeles adopted the *Stormwater Low Impact Development (LID) Ordinance*, which applies to projects that add more than 500 sq. ft. (46 sq. m.) of impervious area.[35] It requires them to capture and mitigate urban runoff on-site by adopting best management practices that increase infiltration, evapotranspiration, bioretention, phyto-purification, and use of stormwater. Although the *Stormwater LID Ordinance* and the previously-mentioned *Irrigation Guidelines* both address infiltration, and use of stormwater, they are

[32] In coastal areas, the *Ocean Dumping Act* (1972) partly overlaps with it.

[33] Since 1990, the National Pollutant Discharge Elimination System (NPDES) permit issued by the California State Water Resources Control Board (Los Angeles Region) to the Los Angeles County Flood Control District sets the allowable pollutant loads that can be discharged from their Municipal Separate Storm Sewer Systems (MS4) to the ocean (Santa Monica Bay). As stated in the permit: "the primary pollutants of concern (…) are indicator bacteria, total aluminum, copper, lead, zinc, diazinon, and cyanide. Aquatic toxicity, particularly during wet weather, is also a (…). Storm water and non-storm water discharges of debris and trash are also a pervasive water quality problem in the Los Angeles Region (…)" (LARWQCB 2012, 10). For the Los Angeles County permit (Order No. R4-2012-0175), see the website of the Los Angeles Regional Water Resources Control Board. Retrieved November 16, 2017. https://www.waterboards.ca.gov/losangeles/water_issues/programs/stormwater/municipal/los_angeles_ms4/2016/OrderR4-2012-0175_corrected_120216.pdf For general information regarding the implementation of the NPDES permit program, see the website of the Environmental Protection Agency. Accessed November 16, 2017. https://www.epa.gov/npdes/about-npdes

[34] Municipalities and counties (in unincorporated areas) are given the right to control land use by states; the *Standard Zoning Act* "allowed the 'police power' of the cities to be used not just retroactively (by removing nuisances that were threatening citizens' health and safety) but proactively (to prevent bad things before they occurred)" (Elliott 2008, 17). It is the municipal zoning code that indirectly determines the amount of stormwater runoff when it defines floor area ratios, and the impervious cover limitations. Recognizing the risks inherent in local land use regulations, in a previously-discussed paper, Carl J. Circo called for green building regulations to be adopted at state or federal level (2008, 769). Yet, each of them addresses a different aspect of environmental impact of construction. Restraining development is counter-productive from the point of view of (green) economy, which thrives on more, not less construction. Paradoxically, in the City of Los Angeles, the *Stormwater LID Ordinance* meant to improve stormwater runoff management was applied in parallel to the green building floor area bonus, an incentive which allowed homeowners to build more (and hence generated more impervious areas and runoff) if they complied with the basic LEED green building standards. The incentive was phased out in April 2017. See note 44 and related text in Chapter 5.3. (Except for the City of Los Angeles where almost half of the population is concentrated, the County of Los Angeles has 87 other incorporated cities (e.g. Beverly Hills, Santa Monica, West Hollywood). The unincorporated areas are home to only 10% of its population but constitute two-thirds of its territory.)

[35] The 2011 ordinance (#181899) is part of the Planning and Land Development Program, and Standard Urban Stormwater Mitigation Plan (SUSMP), both requirements of the NPDES permit (City of Los Angeles 2016, 3-4).

Fig.6. 6 The Hyperion sewage treatment plant in Los Angeles (left), a composting, waterless toilet (right).

driven by different agendas promoted by different authorities. The former, federal measure is clearly environmentally-driven, the nature of the latter, imposed by the state in drought emergency, is conservationist and managerial. While in some way they complement each other, and express a *healthy* system of checks and balances, it is here that the lack of coordination between the geography of the rule-making matrix and that of watershed is most evident. Eighty-four municipalities (including Los Angeles) share one watershed and one runoff discharge permit, yet each municipality is free to choose and implement its own mitigation measures. The watershed, the permit issuing body, and the authority that implements the measures all have different geographic boundaries. Heavily managed, the watershed remains nobody's *oikos*.

Sanitary Sewage. Within less than a mile's distance from the outlet of the Ballona Creek flood-protection channel where stormwater from the Los Angeles basin is discharged, the Hyperion treatment plant (Fig.6. 6) discharges wastewater from a slightly different area; less than the watershed, more than the Los Angeles municipality, it reflects cross-municipal contracts rather than geography. In the *Clean Water Act*, sanitary sewage generated by individual households is considered "point source pollution" since it is

collected and disposed of by a treatment plant, and it is the plant, rather than individual residents, that is responsible for respecting the federal provisions contained in another NPDES permit issued by the same Regional Water Quality Control Board.[36] In single-family households, approx. half of fresh water supply is used indoors,[37] and most of it is eventually piped to a treatment plant. The largest single indoor use of water (more than 21%) is to flush toilets, a significant portion of the second largest use (18% via faucets) is used in kitchens, in part to dispose of food waste.[38] Neither of them can be recycled as greywater. Although water-borne disposal of waste is an act of extravagant luxury, unlike distributed stormwater management or energy production, decentralized sewage treatment has not entered the mainstream sustainable discourse. This might, in part, be because the EPA has not yet launched a label equivalent to WaterSense or Energy Star for on-site composting of food scraps or human waste. The two appliances are waiting to be marketed as a *green* technology. Yet, centralized treatment of human waste is not only a waste of water. Even an award-wining plant such as Hyperion,[39] relies on an extensive network of pipes susceptible to leakage, and overflow during wet weather. Even if all greywater and stormwater were to be captured and reused locally, these pipes would still have to be maintained to dispose of the bodily waste and food left-overs. While water-borne disposal of kitchen waste is not a problem for the treatment plant, the Los Angeles Department of Public Works warns not to "put food scraps and other solids in the drain," and "dispose of these in the trash or compost," to minimize clogging and breakage of pipes which this authority maintains. Nevertheless, since in-sink garbage disposal seems not to significantly increase water consumption,[40] and reduces the amount of waste transported to landfills, it is a market standard normed (and therefore normalized) in the state-approved building code.[41]

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[36] The permit (ORDER R4-2017-0045) can be downloaded from the website of the EPA's Region 9 Water Division. Retrieved November 19, 2017. https://www3.epa.gov/region9/water/npdes/pdf/ca/hyperion/npdes-ca0109991-r4-2017-0045-hyperion-2017-02-02.pdf

[37] According to the *Urban Water Management Plan* (LADWP 2015a, 2-5), 46% of water consumed by single-family households is used indoors. According to the 2011 *California Single Family Water Use Efficiency Study* (sponsored by the California Board of Water Resources), it was 47% in the entire state (Aquacraft, Inc. Water Engineering and Management 2011, 25).

[38] The data comes from the above-mentioned *California Single Family Water Use Efficiency Study* (274).

[39] First open in 1894, Hyperion was modernized and expanded in the 1990s. In 2001, the American Public Works Association named it one of the ten most outstanding public works projects of the 20th Century. A year earlier it won the 2000 Superior Achievement in Environmental Engineering Excellence. The plant uses the methane generated by the digesters as an energy source, sludge is turned into biosolids, and a small percentage (6%) of reclaimed water is further treated and reused. See the Los Angeles Sanitation website. Accessed November 19, 2017. https://www.lacitysan.org/san/faces/home/portal/s-lsh-wwd/s-lsh-wwd-cw/s-lsh-wwd-cw-p/s-lsh-wwd-cw-p-hwrp/s-lsh-au-h?_adf.ctrl-state=1c68zh491f_4&_afrLoop=5541779804890912#!

[40] See again the *study* mentioned above, in note 38 (260).

[41] In-sink disposal is regulated in the Plumbing Code. Section 419.1 specifies that disposers must comply with standard UL 430, and ASSE 1008 (CBSC 2016c, 62).

The issue of waterless toilets is more problematic (Fig.6. 6). Clearly, composting human waste on-site requires occasional work, can constitute a health hazard if not handled properly, and the *end-product* needs to be used or disposed of.[42] Yet, the problem might be mainly cultural, which is reflected in the regulatory language. According to the *Residential Code*, one of the provisions that *makes* a dwelling is the presence of a toilet, or rather, a *water closet*:

> R306.1 Toilet facilities. Every dwelling unit shall be provided with a water closet, lavatory, and a bathtub or shower (CBSC 2016a, 77).

Individual parts of the building code are based on model codes developed by different national non-governmental organizations.[43] The model codes also refer to a multitude of technical standards, and consequently national but non-governmental standard-setting organizations exert a tremendous influence on the environment by defining the rules hidden in the code.[44] If the mention in the model code or a reference to an existing standard is lacking, the issue will likely be poorly regulated also by the state. In fact, the state-written *CALGreen Code* mentions composting toilets in one of the voluntary standards pertaining to indoor water use, yet it fails to define the technicalities:

> A4.303.4 Nonwater supplied urinals and waterless toilets. Nonwater supplied urinals or composting toilets are installed. (CBSC 2016e, 73).

No part of the code defines what a composting toilet is, or how it should be installed. In the *Plumbing Code*, the terms 'toilet' and 'water closet' are used interchangeably:

> Water Closet. A fixture with a water-containing receptor that receives liquid and solid body waste and on actuation conveys the waste through an exposed integral trap into a drainage system. Also referred to as a toilet (CBSC 2016c, 464).

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[42] Since the *Ocean Dumping Act* prohibits dumping of the wastewater sludge into the ocean, at the Hyperion plant, sludge is transformed into biosolids, and then transported by road to be used as fertilizer on a city-owned farm in Kern County. Compost from single-family households can be used directly by the owner as fertilizer, which requires either a garden or a service contractor who will occasionally transport it away to be used elsewhere.

[43] See note 51, Chapter 4.1 for all model codes used in California.

[44] USGBC's LEED rating system is referenced in the Los Angeles Municipal Code as a "standard of sustainability," regardless the fact that California has its own *Green Building Standards Code*. See *Los Angeles Municipal Code*, Chapter I, Article 6.1 Review of Development Projects, Section 6.10 Green Building Program. Also, see note 44, and related text in Chapter 5.3, where the green building floor area bonus which until recently applied to single-family construction is mentioned.

Not only does the *Plumbing Code* not mention composting toilets, but waterless toilets are prohibited:

> 405.3 Miscellaneous Fixtures. (…) No dry or chemical closet (toilet) shall be installed in a building used for human habitation, unless first approved by the Health Officer (56).

An option listed as a standard of sustainability in the *CALGreen Code* requires a special approval from a health officer. In the absence of clear regulations, lack of technical knowledge, or willingness to take risk, officers refer to precedents, or to existing standards. The *Residential Code* lists standards written by fifty different organizations, each concerned with a narrowly-defined aspect of safety and performance pertaining to an equally narrowly-defined aspect of construction.[45] Many standards regulate the type and installation of water closets,[46] and while the *Residential Code* does not mention composting toilets, it does list a NSF standard related to it. However, while the standard *41—2011 Nonliquid Saturated Treatment Systems (Composting Toilets)* is used in the 2015 *International Residential Code*, in California, "Part VII. Plumbing" (where the standard is mentioned[47]) is not adopted. This is because the *California Residential Code* refers to the IAPMO *Uniform Plumbing Code* for all plumbing-related regulations (CBSC 2016c). In any case, what is clear is that the ICC model code only allows NSF-compliant manufactured toilets,[48] indirectly prohibiting those built on-site. Meanwhile, thanks to an initiative launched by the Oregon-based

[45] The previously-used example of flammability requirements for plastic foam insulations highlights two issues. Firstly, most individual standards, such as *ASTM E84*, rate a specific aspect of performance, without reference to environmental concerns. Secondly, overlaps and redundancies between standards - such as imposition of specific material burning characteristics and a physical thermal barrier - often induces unnecessary additional environmental impact without improving human safety. The previously-mentioned paper (see note 15 above) points out that standards can be also used inappropriately which makes their indirect environmental impact even more problematic: "The Steiner Tunnel (ASTM E 84) test is unreliable in characterizing the fire hazard properties of foam plastics." It continues: "Foam plastic insulation that is not protected by a thermal barrier has an unacceptable level of fire hazard, irrespective of the use of flame retardants" (Babrauskas et al 2012, 742). The same paper claims that the thermal barrier provides sufficient protection, and the environmentally-detrimental flame retardants are redundant" (Babrauskas et al 2012, 740).

[46] Numerous standards related to water closets are used in the code, they were written by one of the following standard-setting organizations: the American Society of Mechanical Engineers (ASTME), American Society of Sanitary Engineering (ASSE), American Water Works Association (AWWA), CSA Group, IAPMO, International Organization for Standardization (ISO), and NSF International. See the *Residential Code*, "Chapter 44. Referenced Standards" (CBSC 2016a, 503-53).

[47] In the ICC model residential code, Section P2725. Nonliquid Saturated Treatment Systems, in "Chapter 27. Plumbing Fixtures" contains the following provision: "P2725.1 General. Materials, design, construction, and performance of Nonliquid Saturated Treatment Systems shall comply with NSF 41." See the ICC website. Accessed October 20, 2017. https://codes.iccsafe.org/public/document/code/553/9868145

[48] As of October 2017, only two manufacturers meet the standard. See the NSF website for the listed companies. Accessed October 23, 2017. http://info.nsf.org/Certified/wastewater/Listings.asp?TradeName=&Standard=041

Recode,[49] the IAPMO has been developing a new standard called *Water Efficiency and Sanitation Standard (WE-Stand)* which among other issues will include the requirements for site-built (and hence more affordable) composting toilets.[50] It is unclear how, and if, it will be used in the *Pluming Code*, and whether it will be adopted by the state of California. When a non-standard practice conquers the popular imagination, standard-makers are eventually forced to standardize it.[51] Yet, it is still easier to add than amend or delete a standard. In fact, some standards persist, and oppose a particular inertia. The issue of water-borne waste disposal will remain unresolved if composting toilets are only allowed once the first water closet has been installed, and connected to a public sewer system as specified in the following section:

> R306.3 Sewage disposal. Plumbing fixtures shall be connected to a sanitary sewer or to an approved private sewage disposal system (CBSC 2016a, 77).

One may hope that the state of California will once again lead the nation by amending the above section,[52] so that composting toilets are not just a West Coast extravagance, but an option that allows any

[49] Prior to the collaboration with IAPMO on the ANSI WE-Stand Standard, Recode managed to convince the Oregon authorities to legalize the waterless toilets: "Recode successfully legalized site-built (i.e. built custom to the location or nonproprietary) composting toilets & non-NSF certified composting toilets through the Reach Code in 2011." See the Recode website. Accessed October 23, 2017. http://www.recodenow.org/portfolio/legalized-site-built-composting-toilets/ and http://www.recodenow.org/portfolio/developing-national-model-code-site-built-and-urine-diverting-composting-toilets/

[50] WE-Stand is supposed to be launched in November 2017 as an American National Standard (ANSI). Except for the requirements for composting toilets, it will also include a new method for water demand calculation which is supposed to help reduce oversizing of plumbing. IAPMO's promise is to address treatment of black water in the next edition (2020). See the IAPMO website. Accessed October 23, 2017. http://www.iapmo.org/WEStand/Pages/default.aspx

[51] It is clear that the problem is not that something is not regulated (and hence it is not forbidden) but precisely that it is not regulated and hence cannot be permitted. This happened with many traditional methods and technics, for example straw bale construction, which is now regulated in the Residential Code, Appendix R Light Straw-Clay Construction, and Appendix S Strawbale Construction (CBSC 2016a, 631-644).

[52] Although most codes are based on a national model (water is regulated in the *Residential Code* based on the ICC model, the *Plumbing Code* based on the IAPMO model, and in California also in the *CALGreen Code* written in California in absence of a national model) the state amendments – especially in a progressive state such as California – can significantly alter the details. States adopt, amend and repeal regulations following directives from a number of state agencies depending on the building occupancy. The main agencies that develop and propose building standards related to residential construction are the Office of the State Fire Marshal for fire and panic safety, and the Department of Housing and Community Development (HCD1) for structural, construction, mechanical, plumbing, and electrical standards (contained in the Residential, Mechanical, and Plumbing Codes). The latter agency also proposes green building standards for dwellings contained in the *CALGreen Code*. The California Energy Commission develops, proposes, and adopts standards contained in the *Energy Code* which are also developed by the state. See *Guide to Title 24* for a full list of agencies (CBSC 2016, 18). See note 78, in Chapter 4.2. for an example of a state amendment which increases the minimum size of an efficiency dwelling unit. Municipal amendments are also allowed due to climatic, geological and topographical conditions.

household, not just a rural dwelling,[53] not to rely on the sewage pipes. At this point, it will be possible to say that "the nice thing about standards is that there are many to choose from."[54]

Water Consumption. Water-borne sewage disposal is so enmeshed in the modern society that it might be impossible to ever eliminate it. It is no longer perceived as an extravagance, and its environmental risks are not tangible enough to exert enough influence on state and municipal legislators. Hence, the specter of water scarcity makes most regulations and economic instruments concentrate on minimizing use of water. Sewer service charges are based on the amount of used water.[55] State building codes, municipal ordinances,[56] and federal incentives impose high-efficiency, low-flow water appliances.[57] Yet, indoor water use is just the tip of the iceberg. Firstly, water evaporates on its way to Los Angeles, and Colorado River never reaches Mexico due to over extraction. Secondly, American households waste one-fifth of food,[58] which is full of *hidden water*: approx. 35 gallons (132L) in a cup of coffee, and 460 gallons (1741L) in a quarter-pound of bovine meat.[59] One-fifth of this *embodied* water goes wasted, which corresponds to 25% of all water used in agriculture. While the water footprint of domestic activities (not to mention construction materials, or household appliances) is largely ignored, the focus on conservation makes residents underestimate the importance of such *distant* environmental issues as ocean pollution, or

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[53] Section 303.0 Disposal of Liquid Waste contained in the 2016 edition of the *Plumbing Code* includes the following amendment: "**Exception: [HCD 1]** Limited-density owner-built rural dwellings. A water closet shall not be required when an alternate system is provided and has been approved by the local health official" (CBSC 2016c, 46).

[54] A statement made by Christopher Kelty and quoted in "A World of Standards but not a Standard World" (Timmermans and Epstein 2010, 79).

[55] As explained by LA Sanitation, "the residential Sewer Service Charge is calculated based of the amount of water used "because most of that water eventually goes down the drain and into the sewer system." See the 2017 pamphlet entitled "Information about Your Sewer Service Charge." Retrieved October 22, 2017. https://www.lacitysan.org/cs/groups/sg_rates/documents/document/y250/mdez/~edisp/cnt013106.pdf

[56] Los Angeles has used ordinances to limit use of water since the 1980s. See *Urban Water Management Plan* for the minimum requirements contained in the 2009 *Water Efficiency Requirements Ordinance* (LADWP 2015a, 3-9 – 3-12).

[57] Federal programs such as WaterSense are directly referenced in the state building codes, they couple environmental regulation with incentivization of green technologies, in this case, low-flow water closets and faucets. Compliance with this type of standards is often also the condition for the receipt of federal incentives for acquisition of new appliances. For example, in the *American Recovery and Reinvestment Act* of 2009 (ARRA) the condition for receipt of federal funds was the adoption of energy conservation standards by the state (i.e. International Energy Conservation Code, and ASHRAE 90.1). See Chapter 2.3 for more detail.

[58] According to a 2014 report by the U.S. Department of Agriculture: "In the United States, 31 percent (…) of the available food supply at the retail and consumer levels in 2010 went uneaten. Retail-level losses represented 10 percent (43 billion pounds) and consumer-level losses 21 percent (90 billion pounds) of the available food supply." Retrieved November 23, 2017. https://www.ers.usda.gov/webdocs/publications/43833/43680_eib121.pdf

[59] The statistics come from the website of the Water Footprint Network. Accessed November 23, 2017. http://waterfootprint.org/en/water-footprint/product-water-footprint/water-footprint-crop-and-animal-products/ and http://waterfootprint.org/en/resources/interactive-tools/product-gallery/

disrupted nutrient cycles.[60] Still, although passive water conservation measures might be a perfect example of "seeking the optimal arrangement of deck chairs on the Titanic" (Daly 1991, 89), other measures are either unavailable to the rule-makers, or simply economically not viable. No federal law can undo a century of local appropriation deals *written into* the landscape with permanent, concrete, channels. No state act can force municipalities to reuse stormwater that falls on the land they are entitled to use and control. No municipal act can possibly stop residents from buying too much food; such a tax revenue loss would be against market logics. Yet, as discussed above, the rule-making matrix does contain a measure of last resort: the *Clean Water Act*, and the *Ocean Dumping Act* can deny the states and cities the possibility of discharging waste into U.S. and international waters.[61] As outlandish as it may sound, the vicious cycle could be stopped, maybe even made more virtuous, at the very end – by denying the right to use rivers and the ocean as a sink for food left-overs and bodily waste.

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Regulations that affect households originate from a complex legislative matrix. Many different rule-makers and standard-setters *pre-design* households and pre-determine their impact. How environmental concerns are dealt with is, to a large extent, a reflection of this complicated network of agents invested with different powers and responsibilities and representing a fragile equilibrium of private and public interests, shaped by national and local perspectives. The concurrent agency of various legislators (some as old as the building code, others as young as the sustainable agenda) is in part the reason for which the original objectives (in this case: sanitation), the current environmental concerns (water conservation), and other crucial yet mostly overlooked environmental problems (disrupted nutrient cycles) continue to coexist, if not conflict, and compete in the codes.

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[60] According to the *Urban Water Management Plan*, the city's objective to reduce water use by 25% by 2035 cannot be achieved by only adopting passive conservation measures (such as efficient faucets). These measures might help slow down the rate of water use increase. In fact, in 2014 Los Angeles water demand was at the level from the 1970s although the city has 1 million more residents (LADWP 2015a, ES-9 - ES-11). While everyone agrees that water should be managed more wisely, the reasons go beyond scarcity and the end-user waste. Not only is importing water via open channels wasteful as it is subject to gradual evaporation and leakage, but it is also harmful for the ecosystems disrupted in the process of extraction and transportation of water. Water-borne disposal of wastewater should be limited to minimize imports of water but also to limit disruption of nutrient cycles. Paradoxically, we mine the rock deplete natural reserves to make phosphate fertilizers and we use the energy-intensive Haber process to artificially fix nitrogen while we release excessive amounts of both nitrogen and phosphorus to the environment by not recycling organic waste. Stormwater runoff should be captured to recharge aquifers, but also to limit overheating and pollution of waterbodies with hundreds of contaminants. (126 Priority Pollutants are regulated by the EPA under the *Clean Water Act*. See the EPA website. Accessed October 23, 2017. https://www.epa.gov/eg/toxic-and-priority-pollutants-under-clean-water-act)

[61] While global environmental movement has been of particular importance (see chapters before) in the fight against climate change, the adoption of the *Ocean Dumping Act* (which forced Hyperion to modernize, treat water, and transform sludge into biosolids) was also triggered by an international agreement; the 1972 *London Convention*. (The stricter 1996 *London Protocol* which amends the 1972 convention and prohibits all dumping by removing most of the previous exceptions remains unratified in the U.S.) The full title of the *London Convention* is the *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter*. See the website of the International Maritime Organization for details. Accessed November 23, 2017. http://www.imo.org/en/OurWork/Environment/LCLP/Pages/default.aspx

The way water rights have been granted and managed is a striking legacy of the finders-keepers spirit that contributed to the West Coast's success, and to the demise of other ecosystems inhabited by less entrepreneurial communities. Control of water supplies remains a state matter outside of federal jurisdiction, yet, while the federal code-makers have little to say about where water is extracted from, they do have control over how it is disposed of. While they cannot easily remove the word 'water' from the expression 'water closet', they have the power to deny the right to use the common waters as sink for waste. And while international agreements often trigger local environmental action in the face of federal resistance to ratify them, the *Ocean Dumping Act* is one example of a global initiative supported and implemented by the federal government to protect not just the U.S. waters but also the oceans. While Hoover's vision of an associative state is still present in the common reference to standards established by non-governmental organizations, and to manufacturer's instructions, the division of power between the federal and state governments explains, among other things, the multilayered character of the building code which is the subject of the next section.

6.3. The Stack: What is Regulated and Why in Multiple Codes? Focus: Air.

The *California Building Standards Code* is composed of twelve thematic parts, nine based on model codes authored by three different non-governmental entities, and the remaining three developed by the state of California. All parts are periodically revised by their respective authors, and those based on the model codes are also amended by the state to comply with other state laws and regulations before their final adoption. In this section, the internal structure of the building code is examined in relation to the issue of air quality and ventilation. While the federal government has jurisdiction over the outdoor air, the management of the indoor *atmosphere* has been historically object of the building code-makers' attention. What is exposed in this section is that the *Residential Code* which seems to be a complete "cookbook" for residential construction, serves as an annotated guide to other, more technical parts of the code. The mechanics of air supply are mainly regulated in the *Mechanical Code*, while aspects related to its impact on energy-consumption are addressed in the *Energy Code* developed by the state in the aftermath of the oil crisis. The issue of indoor air quality, in itself a recently-emerged concern, is addressed yet in another part, the *CALGreen Code*, custom-written for California, and introduced in 2008.

While this section explores the *atmosphere*-related regulations in order to examine the inner structure of the code, it also exposes how its complicated and fragmented nature reflects a gradual accumulation of air-related agendas. What becomes evident is that the objectives pursued by the early code-makers (i.e. welfare and health - ventilation), the concerns addressed in the 1970s (energy conservation), and those only recently understood and regulated by code-makers (indoor air quality) not only compete for attention, but in this case also expose an unresolvable conflict.

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Ambient Air. Air is another matrix, just more intangible, and hence less controllable than water. While we don't respect watershed boundaries; wind-dependent air does not respect ours, and carries pollutants

across borders.[62] Similarly to indoor air, ambient (or outdoor) air quality was initially responsibility of individual states, and although due to severe smog, California passed the first-in-the-nation air pollution act in 1947, the importance of air quality for public health was not recognized until the passage of the first federal *Air Pollution Act* (CAA) in 1955, and the subsequent amendments passed in the following decades.[63] In response to the CAA standards for automobiles, and the more stringent state Zero Emission Vehicle program, the building code, specifically its *CALGreen* part, includes provisions that indirectly address ambient air quality, by imposing mandatory and voluntary measures to "facilitate future installation and use of EV chargers" in new residential buildings, and promote use of bicycles.[64] Enacted by the state, and hence unable to control local land-use, the *CALGreen Code* encourages municipalities and counties to consider reduction of greenhouse gas emissions by promoting transport-oriented development and other sustainable land-use practices (CBSC 2016e, 65). Due to the current division of powers, the state-enacted building code can only regulate construction practices, and hence cannot, as an example, stop the City of Los Angeles from approving of residential developments within 1,000-feet distance from a freeway. (A fact so commonly recognized as an extreme health hazard that the same municipality releases the building permit together with an advisory notice.[65]) Yet, the structure of the *CALGreen Code* suggests that this might change in the future; while land-use practices are included among

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[62] While the federal nature of the *Clean Air Act* recognized that air like the U.S. waters needed to be protected from local speculation, the wind-dependent nature of air was not addressed until 1990. As explained in *Clean Air Act: A Summary of the Act and Its Major Requirements*, the 1990 amendment addressed the issue of air-borne transport of pollutants by introducing provisions meant to protect downwind states (McCarthy and Copeland 2013, 8)

[63] The provisions contained in the *Clean Air Act* are enforced by states (in California by the Air Resources Board), and local governments but the enforcement is subject to federal control (McCarthy and Copeland 2013, 16). The following are some of the most important provisions gradually included in the amendments that followed the enactment of the *Clean Air Act* in 1955: the National Ambient Air Quality Standards for six main air pollutants (3); provisions targeting Mobile Sources (9) which tightened the nexus between ambient pollution and clean energy sources, and provided federal funds for electric car incentives (as mentioned in Chapter 5.3); Hazardous Air Pollutants, which addressed the importance of small but numerous "area sources" such as gas stations, or dry cleaners (10); pollution generated by Solid Waste Incinerators (12); Prevention of Significant Deterioration in areas where air quality is above minimum standards (e.g. national parks) (13); Acid Deposition Control (14) which addressed acid rain and introduced the cap-and-trade method (see Chapter 4.1); and Stratospheric Ozone Protection which implements the Montreal Protocol (16).

[64] The mandatory provisions are included in section **4.106.4 Electric vehicle (EV) charging for new construction** (CBSC 2016e, 20-21), the additional voluntary measures in section A4.106.8 (68). The voluntary provision A4.106.9 regulates bicycle parking spaces (69).

[65] First released in 2012, the notice explicitly stated that it was not a moratorium on development, but an instrument meant to assist developers in decision-making. It did, however, "advise" the applicants to: 1) install high-efficiency air filters, and only after that to: 2) consider building orientation, screening with vegetation, and reduction of operable windows. For the full text of the "Freeway adjacent advisory notice for sensitive uses," see the link. Retrieved November 29, 2017. https://assets.documentcloud.org/documents/3478483/Los-Angeles-advisory-for-projects-within-1-000.pdf For a general overview of the problem, see the Los Angeles Times article published on March 2, 2017, and entitled "L.A. keeps building near freeways, even though living there makes people sick." Accessed November 29, 2017. http://www.latimes.com/projects/la-me-freeway-pollution/

voluntary measures in form of recommendations, and the section entitled "Outdoor Air Quality" is a "reserved" *placeholder*,[66] we know from the previous editions that what is now voluntary is meant to become mandatory in the future, and what is "reserved" will one day contain new provisions.

Indoor Air. While of relatively little influence on ambient air, the *CALGreen Code* and other parts of the *California Building Standards Code* are extensively used to regulate air quality indoors, which remains outside the jurisdiction of the federal government.[67] After all, ventilation has been one of the initial objects of code-makers' attention, and the current *Residential Code* (section 1.1.2 Purpose) continues to list it as one of the fundamental aspects of public health, and welfare.[68] Yet, while ventilation has been regulated for more than a century, indoor air quality emerged as a *side effect* of the post-oil-crisis wave of weatherization, which made buildings warmer but also overly air-tight.[69] Ironically, while Ulrich Beck was warning that "privileged ways of living may still provide a refuge from air and noise pollution, but the waters will soon be polluted everywhere, and we will be equal before more than just the bomb" (1995, 60), researchers were proving that there was nowhere to escape from the *volatile* effects of industrialization. Home too was poisoned. Indoor contaminants, or better, volatile organic compounds, were everywhere; not just in cleaning products handled by domestics, but in carpets, sofas, and wallpapers - the very embodiments of home comfort. Yet, while the buildings were too air-tight to remove these indoor-generated pollutants, they were not air-tight enough to block cold, and more importantly the outdoor-generated contaminants which transform ambient air into smog. Wickedly, they were also not tight enough to keep the natural, yet carcinogenic radon outdoor. Although in 1988, the federal government passed the *Radon Abatement Act* to provide funding for research, and the issue is now addressed in the building code, its adoption depends on the level of risk assessed locally, and this

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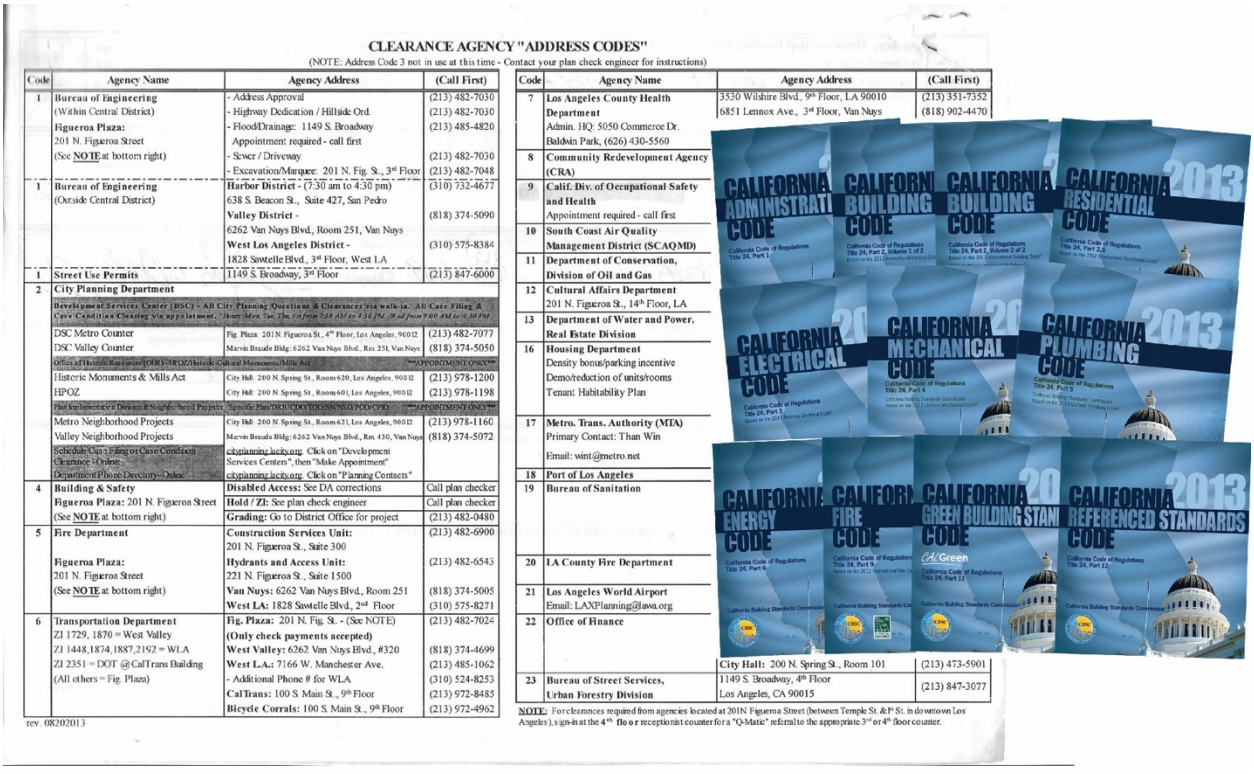
[66] While Sections 4.508 and A4.508 Outdoor Air Quality, both part of the residential measures (CBSC 2016e, 32 and 80) remain a "reserved" placeholder, the nonresidential mandatory measures already address the issue. Sections 5.508 and A5.508 address two issues: 1) Ozone depletion and greenhouse gas reductions as impacted by HVAC, and other types of equipment that uses chlorofluorocarbons, and halons (5.508.1); and 2) Supermarket refrigerant leak reduction (5.508.2) (51).

[67] The Environmental Protection Agency does not regulate Indoor Air Quality but offers advice on how to improve it. For details, see the EPA website. Accessed November 27, 2017. https://www.epa.gov/regulatory-information-topic/regulatory-information-topic-air#indoorair

[68] Although poorly understood, the importance of air quality, and ventilation was addressed in the very first building codes. See note 11, and associated text, in Chapter 2.1. See the first section in this chapter for the text of section 1.1.2. Purpose (CBSC 2016a,3).

[69] See note 54, and associate text in Chapter 3.2 for a brief account of the initial research into indoor air quality. See the Berkeley Lab's website for current research in the area. Accessed November 27, 2017. http://www.cbe.berkeley.edu/research/research_ieq.htm



CLEARANCE AGENCY "ADDRESS CODES"

(NOTE: Address Code 3 not in use at this time - Contact your plan check engineer for instructions)

Code	Agency Name	Agency Address	(Call First)
1	**Bureau of Engineering** (Within Central District)	- Address Approval	(213) 482-7030
		- Highway Dedication / Hillside Ord.	(213) 482-7030
	Figueroa Plaza: 201 N. Figueroa Street (See NOTE at bottom right)	- Flood/Drainage: 1149 S. Broadway	(213) 485-4820
		Appointment required - call first	
		- Sewer / Driveway	(213) 482-7030
		- Excavation/Marquee: 201 N. Fig. St., 3rd Floor	(213) 482-7048
1	**Bureau of Engineering** (Outside Central District)	**Harbor District** - (7:30 am to 4:30 pm) 638 S. Beacon St., Suite 427, San Pedro	(310) 732-4677
		Valley District - 6262 Van Nuys Blvd., Room 251, Van Nuys	(818) 374-5090
		West Los Angeles District - 1828 Sawtelle Blvd., 3rd Floor, West LA	(310) 575-8384
1	**Street Use Permits**	1149 S. Broadway, 3rd Floor	(213) 847-6000
2	**City Planning Department**		
	Development Services Center (DSC) - All City Planning Questions & Clearances via walk-in. All Case Filing & Case Condition Clearing via appointment. *Hours: Mon, Tue, Thu 7:30 from 7:30 AM to 4:30 PM. Wed from 9:00 AM to 4:30 PM*		
	DSC Metro Counter	Fig. Plaza: 201 N. Figueroa St., 4th Floor, Los Angeles, 90012	(213) 482-7077
	DSC Valley Counter	Marvin Braude Bldg: 6262 Van Nuys Blvd., Rm. 251, Van Nuys	(818) 374-5050
	Office of Historic Resources (OHR) - HPOZ/Historic-Cultural Monuments/Mills Act		***APPOINTMENT ONLY***
	Historic Monuments & Mills Act	City Hall: 200 N. Spring St., Room 620, Los Angeles, 90012	(213) 978-1200
	HPOZ	City Hall: 200 N. Spring St., Room 601, Los Angeles, 90012	(213) 978-1198
	Plan Implementation Division & Neighborhood Projects	Specific Plan/DRB/CDO/TOD/SN/NSO/POD/CPIO	***APPOINTMENT ONLY***
	Metro Neighborhood Projects	City Hall: 200 N. Spring St., Room 621, Los Angeles, 90012	(213) 978-1160
	Valley Neighborhood Projects	Marvin Braude Bldg: 6262 Van Nuys Blvd., Rm. 430, Van Nuys	(818) 374-5072
	Schedule Case Filing or Case Condition Clearance - Online:	cityplanning.lacity.org. Click on "Development Services Centers", then "Make Appointment"	
	Department Phone Directory - Online:	cityplanning.lacity.org. Click on "Planning Contacts"	
4	**Building & Safety**	**Disabled Access:** See DA corrections	Call plan checker
	Figueroa Plaza: 201 N. Figueroa Street (See NOTE at bottom right)	**Hold / ZI:** See plan check engineer	Call plan checker
		Grading: Go to District Office for project	(213) 482-0480
5	**Fire Department**	**Construction Services Unit:** 201 N. Figueroa St., Suite 300	(213) 482-6900
	Figueroa Plaza: 201 N. Figueroa Street (See NOTE at bottom right)	**Hydrants and Access Unit:** 221 N. Figueroa St., Suite 1500	(213) 482-6543
		Van Nuys: 6262 Van Nuys Blvd., Room 251	(818) 374-5005
		West LA: 1828 Sawtelle Blvd., 2nd Floor	(310) 575-8271
6	**Transportation Department** ZI 1729, 1870 = West Valley ZI 1448,1874,1887,2192 = WLA ZI 2351 = DOT @ CalTrans Building (All others = Fig. Plaza)	**Fig. Plaza:** 201 N. Fig. St. - (See NOTE) **(Only check payments accepted)**	(213) 482-7024
		West Valley: 6262 Van Nuys Blvd., #320	(818) 374-4699
		West L.A.: 7166 W. Manchester Ave.	(213) 485-1062
		- Additional Phone # for WLA	(310) 524-8253
		CalTrans: 100 S. Main St., 9th Floor	(213) 972-8485
		Bicycle Corrals: 100 S. Main St., 9th Floor	(213) 972-4962

rev. 08202013

Code	Agency Name	Agency Address	(Call First)
7	**Los Angeles County Health Department** Admin. HQ: 5050 Commerce Dr. Baldwin Park, (626) 430-5560	3530 Wilshire Blvd., 9th Floor, LA 90010	(213) 351-7352
		6851 Lennox Ave., 3rd Floor, Van Nuys	(818) 902-4470
8	**Community Redevelopment Agency (CRA)**		
9	**Calif. Div. of Occupational Safety and Health** Appointment required - call first		
10	**South Coast Air Quality Management District (SCAQMD)**		
11	**Department of Conservation, Division of Oil and Gas**		
12	**Cultural Affairs Department** 201 N. Figueroa St., 14th Floor, LA		
13	**Department of Water and Power, Real Estate Division**		
16	**Housing Department** Density bonus/parking incentive Demo/reduction of units/rooms Tenant Habitability Plan		
17	**Metro. Trans. Authority (MTA)** Primary Contact: Than Win Email: wint@metro.net		
18	**Port of Los Angeles**		
19	**Bureau of Sanitation**		
20	**LA County Fire Department**		
21	**Los Angeles World Airport** Email: LAXPlanning@lawa.org		
22	**Office of Finance**	**City Hall:** 200 N. Spring St., Room 101	(213) 473-5901
23	**Bureau of Street Services, Urban Forestry Division**	1149 S. Broadway, 4th Floor Los Angeles, CA 90015	(213) 847-3077

NOTE: For clearances required from agencies located at 201N Figueroa Street (between Temple St. & 1st St. in downtown Los Angeles), sign-in at the 4th floor receptionist counter for a "Q-Matic" referral to the appropriate 3rd or 4th floor counter.

Fig.6. 7 Agencies having jurisdiction (left), all Parts of the California, Building Standards Code (right).

colorless and odorless gas remains elusive.[70]

The Structure of the Stack. The building code regulates indoor air, but for historical and practical reasons, it regulates it in different parts, in different ways, and for different reasons. When new environmental imperatives emerge, but the Constitution of the United States is silent about them (as it is about all aspects of environmental protection), the individual states and their code-makers are free to impose new rules based on custom-written, or third-party standards.[71] When the environmental discourse started to influence regulations in the 1970s, the building code was already a crystalized (and criticized[72]) system of complicated (and often forgotten) origins. For example, when the *Energy Conservation Standards* were

[70] The *Residential Code* contains "Appendix F – Passive Radon Gas Controls" (CBSC 2016a, 571) which is adopted by local governments depending on the level of risk. In California, the appendix is not adopted in case of residential construction, and the *CALGreen Code* makes the provisions mandatory only for nonresidential buildings Section 5.505.1 (CBSC 2016e, 136)

[71] This is until a federal law is enacted, and depending on its nature, states are either forces to, or encouraged with financial incentives, to adjust their regulations accordingly.

[72] For example, in *The Code of the City*, Eran Ben-Joseph mentions a 1976 study by Stephen Seidel entitled *Housing Costs and Government Regulations: Confronting the Regulatory Maze* (2005, 104).

first introduced by the state of California in the mid-1970s,[73] they were added to the existing set of codes as a separate part like an emergency *Band-Aid*.[74] Because states still have the right to decide whether to impose energy conservation measures,[75] even when new model codes were born in the green 1990s, the International Code Council was forced to keep the energy code separate from the residential model code to allow for selective adoption. Similarly, when California adopted the *Green Building Standards Code* in 2008, it was introduced as another overlay, Part 11 of Title 24.[76] As a result of this gradual expansion of building regulations, California's building code consists of eleven *books* (Fig.6. 7). It is composed of three state-developed parts, four parts based on the International Code Council (ICC) model codes, two parts based on models developed by the International Association of Plumbing and Mechanical Officials (IAPMO), and one on a model published by the National Fire Protection Association (NFPA*)*. Although the *Residential Code* (Part 2.5 of Title 24) is meant to be a "complete cookbook" for common residential construction methods,[77] its California edition adopts its chapters and sections selectively and refers to other codes for more technical provisions. In fact, one must consult Parts 3, 4, and 5 for prescriptions pertaining to electrical, mechanical and plumbing systems. Part 6 for energy-efficiency standards, Part 8 for specific provisions applied to historical buildings, Part 9 for minimum fire safety requirements, Part 10 for regulations that govern existing buildings, and last but not least Part 11 for green building standards. As a consequence, ventilation and air quality are regulated in four different volumes: the *Residential Code* (Part 2.5), the *Mechanical Code* (Part 4), the *Energy Code* (Part 6), and the youngest *CALGreen Code* (Part 11).[78]

Ventilation. Ventilation is addressed in the central chapter of the *Residential Code, "*Chapter 3. Building and Planning". Section R303 Light, Ventilation and Heating contains the following prescriptions:

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[73] See note 23, and related text, in Chapter 3.1.

[74] An expression used by Ben-Joseph in *The Code of the City* (2005, 168).

[75] This and many other aspects of land-use control and environmental protection are considered examples of "police powers," powers, as suggested in the Tenth Amendment to the U.S. Constitution, reserved to the States.

[76] Title 24 is part of the *California Code of Regulations*, it contains the *California Building Standards Code*, and is composed of thirteen parts, the first one is administrative, and the last lists all the referenced standards. See the website of the California Building Standards Commission for the complete list. Accessed November 27, 2017. http://www.bsc.ca.gov/Codes.aspx

[77] As explained in the introduction to the Residential Code (CBSC 2016a, xii), when an adopted solution is not regulated by the code, or the dwelling has more than three stories, one must refer to the main *Building Code* (Part 2 of Title 24).

[78] As it became evident in the previous section, water is also regulated in multiple parts of the code; in the *Residential Building Code* based on an ICC model, the *Plumbing Code* based on the *IAPMO Uniform Plumbing Code*, and the *CALGreen Code* written in California in absence of a model.

> R303.1 Habitable rooms. (…) Natural ventilation shall be through windows, skylights, doors, louvers or other approved openings to the outdoor air. Such openings shall be provided with ready access or shall otherwise be readily controllable by the building occupants. The openable area to the outdoors shall be not less than 4 percent of the floor area being ventilated (CBSC 2016a, 75).

Not only after having provided 4% of openable area, are spatial considerations complete, and one no longer requires architectural expertise to manage ventilation, but there is also an exception which reads:

> 1. The glazed areas need not be openable where the opening is not required by Section R310 and a whole-house mechanical ventilation system is installed in accordance with the *California Mechanical Code*.

While according to section R310 Emergency escape and rescue openings openable areas are not required in kitchens and bathrooms, it is hard to justify why one would want to avoid having the option of opening a window once it is there.[79] While such choice might be in fact rare, mechanical ventilation is in any case almost always obligatory for other reasons. Not only section R303.3.1 Bathroom exhaust fans imposes mechanical ventilation for humidity control referring to two other codes (*Mechanical* and *CALGreen Codes*), and excluding an openable window as an acceptable solution,[80] but also because of the following provisions included in the *Mechanical Code*:

> 402.2 Natural Ventilation. Natural ventilation systems shall be designed in accordance with this section and shall include mechanical ventilation systems designed in accordance with Section 403.0. Section 404.0. or both (CBSC 2016b, 63).

Although one of the exceptions specifies that "a mechanical ventilation system is not required where the

[79] Unless, one happens to live within 1,000 feet of a freeway.

[80] The section reads: "Each bathroom (…) shall be mechanically ventilated for purposes of humidity control in accordance with *the California Mechanical Code, Chapter 4*; and *the California Green Building Standards Code, Chapter 4, Division 4.5.* Note: Window operation is not a permissible method of providing bathroom exhaust for humidity control" (CBSC 2016a, 75). It is commonly-accepted and permitted by the code to design a windowless bathroom. Although section R303.3 Bathrooms reads: "Bathrooms, water closet compartments and other similar rooms shall be provided with aggregate glazing area in windows of not less than 3 square feet (0.3 m^2), one half of which must be openable," the requirement is practically cancelled by what follows: "Exception: The glazed areas shall not be required where artificial light and a local exhaust system are provided. The minimum local exhaust rates shall be 50 cubic feet per minute (25 L/s) for intermittent ventilation or 20 cubic feet per minute (10 L/s) for continuous ventilation in accordance with *the California Mechanical Code*, *Chapter 4.* Exhaust air from the space shall be exhausted directly to the outdoors" (75).

zone is not served by heating or cooling equipment [ASHRAE 62.1:6.4]," most American homes are provided with at least the heating system in most "zones", and hence cannot avoid installing mechanical ventilation.[81]

The *Residential Code* defines ventilation as "the natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space." (CBSC 2016a, 41) Since air does not simply circulate but is "supplied", the mechanics of this act surely require a mechanical standard. Section **R303.4 Ventilation** specifies that "ventilation air rates shall be in compliance with *the California Mechanical Code"* (CBSC 2016a, 76).[82] Although at this point almost superfluous, the provisions (however basic) related to natural ventilation are also contained in the *Mechanical Code*, even if it is here that one would expect to consult an architect, rather than a mechanical engineer. Yet, since architects rarely understand the mechanics of "thermal, wind, or diffusion effects" responsible for natural ventilation, this ASHRAE definition of the term is reported in the *Mechanical* Code, meant for mechanical engineers.[83] Sections **402.2.1 Floor Area To Be Ventilated** specifies where operable openings should be positions, depending on whether they are single-, double-side, or corner openings. Confusingly, the following section **402.2.2 Location and Size of Openings** repeats provisions already included in the above-mentioned section **R303.1** contained in the *Residential Code*.[84] More than a "complete cookbook", the *Residential Code* is an

[81] Section **R303.9 Required heating** included in the *Residential Code* reads: "Where the winter design temperature in Table R301.2(1) is below 60°F (16°C), every dwelling unit shall be provided with heating facilities capable of maintaining a room temperature of not less than 68°F (20°C) at a point 3 feet (914 mm) above the floor and 2 feet (610 mm) from exterior walls in habitable rooms at the design temperature. (…)" (CBSC 2016a, 76).

[82] It is noteworthy that **Chapter 4. Ventilation Air** refers to other standards. Section **402.1.2 Dwelling** reads: **"**Requirements for ventilation air rate for single-family dwellings shall be in accordance with this chapter or ASHRAE 62.2" (CBSC 2016b, 63). Those are then listed in **Table 402.1 Minimum Ventilation Rates in Breathing Zone** (CBSC 2016b, 78). In residential construction, the two important parameters are: People Outdoor [ventilation] Air Rate - 5 cfm/person per dwelling Unit; and Area Outdoor [ventilation] Air Rate - 0.06 cfm/ft^2 for each occupant. (Default occupancy is specified to be 2 persons per studio or one-bedroom unit, and 1 additional person for each additional bedroom.)

[83] In Chapter 2 Definitions, one reads: "**NATURAL VENTILATION.** Ventilation provided by thermal, wind, or diffusion effects through doors, windows, or other intentional openings in the building. [ASHRAE 62.1 :3]" (CBSC 2016b, 38).

[84] Section **402.2.2 Location and Size of Openings reads: "**Spaces, or portions of spaces, to be naturally ventilated shall be permanently open to operable wall openings directly to the outdoors, the openable area of which is a minimum of 4 percent of the net occupiable floor area. Where openings are covered with louvers or otherwise obstructed, openable area shall be based on the net free unobstructed area through the opening. Where interior rooms, or portions of rooms, without direct openings to the outdoors are ventilated through adjoining rooms, the opening between rooms shall be permanently unobstructed and shall have a free area of not less than 8 percent or the area of the interior room nor less than 25 square feet (2.3 m^2). [ASHRAE 62.1 :6.4.2]" (CBSC 2016b, 63). Not only does it repeat a provision included in the *Residential Code,* but it also refers to an ASHRAE Standard.

annotated index, only that the hyper-links are missing.[85] It acts as a textual map which helps hire the right consultants. In fact, once the ventilation rates, and the size and location of openings have been specified by a mechanical engineer, one still needs to consult an energy expert to comply with the efficiency standards contained in yet another book, the *Energy Code*.[86] While general efficiency requirements for different appliances are contained in **Tables 110.2-A** through **110.2-K**. (CBSC 2016b, 31-38), those that affect ventilation, albeit indirectly, can be found in **Section 110.7 Mandatory Requirements To Limit Air Leakage:**

> All joints, penetrations and other openings in the building envelope that are potential sources of air leakage shall be caulked, gasketed, weather-stripped or otherwise sealed to limit infiltration and exfiltration (CBSC 2016b, 42);

More mandatory provisions are contained in **Section 150.0**, especially letter **(m) Air-distribution and ventilation system ducts, plenums and fans** (e.g. point **4. Duct insulation R-value ratings; 5. Duct insulation thickness)** (CBSC 2016d, 123-4). The *Energy Code* guarantees that the ventilation system is efficiently sealed; air-tight. Both codes ensure that the provisions included in the *ASHRAE Standard 62.2* are observed.

Indoor Air Quality. Surprisingly, the above-mentioned **Section 150.0**, letter **(m) contained in** the *Energy Code* also addresses the quality of air. One wonders whether it is to protect the human respiratory system or the equipment:

> **12. Air filtration.** Mechanical systems that supply air to an occupiable space through ductwork exceeding 10 feet (3 m) in length and through a thermal conditioning component, except

[85] In part, what precludes the code from being a hypertext freely available on-line is the fact that it references model codes. Although the model code enters the public domain when it is incorporated into the state code, the California Title 24 is not easily available online. The website of the Building Standards Commission, links to that of the relevant model-code company. The accessibility varies according to the owner. On the ICC site, one can view rasterized pages of the code but cannot search for terms, or directly access the referenced codes. On the IAPMO website, one can search the Mechanical Code, and quickly navigate inside it, but cannot access external references. See the ICC and IAMPO websites for details. Accessed November 27, 2017. https://codes.iccsafe.org/public/chapter/content/9940/ and http://epubs.iapmo.org/2016/CMC/mobile/index.html#p=1

[86] The *Mechanical Code* refers to the *Energy Code* in relation to ventilation in section **402.1 Occupiable Spaces** (CBSC 2016b, 63). In the *Residential Code* reference to the *Energy Code* for insulation standards can be found, for example, in section **R408.3 Unvented crawl space**, part of **Section R408 Under-Floor Space.** This section specifies when ventilation openings in under-floor spaces (requirement included in R408.1 and R408.2) are not required. One of the possible solutions (2.2) requires "conditioned air supply" and specifies that "*crawl space perimeter walls shall be insulated in accordance with the minimum insulation requirements established in the California Energy Code*" (CBSC 2016a, 171).

> evaporative coolers, shall be provided with air filter devices (…) (CBSC 2016d, 125).

The *Residential Code* addresses indoor air quality only once, to acknowledge the issue, and again refer the reader to another part of the code:

> R340.1 Finish material pollutant control. Finish materials including adhesives, sealants, caulks, paints and coatings, aerosol paints and coatings, carpet systems, carpet cushion, carpet adhesive, resilient flooring systems and composite wood products shall meet the volatile organic compound (VOC) emission limits in accordance with the *California Green Building Standards Code, Chapter 4, Division 4.5* (CBSC 2016a, 125).

Once the ventilation system is made sufficiently air-tight thanks to sealants and caulks, one must refer to the *CALGreen Code* to protect the home and its inhabitants from VOCs trapped in the very same materials used to seal it from the outside, materials which, to use Back's words, "provide a refuge" from air pollution. This is what Division 4.5. Environmental Quality does:

> 4.501.1 Scope. The provisions of this chapter shall outline means of reducing the quantity of air contaminants that are odorous, irritating and/or harmful to the comfort and wellbeing of a building's installers, occupants and neighbors (CBSC 2016e, 29).

What is not clearly acknowledged in this section is that these contaminants are emitted by construction materials allowed in other parts of the code. The mandatory section 4.504.2 Finish material pollutant control lists them all: adhesives, sealants, and caulks; paints and coatings, carpet systems, flooring systems, and composite wood products. The voluntary section A4.504.2 also addresses pollutants emitted by insulation materials.[87] It would be easier to simply ban the production of these materials, but since this would be against the spirit of the free market and customer choice, the only thing that the state-written

[87] Although section R340.1 does not list insulation materials as potential sources of VOCs, the *CALGreen Code* addresses it in the "Appendix A4 Residential Voluntary Measures." Section A4.504.3 Thermal insulation reads: "Thermal insulation installed in the building shall meet the following requirements: Tier 1. Install thermal insulation in compliance with the California Department of Public Health, "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.1, February 2010 (also known as Specification 01350), certified as a CHPS Low-Emitting Material in the Collaborative for High Performance Schools (CHPS) High Performance Products Database; products certified under the UL GREENGUARD Gold (formerly Greenguard Children & Schools program); or meet California Department of Public Health, "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.1, February 2010 (also known as Specification 01350). Tier 2. Install insulation which complies with Tier 1 plus does not contain any added formaldehyde. Note: Documentation must be provided that verifies the materials are certified to meet the pollutant emission limits in this section (CBSC 2016e, 79).

CALGreen Code can do is to impose state rules to be observed "unless more stringent local limits apply."[88]

The remaining sections of the "Division 4.5 Environmental Control" repeat, or slightly expand provisions included in other codes. **Section 4.506 Indoor Air Quality And Exhaust** and **Section 4.507 Environmental Comfort** both address issues already regulated in the *Mechanical Code*, confirm the authority of the *Energy Code* with respect to lighting efficiency, Energy Star as a standard of fan efficiency, [89] and also refer the reader to ASHRAE for standards related to heating and air-conditioning.[90] **Section 4.505 Interior Moisture Control** expands two measures already contained in the *Residential Code*. One of them includes the following prohibition:

> **4.505.3 Moisture content of building materials.** Building materials with visible signs of water damage shall not be installed. Wall and floor framing shall not be enclosed when the framing members exceed 19-percent moisture content. (…)" (31).

The expression "19-percent moisture content" is what transforms plain good judgment that an experienced craftsman would make, into technical expertise. Still, one wonders why this provision is not simply added to those chapters in the *Residential Code* that regulate wood framing practices and the grade of lumber.[91] Yet, there it would be simply addressing an aspect of structural soundness. Listed in the

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[88] The VOC limits imposed by the California Air Resources Board are listed in Tables 4.504.1- 5 (CBSC 2016e, 30-1)

[89] The repetitive nature of the building code makes it that the Energy Star requirement for the same appliance is referenced multiple times. For example, Energy Star-rated dishwashers and clothes washers are mentioned in the *Plumbing Code*, "Appendix L Sustainable Practices," Section L403.0 Appliances (CBSC 2016c, 466), and in the *CALGreen Code*, "Appendix A4 Residential Voluntary Measures," Section A4.303 Indoor Water Use (CBSC 2016e, 73). See note 48, and related text, in Chapter 4.1. for a brief story of the Energy Star program.

[90] The issues regulated in the CALGreen sections **4.506.1 Bathroom exhaust fans**, and **4.507.2 Heating and air-conditioning system design** are both addressed in the *Mechanical Code*. While "Appendix E Sustainable Practices" which copies the CALGreen section **4.506.2** in its entirety is not adopted by California (its objectives overlap with those includedin the CALGreen code), other numerous sections, including **311.0 Heating or Cooling Air System** address the issue, and could be simply amended by the state authorities to include the provision listed in the *CALGreen Code*. Yet, Section **402.5 Bathroom Exhaust** was added to the *Mechanical Code* by the California Department of Housing and Community Development (HCD has jurisdiction over residential occupancies) specifically to refer back to the *CALGreen Code*: "**402.5 Bathroom Exhausts Fans**. [HCD 1 & HCD 2] Each bathroom shall be mechanically ventilated in accordance with Division 4.5 of the *California Green Building Standards Code* (*CALGreen*)" (CBSC 2016d, 65).

[91] Wood framing in floors is addressed in section R502 (CBSC 2016a, 173), and wood framing in walls is regulated in section R602 (207). Both, section **R502.1.1** and **R602.1.1 Sawn lumber** addresses lumber grading: "Sawn lumber shall be identified by a grade mark of an accredited lumber grading or inspection agency and have design values certified by an accreditation body that complies with DOC PS 20. In lieu of a grade mark, a certificate of inspection issued by a lumber grading or inspection agency meeting the requirements of this section shall be accepted" (173). Among other issues, lumber grading covers moisture content. One of the designations stamped on lumber is: KD which stands for "Kiln Dry," which indicates that lumber was dried in a heated kiln to a moisture content less than 19%. Specifying the grade in this section would make the provision currently included in the *CALGreen Code* unnecessary. See the website of the Pacific Lumber Inspection Bureau. Accessed November 30, 2017. http://www.plib.org/

CALGreen Code, the same provision *improves* air quality. It becomes a sign of sustainability. CALGreen, like the *Residential Code*, is mostly an annotated guide to other sources of expertise, and other authorities having jurisdiction. The difference is that here the search filter is *green*.

Why Continue Stacking? The *Residential Code* specifies *what* needs to be regulated; it is thanks to this code that "habitable rooms" receive air. The *Mechanical, Plumbing, Electrical*, and the *Energy Codes* provide the answers to the *how* questions. The *Mechanical Code* defines air flow rates, and lays out pipes and vents to bring the air in. The *Energy Code* efficiently insulates them. The *CALGreen Code* provides protection from the very methods and materials. Yet, more than an answer to how to build in a more sustainable and healthier way (an objective achievable through possible amendments to the other parts), the *CALGreen Code* provides a way to emphasize, or better advertise, the *why*. The length, fragmentation, and repetitiveness of the building code are all effects of the extreme standardization of various aspects of planning, design, construction, and occupation of buildings, which in turn triggers excessive professional specialization, proliferation of licensed consultants and contractors, and ultimately need for clearly compartmentalized regulations accessible to the narrowly-defined trades and experts. Multiple standard-setting, and model-code companies, and different authorities having jurisdiction over different occupancies results in many, inevitably poorly-coordinated authors. Yet, while these are the reasons for the existence of many technical parts, the more recent additions to the *stack* reveal yet another motivation. Rather than an effect of the need for a quick *Band-Aid* on a newly-emerged problem, the growing stack is a reflection of the political necessity to *package* each new set of solutions in a way that is clearly visible to the citizens, and signals the importance of the agenda in focus.[92] This was the *why* behind the adoption of the *Energy Code* in the age of weatherization, and this is the *why* behind the very existence of *CALGreen*. It will not be surprising, if the *California Building Standards Code* acquires yet another part: a *Resilient Building Code.*[93]

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The *California Building Standards Code* is a complicated, and often repetitive stack of regulations which reflects the involvement of multiple authors, and various state authorities. This section examined how regulation of a specific, yet highly volatile aspect of

[92] In "A World of Standards but not a Standard World" Timmerman and Epstein observe: "Even the standards that do not obtain anything materially may have an important signaling function. Measured by certification, the ISO 9000 standard is a success: in 2006, more than 775,000 firms had been certified worldwide (Storz 2007). Yet in spite of extensive auditing and consulting, many Japanese companies comply with the standard only formally, paying for the audit as a marketing move but not changing management processes according to ISO principles" (2010, 82). (The ISO 9000 addresses quality management.)

[93] See note 89, and associated text, in Chapter 4.2.

residential construction, air circulation and quality, is influenced by the multi-layered structure of the code. Although the importance of indoor *atmosphere* for human well-being is addressed in the core sections of the *Residential Code*, not only the technical aspects of air supply but also the spatial implications pertaining to air circulation are regulated elsewhere. What became evident is that ventilation is not only regulated in the *Mechanical Code*, but it is predominantly mechanical. Although the quality of outdoor air is controlled at the federal level, the state does *venture outdoors,* and uses the building code, specifically its sustainable *CALGreen* part, to improve the quality of *supplied* air by imposing charging plugs for electric vehicles. Since buildings cannot be air-tight for health reasons, and heavily rely on mechanical systems for supply and filtering of outdoor air, another part, the *Energy Code*, regulates the (thermal) efficiency of ventilation. Now extremely air-tight thanks to the *Energy Code*, the quality of indoor atmosphere is rectified again by the *CALGreen Code*, which again ventures into a field regulated at the federal level, the toxicity of materials. While this section explored the structure of the code to understand its impact on the way residential buildings are regulated, what became evident is that its fragmented nature reflects more than just a gradual accumulation of air-related agendas that must be reconciled and integrated. It reflects a political need to keep them separate; as a distinct proof of sustainable action.

Irrespectively of these considerations, the conflict between the objectives of the early code-makers (i.e. health and welfare - ventilation), more recent concerns (in this case: energy conservation), and the latest attempt to regulate a less-understood issue (indoor air quality) remains unresolved in each single part, and in all of them read together. Distressingly, what will become clear in the next and closing section of this chapter, is that the complicated geography or rule-making, and the fragmented structure of the building code stack, conceal yet a deeper problem. It is because of the way in which the rules are formulated, that this conflict can be mitigated by a mechanical air filter, but not by vegetation.

6.4. The Inner Workings: How are the Appropriate Solutions Achieved? Focus: Vegetation.

In this section, regulations pertaining to shading, insulation, water, and air quality are examined to understand how the manner in which they are expressed informs the effects, and by consequence how their internal grammar excludes certain solutions, specifically use of vegetation, and its capacity to *perform* environmental functions. Three issues arise from this analysis of the meta-rules that govern regulations and are interwoven in this section. The first issue is the need to precisely quantify both means and desired effect, in order to limit the need for specialized knowledge and decision-making, and ultimately reduce risks. The second issue is the adoption of performance-driven regulations, which while apparently flexible, are heavily limited by internal constraints, again meant to limit risk and legal liability. The third issue is the influence of the internal grammar on the freedoms and responsibilities vested in the involved actors, its impact on the agency of plan-checkers, manufacturers, users, architects, and last but not least, the software engineers incarnated in digital simulation packages.

As the meta-rules are discussed in relation to vegetation, the environmental consequences of the inner workings also start to emerge. Since the rules written by early code-makers treat vegetation as an obstruction (a safety hazard - for example, in relation to fire), they limit its use to address environmental issues currently being regulated (i.e. shading, insulation, or water treatment for energy and water conservation). For these reason, the fundamental problems tackled by ecologists, and environmental activists (i.e. loss of biodiversity and habitats) are unlikely to receive even indirect attention from the code-makers focused on protecting buildings and improving their operations.

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The Meta-Rules. In an overview of regulatory practices used to norm construction, William Baer pointed out (referring to Herbert Simon) that "rules are merely human devices to translate between desired ends and possible means" (2011, 278). Like other devices, rules - especially when formalized as professional standards, or government-enacted regulations - function according to an inner protocol. As Bear puts it, they "have an internal organization or grammar and meta-rules for its organization" (277). While some rules are prohibitive (in other words, proscriptive),[94] and concentrate on avoiding negative effects (or at least the worse-case scenarios), most of them tend to be formulated as positive prescriptions, even if in practice they still simply prohibit what is not permitted.[95] They promote positive outcomes either by imposing a method tested to be beneficial or at least safe, or they do it by indicating a desired performance without defining specific means. The former approach reduces the risk, but does not necessarily promote optimal solutions, or encourage innovation. The latter attempts to maximize the benefits by accepting an elevated level of risk. The specificity of regulations can also vary: they can impose exact standards, or whenever such degree of absolute precision is impossible, more relative criteria which require specialized knowledge and professional judgement (Fig.6. 8). At the *soft* end of the spectrum, performance-based, process-oriented criteria only signal desired results, and vaguely suggest means. As an example: Provide clean indoor air [performance], by venting air to the outside [process] to carry out harmful pollutants [relative criterion]. In thus expressed prescription, neither the means nor the effects are clearly defined; designers, plan-checkers, and users are all entrusted with a significant amount of responsibility. Not surprisingly, it is difficult to find suitable examples of thus expressed rules in the current building code. What is more common, is what one finds at the other end of the spectrum: prescriptive, product-oriented standards which impose precise outcomes, leave little freedom to designers, plan-checkers, and users, and shift responsibility onto manufacturers, and installers. The following regulation contained in the *Mechanical Code* can serve as an example:

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[94] For example, the previously-cited regulation contained in the *Plumbing Code*, prohibits certain types of fixtures: "**405.3 Miscellaneous Fixtures.** (…) No dry or chemical closet (toilet) shall be installed in a building used for human habitation, unless first approved by the Health Officer" (CBSC 2016c, 56). Another prohibitive, but more flexible proscription reads: "**411.2 Water Consumption.** The effective flush volume of all water closets shall not exceed 1.28 gallons (4.8 L) per flush (…)" (CBSC 2016c, 60).

[95] For example, sub-section **411.2.2 Performance (**part of section **411.0 Water Closets)**, reads: "Water closets installed shall meet or exceed the minimum performance criteria developed for certification of high-efficiency toilets under the WaterSense program sponsored by the U.S. Environmental Protection Agency (EPA) (60). Interestingly, while this prescriptive regulation is expressed in a positive way its ultimate meaning is very similar to the one cited in the above note. The latter prescribes a standard (defined in detail elsewhere), the former prohibits performance below a precise numeric value (1.28 gallons / flush).

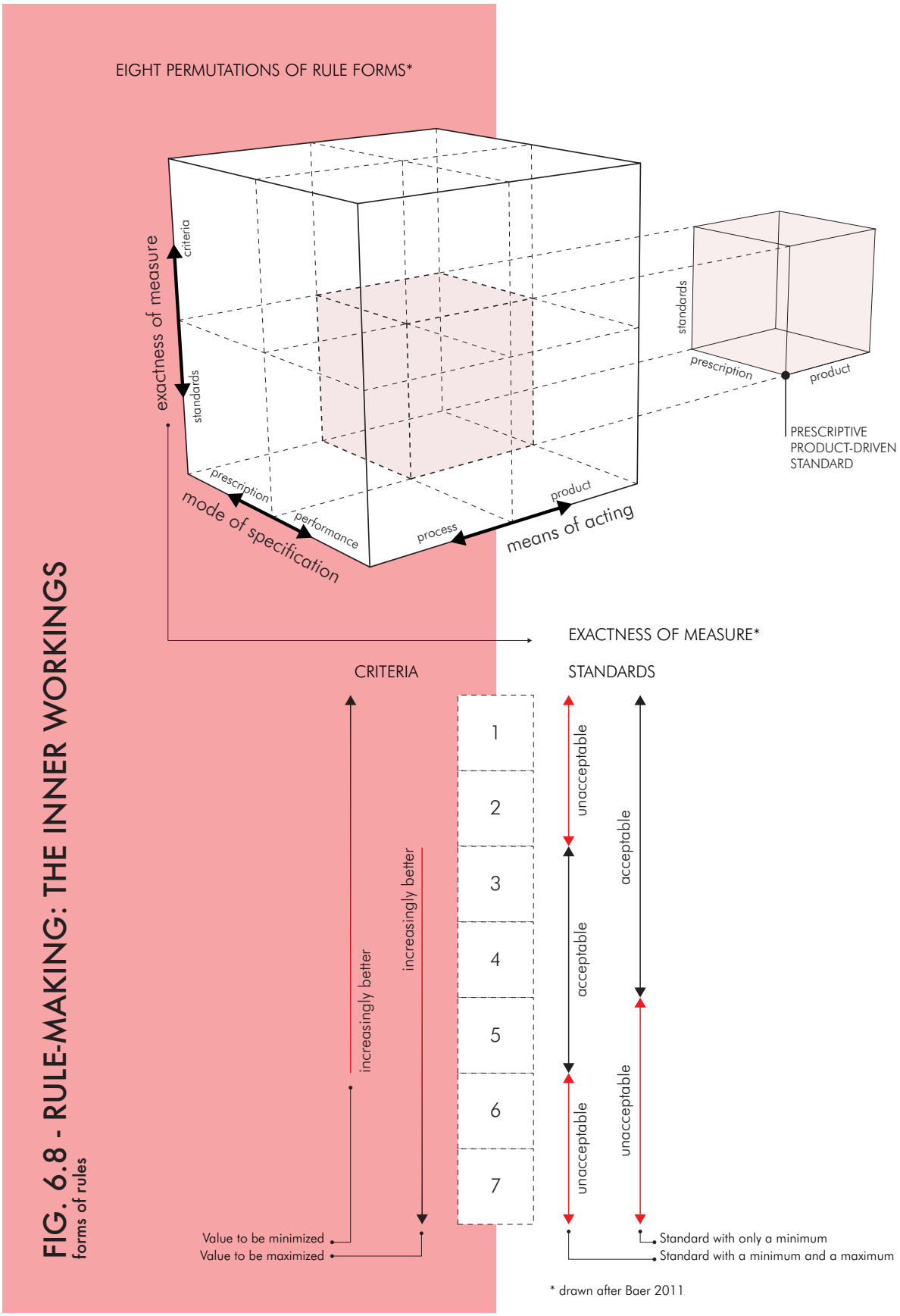

FIG. 6.8 - RULE-MAKING: THE INNER WORKINGS
forms of rules

> A4.506.1 Filters. Return air filters [product] with a value greater than MERV 6 [exact quantitative standard] shall be installed [prescription] on HVAC systems (CBSC 2016e, 79).

This level of precision is preferred by code-makers as it reduces need for specialized knowledge and minimizes legal liability. As it will become evident in the rest of this section, the way of expressing standards and regulations determines how we *practice* sustainability as a society. The freedoms and responsibilities assigned to each of us - manufacturers and certifiers, users, plan-checkers, architects, and nowadays also simulation software - are embedded in these meta-rules; they define our relationship with the environment.

Vegetative Shade: the Simulation Engine and its Agency. Historically, U.S. building codes have been either prohibitive or, when expressed in a positive way, prescriptive; granting little freedom to designers, and trust to users. While over the last decades, performance-based rules have occasionally been woven into the existing prescriptions,[96] the California-written *Energy Code* appears very progressive as it explicitly offers two options; a prescriptive compliance path, and a performance-oriented approach.[97] Yet, while in part the choice reflects the increasing acceptance of digital simulation as a way to assess untested solutions, and need to encourage technological innovation, the caveat is twofold. Performance must be "computed by compliance software certified for this use by the Commission,"[98] and the software only

[96] A certain degree of freedom is inscribed into this measure (cited in the introductory part of this chapter): "**R316.4 Thermal barrier.** Unless otherwise allowed in Section R316.5, foam plastic shall be separated from the interior of a building by an approved thermal barrier of not less than 1/2-inch (12.7 mm) gypsum wallboard, 23/32-inch (18.2 mm) wood structural panel *or a material that is tested in accordance with and meets the acceptance criteria of* both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275" (CBSC 2016a, 104). While it refers to a specific standard of performance, the emphasized expression "or a material that is tested in accordance with and meets the acceptance criteria of" leaves some space for innovation and allows for use of new materials.

[97] **Section 150.1 Performance and Prescriptive Compliance Approaches for Low-Rise Residential Building**, defines both approaches: "b) **Performance standards.** A building complies with the performance standard if the energy budget calculated for the proposed design building under Subsection 2 is no greater than the energy budget calculated for the standard design building under Subsection 1. **1. Energy budget for the standard design building.** The energy budget for a standard design building is determined by applying the mandatory and prescriptive requirements to the proposed design building. The energy budget is the sum of the TDV energy for space-conditioning, mechanical ventilation and water heating. **2. Energy budget for the proposed design building.** The energy budget for a proposed design building is determined by calculating the TDV energy for the proposed design building. The energy budget is the sum of the TDV energy for space-conditioning, mechanical ventilation and water heating. The energy budget for the proposed design building is reduced if on-site renewable energy generation is installed, according to methods established by the Commission in the Residential ACM Reference Manual" (CBSC 2016d, 129).

[98] The above-mentioned section 150.1 explains how to prove the future performance when using the performance approach: "**3. Calculation of energy budget.** The TDV energy for both the standard design building and the proposed design building shall be computed by compliance software certified for this use by the Commission. The processes for compliance software approval are documented in the Residential ACM Approval Manual" (CBSC 2016d, 129).

Fig.6. 9 The California Residential Compliance Manual where performance compliance options are listed and where it is specified that no credit is offered for shading from trees (left), an advertisement for free shade trees in Anaheim, CA (middle), a green shading wall (right).

accepts a limited range of solutions (or *inputs),* all itemized in additional reference volumes.[99] Rather than granting complete freedom, the software engine assesses the effects of combinations which, while finite and quite limited, exceed the capacities of a human brain. The limits to freedom are clearly expressed in one of the guides, the *Residential Compliance Manual*, section 3.5.8 Compliance Alternatives: "While the prescriptive requirements and mandatory measures establish a minimum level of building energy performance,[100] opportunities to exceed the requirements of the Energy Standards are considerable. (...) Options that are recognized for credit through the performance method are called compliance options" (CEC 2015c, 3-26) (Fig.6. 9). A quick look at how shading is defined in section 3.5.8.4 Fixed Permanent

[99] As anticipated in the previous notes, there are numerous additional manuals. The *Residential ACM (Alternative Calculation Method) Reference Manual* is one of them, it specifies: "This document establishes the rules for creating a building model, describing how the proposed design (energy use) is defined, how the standard design (energy budget) is established, and ending with what is reported on the Certificate of Compliance (CF1R)" (CEC 2015b, 3). It also indicates other sources: "The basis of this document is the 2016 Building Energy Efficiency Standards [the *Energy Code*]. Documents also relied upon include the Reference Appendices for the 2016 Building Energy Efficiency Standards and the 2016 Residential Compliance Manual (CEC-400-2015-032). Detailed modeling information for the software user can be found in the California Building Energy Code Compliance (CBECC) User Manual" (1).

[100] These measures are listed under Section 150.1, (c) Prescriptive standards/component packages. 4. Shading (CBSC 2016d, 131).

Shading Devices illustrates how those compliance options are defined:

> Overhangs or sidefins that are attached to the building or shading from the building itself are compliance options for which credit is offered through the performance approach. *However, no credit is offered for shading from trees, adjacent buildings, or terrain* [my emphasis] (3-27).

Further in the same section one reads:

> Shading is much more difficult on the east and west sides of the house. When the sun strikes these façades, it is fairly low in the sky, making overhangs ineffective. Vertical fins can be effective, but they degrade the quality of the view from the window and limit the natural light that can enter. In cooling climates, the best approach is to minimize windows that face east and west. *Landscaping features can be considered to increase comfort but cannot be used for compliance credit* [my emphasis] (3-27).

Landscaping features (i.e. shrubs and trees) do "increase comfort" but cannot be *inputted* into the compliance software certified by the Commission. Since the shade that they provide (or shadow they cast[101]) is variable, it cannot be easily quantified to be expressed numerically as in Table 3-3: Exterior Shades and Solar Heat Gain Coefficients (3-29) where an array of devices (i.e. bug screens, woven and louvered sunscreens, vertical roller shades, operable awnings, roll down blinds, and slats) is ranked according to the percentage of transmitted sunlight. Even though unlike vertical fins and bug screens, trees do not "degrade the quality of the view,"[102] they are not on the list. In the meantime:

> All operable windows and skylights are assumed to have an insect screen, and this is the default

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[101] The rest of the building code either does not mention vegetation, or does it is to prevent damage from it. In the *Residential Code*, vegetation is mentioned in Section R337 Materials And Construction Methods For Exterior Wildfire Exposure (117) here the hazard is "vegetation fire"; in relation to foundations and floors in sections R408.5 Removal of debris, and R504.2 and R506.2 Site Preparation, where it is a debris. Trees are also mentioned in Section R324 Solar Energy Systems, R324.7.1 Roof access points where trees are listed among other obstructions. (112) This issue is discussed at greater length in Chapter 5.4. in relation to solar energy generation devices. The mandatory part of the *CALGreen Code* only mentions vegetation in relation to water conservation, in section 4.304.1 Outdoor potable water use in landscape areas (CBSC 2016e, 25). The voluntary part of the code also refers to it in relation to heat island effect in sections A4.106.5-7. Vegetation as a shading device is mentioned as a voluntary nonresidential measure in the following section: A5.106.7 Exterior wall shading. Meet requirements in the current edition of the California Energy Code and comply with either Section A5.106.7.1 or A5.106.7.2 for wall surfaces. If using vegetative shade, plant species documented to reach desired coverage within 5 years of building occupancy. A5.106.7.1 Fenestration. Provide vegetative or manmade shading devices for all fenestration on east-, south-, and west-facing walls. (99) Although the *CALlGreen Code* does not specify the document that ranks plant species according to coverage, these two sections indicate that in the future vegetation might become a shading option. It simply needs to be standardized first.

[102] While it is true that trees "limit the natural light," unlike man-made sunscreens, deciduous species seasonally shed leaves allowing more natural light in when less of it is available.

> condition against which other window / exterior shading device combinations are compared (3-28).

The insect screen is considered to be the default shading option. I permanently removed it on the day I moved into the house in which I live under *Title 24 jurisdiction*.

Vegetative Insulation: Manufacturers, Installers, and Ratings. While the *CALGreen Code* does suggest vegetative shade as a possible voluntary nonresidential measure (specifying that it may be used if documented to reach coverage within 5 years[103]), it never mentions vegetative insulation. It may be because it would not satisfy the provisions that regulate insulation materials in the *Energy Code*, where the expression 'documented' acquires a more absolute meaning; the insulation product must be rated by the manufacturer (Fig.6. 10). **Section 110.8 Mandatory Requirements for Insulation, Roofing Products, and Radiant Barriers** explicitly states:

> **(a) Insulation certification by manufacturers.** Any insulation shall be certified by Department of Consumer Affairs, Bureau of Home Furnishings and Thermal Insulation that the insulation conductive thermal performance is approved pursuant to the California Code of Regulations, Title 24, Part 12, Chapters 12 – 13, Article 3, "Standards for Insulating Material" (CBSC 2016d, 42).

Reliance on manufacturer rating is confirmed in the *Residential ACM Reference Manual* which states that "additional materials may be added to the Compliance Manager" (CEC 2015b, 13), but also specifies how to input properties of these non-listed assemblies into the modelling software:

> **2.3.2 Construction Assemblies** (…) **Proposed Design.** (…) Any variation in insulation R-value, framing size or spacing, interior or exterior sheathing or interior or exterior finish requires the user to define a different construction. Insulation R-values are based on manufacturer-rated properties rounded to the nearest whole R-value [my emphasis]" (17).

Last but not least, exceptions are permitted but exceptional quality has also been normalized; not only is 'quality insulation installation' a clearly standardized procedure, but it must be verified by a licensed installer following HERS104 procedures:

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[103] See note 101 above.

[104] See note 42, in Chapter 4.1 for a mention of this rating system developed by RESNET.

Fig.6. 10 The California Energy Code from which the below article is extracted (left), a green wall by Patrick Blanc in the Musee du Quai Branly in Paris (right).

> 2.2.6. Insulation Construction Quality (…) Verification and Reporting. The presence of improved/verified high quality insulation installation is reported in the HERS required verification listings on the CF1R. Improved quality insulation installation is certified by the installer and field verified to comply with RA3.5. Credit for verified quality insulation installation is applicable to ceilings/attics, knee walls, exterior walls and exterior floors" (9).

As of today, no manufacturer can rate, and no licensed expert can verify the quality of vegetative insulation. Unrated and unverified, vegetation, however exceptional its performance, cannot be considered a viable option when following the performance compliance path offered by the *Energy Code*.

Phyto Air Purification: the Agency of the User. As stated in the previous section where the voluminous nature of the building code was discussed on the example of air-related regulations, the *Residential Code* (section R303.1 Habitable rooms) prescribes openable windows to guarantee natural ventilation (CBSC 2016a, 75). At the same time, the *Mechanical Code* (section 402.2 Natural Ventilation) makes *ASHRAE*

62.2 requirements mandatory, and imposes mechanical ventilation in addition to openable windows.[105] The reason for this level of protectiveness can be found in one of the *Energy Code* reference manuals which states: "Energy Commission-sponsored research on houses built under the *2001 Standards* revealed that overall ventilation rates are lower than expected, (…) and many occupants do not open windows regularly for ventilation" (CEC 2015c, 4-55). This explains why the code emphasizes that while mandatory, since clearly beneficial,[106] "window operations are not a permissible method for providing whole-house ventilation" (3-43) and goes even further by confirming after *ASHRAE 62.2* that an exhaust system can be substituted for openable windows in bathrooms. However, while it is clearly stated that users cannot be trusted to regularly open windows, what is not made equally clear is that outdoor air can no longer be trusted to purify indoor air either. What is necessary is not only a forced supply of air, but also a filter. In fact, a filter in domestic whole-fan systems and local exhausts is required by the *Energy Code*, section 150.0 (m) 12. Air filtration (CBSC 2016d, 125). Yet, while the same code encourages compliance through performance approach, the way this and other prescriptions related to air purification are formulated does not leave space for *phyto-innovation*. A NASA-developed phyto purification system is not a valid compliance option.[107] Since vegetation cannot be rated by a manufacturer, the phyto filters do not comply with the section which imposes MERV labeling,[108] and cannot obtain a HERS certificate. While the code recognizes that outdoor air is polluted - inlets must be located 10-feet away from outdoor air contaminants; nothing prohibits outdoor air intakes from being placed within 1,000 feet of a freeway where cars incessantly emit hazardous pollutants. A phyto purification system developed for the *airless* outer space is also not an acceptable option, although it requires neither supply, nor filtering of outdoor air.[109] When mentioned in the code by their name, plants

[105] See note 80, in section 6.3 above.

[106] Mandatory since clearly beneficial: another section of the same manual, 3.5.8.9 Natural Ventilation Through Fenestration, explains the savings and benefits from natural ventilation both for air quality and thermal comfort.

[107] The system uses Golden Pothos and root microbes, in an irrigated bed of activated carbon, and shale pebbles, and is fitted with an induction fan. For a description of the NASA-developed filter, see the *Whole Building Design Guide*. Accessed November 29, 2017. https://www.wbdg.org/resources/phyto-purification-systems

[108] See the *Energy Code*, section 150.0 (m) 12.D. Air filter media product labeling, which states: "The system shall be provided with air filter media that has been labeled by the manufacturer to disclose the efficiency and pressure drop ratings that demonstrate conformance with Sections 150.0(m)12B and 150.0(m)12C (CBSC 2016d, 125).

[109] As explained in the *Residential Compliance Reference Manual,* section 4.6.6.9 Air Inlets, "when the ventilation system is designed with air inlets, the inlets must be located away from locations that can be expected to be sources of contamination. The minimum separation is 10 ft. Inlets include not only inlets to ducts, but windows that are needed to the opening area. The Energy Standards list some likely sources of contaminants. For typical residential applications, the sources will include: 1. Vents from combustion appliances; 2. Chimneys; 3. Exhaust fan outlets; 4. Barbeque grills; 5. Locations where vehicles may be idling for any significant length of time; 6. Any other locations where contaminants will be generated" (CEC 2015c, 4-82).

are simply considered a hazard, and a nuisance: "air intakes be placed so that they will not become obstructed by snow, plants, or other material" (CEC 2015c, 4-82). While performative enough for the outer space, they are not a valid compliance option here in the down-to-earth residential construction. The code treats humans with well-founded skepticism, it mistrusts organic life, in general.

Phyto Wastewater Purification: the Liability of the Plan-Checker. The *Stormwater Low Impact Development (LID) Ordinance* discussed in the second part of this chapter and meant to mitigate the impact of urban runoff is where such methods as bioretention, and phyto-purification become mandatory prescriptions. While this federally-imposed ordinance embraces the performative capacity of plants (retention and purification) and sets some objectives in exact terms (i.e. the amount of the runoff to be retained on site), it also accepts that other aspects of phyto-performance will remain less well-defined (i.e. the degree to which stormwater runoff is purified). The attitude towards plants is slightly different in the state-imposed and conservation-driven *Irrigation Guidelines*,[110] and in the related building code regulations. Here, vegetation becomes a passive object, if not a culprit in part responsible for water scarcity. It is referred to as "the receiving landscape,"[111] it gets ranked according to water consumption using a numerical system and must meet precise requirements (Fig.6. 11). The *CALGreen Code* states:

> Plant material shall comply with all of the following: (A) For residential areas, install climate adapted plants that require occasional, little or no summer water (average WUCOLS plant factor 0.3) for 75% of the plant area excluding edibles and areas using recycled water (...) (CBSC 2016e, 64). [112]

The attitude towards vegetation is even more distrustful when it comes to wastewater treatment. While the *authorities having jurisdiction* can authorize a private sewage disposal system, such freedom is

[110] See note 25 above, in section 6.2 of this chapter.

[111] See the following definitions in the *Plumbing Code*: 1) "211.0 I: Irrigation Field [BSC & HCD1]. An intended destination for gray water in the receiving landscape, including but not limited to, a drip irrigation system, mulch basin, or other approved method of dispersal for irrigation purposes" (CBSC 2016c, 35); 2) "220.0 R: Receiving Landscape [BSC & HCD1]. Includes features such as spoil, basins, swales, mulch, and plants" (39).

[112] The WUCOLS factor stands for 'Water Use Classifications of Landscape Species', it is explained in *A Guide to Estimating Irrigation Water Needs of Landscape Plantings in California*, published by the University of California Cooperative Extension, California Department of Water Resources (2000). Retrieved November 30, 2017. http://www.water.ca.gov/wateruseefficiency/docs/wucols00.pdf

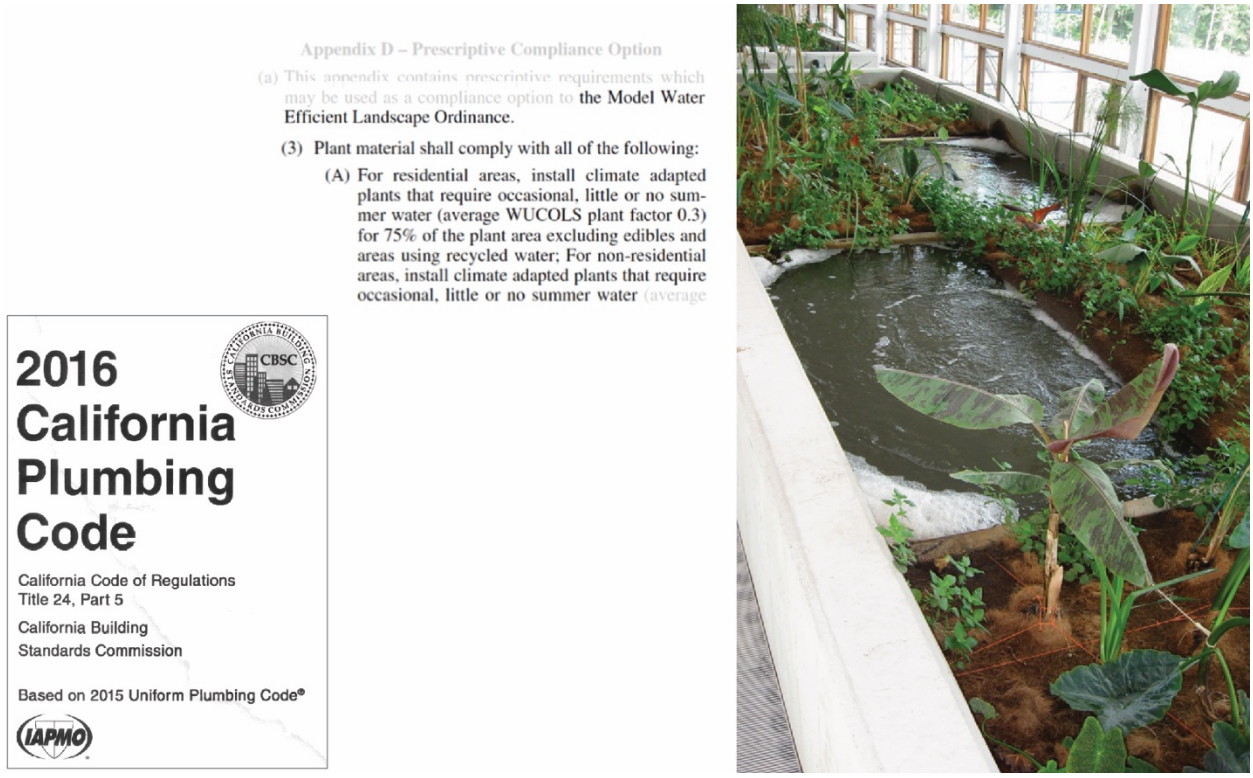

Fig.6. 11 The California Plumbing Code where alternative water treatment systems are regulated (left), a prescription extracted from the CalGreen Code which regulates water use for plants (middle), one of John Todd's phyto wastewater treatment systems called "eco-machines" (right).

granted only in low-density (and low-risk) rural areas.[113] In these areas, they can also approve alternative (aerobic) systems. Section H101.11 Alternate Systems contained in the *Plumbing Code* (Fig.6. 11) explains the conditions:

> Alternate systems shall be permitted to be used by special permission of the Authority Having Jurisdiction after being satisfied of their adequacy. This authorization is based on extensive field and test data from conditions similar to those at the proposed site or require such additional data as necessary to provide assurance that the alternate system will produce continuous and long-range results at the proposed site, not less than equivalent to systems which are specifically authorized. Where demonstration systems are to be considered for installation, conditions for installation, maintenance, and monitoring at each such site shall first be established by the

[113] In California, the guidelines for the design of private sewage disposal systems are contained in the *Plumbing Code*, "Appendix H Private Sewage Disposal Systems" H101.2 General Requirements states: "(…) The system, except as otherwise approved, shall consist of a septic tank with effluent discharging into a subsurface disposal field, into one or more seepage pits, or into a combination of subsurface disposal field and seepage pits. (…)" (CBSC 2016c, 429). Exceptions are possible as stated in section

> Authority Having Jurisdiction. Approved aerobic systems shall be permitted to be substituted for conventional septic tanks provided the Authority Having Jurisdiction is satisfied that such systems will produce results not less than equivalent to septic tanks, whether their aeration systems are operating or not" (CBSC 2016c, 429-30).

Due to the way these rules are expressed, aerobic treatment units (ATU) are still rare, although standardized models are available on the market, and often constitute the only alternative to a conventional septic tank.[114] Yet, since they require continuous maintenance, they are considered even riskier than the risky septic tanks. More experimental, ecologically-engineered systems in which not only aerobic bacteria but also plants are used to treat water, are even less common. John Todd's pioneering Eco-Machines mostly serve research or educational institutions.[115] As mentioned before, in urban areas the code imposes connection to the public sewer,[116] and few municipal treatment plants rely for treatment on natural systems such as constructed wetlands.[117] The potential liability is so high that without a dedicated insurance system local authorities will continue testing and praising natural systems, but insist to send the treated water back to a conventional treatment facility to avoid responsibility.[118] The early Victorian engineers embraced the convenience of water-borne waste removal, and also, as observed by Eran Ben-Joseph, "believed in the purifying nature of water" (2005, 91). Although we no longer share

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[114] As explained in a 2005 article entitled "Aerobic Treatment Units: An Alternative to Septic Systems," and published by the National Environmental Services Center, "septic systems are not suitable for every lot. In fact, approximately two-thirds of all the land area in the U.S. is estimated to be unsuitable for the installation of septic systems. Some homes may not have enough land area or appropriate soil conditions to accommodate a conventional soil absorption drainfield. In some communities, the water table is too high to allow the drainfield to give adequate treatment to the wastewater before it reaches groundwater. Other site-related concerns include homes located on small lots or on lots close to a body of water. The wastewater treated by a septic system is often not of high enough quality to be discharged very close to a body of water." (PIPELINE, 2005, Vol.16, No. 3). Retrieved December 14, 2017. http://www.nesc.wvu.edu/pdf/WW/publications/pipline/PL_SU05.pdf

[115] For example, in the Omega Center Eco-Machine (NY), "treatment is accomplished through a combination of septic and equalization tanks and anoxic tanks, aerated aquatic cells, outdoor wetland and a recirculating sand filter. The Eco-Machine is housed in a state of the art greenhouse that is also used as a classroom, event space and yoga studio." Other, similar projects, include: the National Audubon Society's Corkscrew Swamp (MA), and the Vietnam Veteran's Memorial Rest Stop Eco-Machine (VT) are some of them. For details, see the website of John Todd Ecological Design. Accessed December 14, 2017. http://www.toddecological.com/index.php?id=projects

[116] See **R306.3 Sewage disposal**, cited in section 6.2 above.

[117] The Arcata Wastewater Treatment Plant and Wildlife Sanctuary located in Northern California combines conventional wastewater treatment with the natural processes of constructed wetlands and serves a city of 18,000 inhabitants.

[118] This is the situation described by Eran Ben-Joseph in his book *The Code of the City (2005, 96-7)*: a Living Machine (now called Eco-Machine) designed and built by John Todd in South Burlington (VT) in 1995, was funded and tested by the EPA, but although the results met the federal standards, the agency and the municipal authorities insisted to send the cleaned water back to the local treatment facility to avoid liability (2005, 97). In few cases, the systems designed by Todd in the green 1990s continue to serve institutions where maintenance is ensured since it is part of educational and research activities. This is the case of the Darrow School Eco-Machine located in New Lebanon, New York. See note 115 above, for source.

this believe, we continue to mistrust plants' capacity to purify wastewater, and our own capacity to take care of them.

The Botany of Design. Organic systems, non-standard technologies, and passive spatial solutions are penalized by the prescriptive code which favors manufacturer-rated products over custom-designed spatial configurations, and mistrusts users, and *rebellious* vegetation.[119] Not only is use of plants not prescribed by the building code, but it is also not an acceptable option when satisfying the *quasi*-performance-driven regulations found in the *Energy Code*. As one might expect, the only section of the building code meant to protect vegetation can be found in the *CALGreen Code*. Yet, in the current edition of the green part of the building regulations, its adoption depends on the good will of the client and the architect, it remains a voluntary measure:

> **A4.106.3 Landscape design.** Postconstruction landscape designs shall accomplish one or more of the following: 1. Areas disrupted during construction are restored to be consistent with native vegetation species and patterns. (…) (CBSC 2016e, 67).

As of today, the *botany of design* can only be practiced as an *uncredited* expression of a genuine passion for the environment (to use E.O. Wilson's term, a form of unrewarded biophilia). A dangerous extravagance, considering the multitude of mandatory prescriptions that one must satisfy before engaging with the *otherness* of plants. In his parable of the acrobat, Bateson observed: "For obvious reasons, it is difficult to control by law those basic ethical and abstract principles upon which the social system depends. (…) On the other hand, it is rather easy to write laws which shall fix the more episodic and superficial details of human behavior. In other words, as laws proliferate, our acrobat is progressively limited in his arm movement but is given free permission to fall off the wire."[120] If I return once more to this parable, it is because the acrobatics of sustainability are indeed so accurately regulated by laws, that we, the acrobat-architects, risk not only falling off, but might simply loose interest, and once again apply

[119] While vegetation is still not standardized enough in terms of building performance, it is highly controlled in other fields. Turf grasses and most agricultural products have been engineered for decades (see the story of the engineered potato, in Michael Pollan's 2001 book *The Botany of Desire*). Possibly, organic systems will be accepted by the building industry only when it becomes possible to represent them as CAD blocks and therefore integrate them into the BIM system which provides "a means of organizing and classifying electronic object data and thereby [fosters] streamlined communication among owners, designers, material suppliers, constructors, facility managers, and all stakeholders associated with the built environment." (National Institute of Building Sciences 2014) They will be integral to the project once the process of their scientific management is completed all the way through to representation.

[120] The parable is quoted in greater length in note 82, Chapter 3.2.

our skill to a less standardized facet of the art of building.

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Building regulations originate from a complex matrix of counterbalancing jurisdictions. Sorted in volumes by purpose, *lined with* a protective under-layer of trade standards, they rely on an internal grammar to limit impact of contingencies and human error. Regardless whether they are expressed in prohibitive or positive terms, regulations predetermine acceptable means and ends, demarcating the boundaries of what is safe, decorous, normal. Be it prescriptive or performance-oriented; product- or process-driven, exact or relative, these recipes tell owners, designers, and authorities having jurisdiction how to reach, or at least aim at, the *futures* accepted by the society. Clients, and users; architects, consultants, and builders; code-makers and plan-checkers; manufacturers and certifiers are all vested with specific responsibilities by the very way in which regulations are expressed. The same meta-rules also limit their freedoms to protect them, and the others, from hazards and unknown risks, and from legal and financial liabilities. The meta-code provides a safety buffer between those who are close (clients, designers, users, and community), those in the middle (plan-checkers, and local authorities), and those afar (legislators and code-makers; manufacturers, trade associations, and software engineers). It defines how the actors (human or not) are allowed to relate to each other in the process of reconstructing the environment. By promoting uniformity, compatibility, interoperability, and repeatability, they normalize and safeguard these relations. In this process, the internal grammar of the code inevitably excludes the unpredictable, and incompatible. Be it, a method or actor.

In fact, rather than an active participant, plants, no matter how performative, are predominantly considered a hazard or obstruction. Not only, code-makers have no manifested interest in the loss of biodiversity and habitats, but they mistrust plants and their *environmental services*. Rather than encouraged to shade us from excessive heat and light, trees are prescribed not to "cast shadow" on solar systems. Rather than helping to insulate by enveloping human structures, plants are to be kept at a safe distance, to protect us from fire, moisture, rodents, and insects. Rather than contributing to our well-being as air purifiers, they are feared as an obstruction of air intakes. Rather than helping us to filter wastewater to reuse it locally, they are strictly regulated to use the least amount of it. While themselves an imperfect device of human making, building codes allow no room for vegetal imperfections. Unlike genetically-modified food, and engineered turf on which we play golf, garden plants are insufficiently standardized, and hence are not allowed to contribute to the construction of our future environments. They are enjoyed, but also feared for their uncontrolled nature. Their operations not sufficiently normalized, their performance not entirely predictable, gardens require human collaboration. If biophilia is not mandatory in the code, it is in part due to the fact that it requires human involvement, and acceptance of imprecision.

CHAPTER 7 – Conclusions.

Desire, once freed from the control of authority, can be seen as more real and more realistic, a better organizer and more skillful engineer, than the raving rationalism of the planners and administrators of the present system. Science, innovation, creation - these things proliferate from desire, not from the pseudo-rationalism of the technocrats.

- Félix Guattari, 1984

7.1. Circuits: From Ideas and Programs, to Standards and Recipes.

The ideas and programs that shaped the character of building regulations throughout their history, indirectly also influenced the contemporary attitudes towards the environment, and the ways in which we practice sustainability when we transform it. Many long-forgotten contingencies, and some old but still influential agendas affected building regulations before ecology first gained prominence among scientists, then received attention from the society, and eventually informed the green building standards presently applied to construction practices. While this fact in itself deserved notice – these events and ideas continue to indirectly determine our actions, an even deeper challenge also called for attention. As Bateson acutely observed, ideas and programs interact and survive in circuits.[1] While propagating ways of thinking about ecology, they are themselves propagated across circuits, which are part of a broader, in part mental, ecology. They are canalized along predetermined paths, and in the course of this *journey*, transformed into standards and recipes. Hence, it is these paths, or to use the term coined by C.H. Waddington, "epigenetic chreods" that in large part determine how we think the ideas, devise programs and solutions, and eventually act upon the environment implementing and using them (Fig.7. 1). As

[1] See introduction to Part 1, for reference.

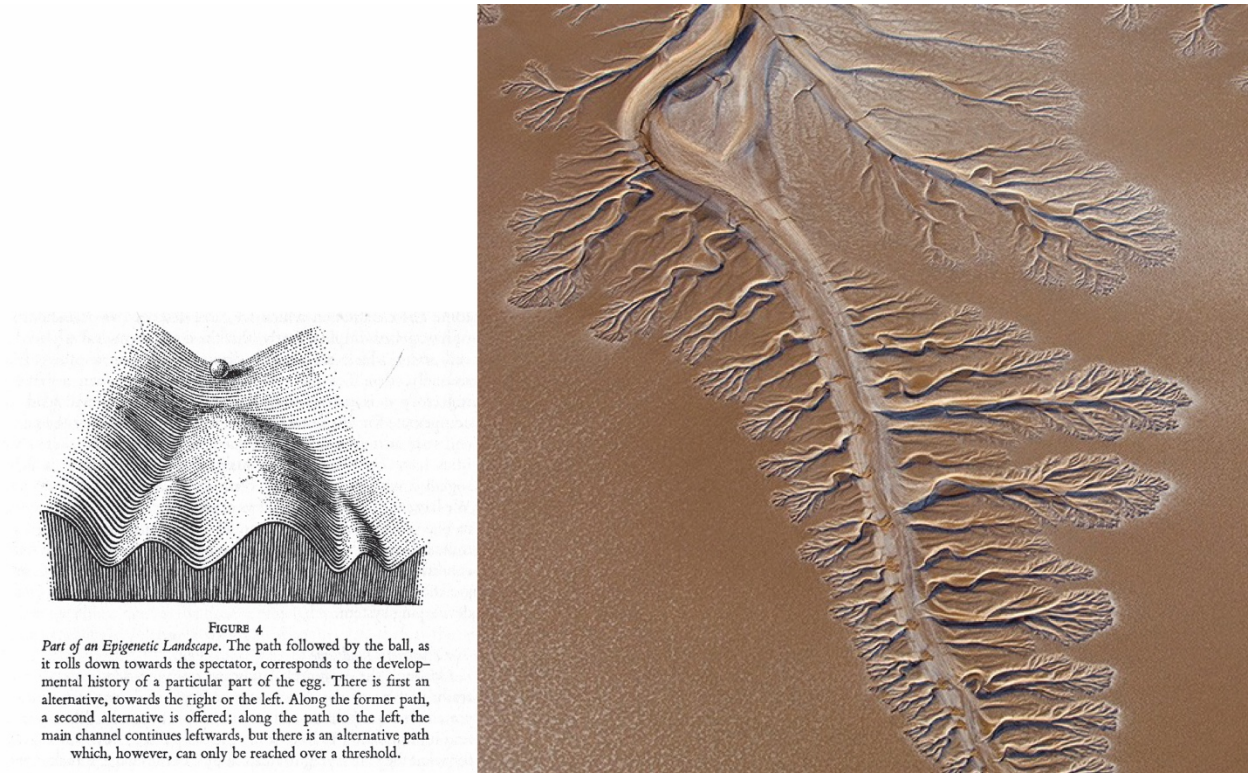

Fig.7. 1 Waddington's "epigenetic landscape" and "chreods" (left), the dry Colorado River delta branches deeply engraved in the landscape (right).

Waddington observed, "many types of change going on in society have a more or less well-developed chreotic character; once they have got well started in a certain direction, it is very hard to divert them" (1977, 106). Building regulations provide a perfect example of this characteristic. Their power lies in the fact that they are not exactly homeostatic; while accepting some types of change, they preserve a particular, for them necessary, type of flow. In that, they are homeorhetic. While standards and recipes can be changed, or at least ignored; once crystalized, the circuits of code-making remain engrained in the regulatory landscape, and continue to determine how we set new standards, and how we operate on the environment. It is therefore a fallacy to assume that by changing ideas and programs, and by updating standards and recipes, we can change our attitude towards ecology. Ideas and programs need to be revised, and standards questioned, but the matrix from which they originate needs to be occasionally *re-circuited* as well.

Since it is beyond the scope of a single research to provide an answer to such a colossal challenge, the intention of this study was to trace some of the key paths and expose the landscape in which they gradually got engrained. The first part of this study provided an account of ecological ideas, economic

agendas, and regulatory programs as they emerged, influenced each other, and informed the construction of American households; it explored the general landscape. The second part concentrated on the circuits of code-making and investigated the mechanics of building regulations used to standardize environmental awareness, and financial incentives meant to promote specific technological artifacts; it sought to understand their ecological implications.

7.2. Agendas: From Welfare and Safety, through Ecology, to Green Building Standards.

The path from welfare and safety, to green building standards led through the era of ecology, but its precise trajectory was determined by economic interests. The recognition of this simple, and in part, obvious fact is crucial for understanding of the current regulatory landscape and the circuits along which green building standards continue to be propagated. Part 1 – Agendas revealed how the original ambitions of code-makers evolved and expanded under the pressure of competing, ecological and economic interests. It provided an account of *pre-ecological* agendas that influenced the American house throughout the century, and in part continue to exert influence today, albeit hidden behind, or disguised as green building standards. It also emphasized when the environmentally-driven regulations addressed environmental protection, as opposed to climatic comfort, or resource management.

Chapter 2 – *From Welfare and Safety, to Ecology*: before the 1970s, concentrated on the events that shaped building regulations before the passage of the *National Environmental Policy Act* in 1969, and the energy crisis that shaped the 1970s. In the pre-1920s period, scientific management was discussed as a major influenced on the household reform and the early regulations, which addressed, next to safety, indoor climate control as a health and welfare-related concern. It then discussed the importance of market-driven motivations in the 1920s, when homeownership and consumer products were promoted by reformers and the federal government. When analyzing the years of the Great Depression, it focused on the impact of the Federal Housing Administration and its mortgage underwriting standards in promoting predictability and uniformity in construction. It also emphasized the distance between the pro-growth agendas of these standard-setters, and the environmental issues which emerged during the Dust Bowl. Attention then focused on the growing influence of the FHA standards after World War II. Their role in promoting residential construction as a form of low-risk financial investment was contrasted with their negative impact on design experimentation, and the disconnection from the re-emerging environmental discourse. Eventually, attention turned towards the early environmental activism and federal legislation which, while still disconnected from building regulations, addressed environmental degradation, both

with concern for human health and welfare, and the environment itself as well. The overall aim in the chapter was to trace the transition from welfare and safety, to ecology, and demonstrate how far apart the architecture of individual dwellings and the protection of natural environment stood while building regulations were gradually defined. Not only was their aim to improve safety, health, and welfare of American citizens, but also the underlying agenda was often driven by the need to minimize financial risks faced by industrial employers first, and merchant builders later, both fundamental engines of national economic growth.

In the following chapter, Chapter 3 – *Environmental Protection and Sustainable Development*: 1970s-1980s, the account revolved around environmental protection as shaped by the energy crisis in the 1970s, and the advent of sustainable discourse in the 1980s. The first section concentrated on the regulatory event that brought environmental legislation into the households in form of energy conservation standards, emphasizing concerns for economy and energetic security as the actual reason for the adoption of these measures. Despite the growing concern for the environment and its limited resources, as expressed by many ecological economists, conservation efforts focused on relative efficiency rather than restraint. As such they were part of the environmental resource management efforts rather than environmental protection. This directly affected the nature of building regulations as well. While standards targeted efficiency, first incentives were introduced to promote energy-efficient technological artifacts. Environmental discourse was co-opted by mainstream economists to control use of resources without obstructing growth. The second section focused on the period of accelerated economic development in the 1980s, when the international community struggled to define sustainable development as a global imperative during the first decade of globalization of markets. The agendas that determined the character of residential construction remained distant from the international efforts to protect the environment, first measures to deregulate the mortgage market only helped accelerate construction. Although first climate change acts were passed in the late 1980s, the decade saw a backlash against environmentally-driven regulations. The 1980s defined the term sustainable development but it was hijacked by the pro-growth establishment. It was the mantras of sustainable growth and energy-efficiency that were inherited by the green 1990s.

In the last chapter of the first part, Chapter 4 – *Green Economy and Green Building Standards*: 1990s - present, the focus was on the period in which the present-day green building standards were developed, and eventually adopted. The main issues discussed in the first section were the global efforts towards sustainable growth, and new market-driven environmental regulations. In the 1990s command-and-

control gave way to cap-and-trade. Economy turned green at all scales, co-opting the imperative of sustainable development for its own purposes while global markets expanded due to a series of epoch-making events – the collapse of Communism, opening of Chinese markets, and the signing of NAFTA. The aim was to understand the agendas that shaped the green movement in architecture, and determined the motivations of third-party rating organizations, most famously the U.S. Green Building Council. USGBC's LEED program emerged as an island in an expanding sea of unsustainable construction accelerated by increasingly deregulated mortgage market which promoted financial rather than material obsolescence as a reason for new construction. The second section concentrated on the events triggered by the subprime mortgage crisis, and the coinciding with them adoption of first green building standards. It emphasized the ironic contrast between the agendas that shaped the green building standards, and the actual impact of construction during the housing boom. The effects of the bubble, a massive wave of foreclosures, and thousands of abandoned houses, made the limitations of the green construction standards even more evident. Green construction might have in part emerged in reaction to growth-driven economy, but it evolved to serve it, and its nature was determined by it. In fact, when the stimulus acts were passed, they again co-opted the energy-efficiency discourse to relaunch the collapsed economy. Yet, this time, they were stronger: energy conservation efforts were re-validated by the climate change discourse. While undeniably fundamental, global warming provided another reason to re-launch energy efficiency as a national imperative, and to largely ignore other, on-going, environmental emergencies while salvaging economy.

7.3. Mechanics: Economic Incentives and Building Regulations.

The events, ideas, and programs that gradually connected the knowing of nature – science of ecology, with the making of domestic architecture – art of building, also exposed the double, and from an ecological perspective, troublesome nature of technology. More than just an interface between nature's and man's economies, technology, and its technics and artifacts, serves as a profit-making hinge. Rather than curbing growth, green standards indirectly supported it. It became quickly clear that market-driven interests influenced environmental action in the same way in which they once influenced the social reform. Back then, by co-opting the health and welfare discourse, and later under the green banner of sustainability, policy-makers and standard-setters used their technics to help promote artifacts which perpetuate economic growth. As a result, a study of the actual impact of green building standards would be incomplete if it only addressed coercive methods, without paying attention to the technics of

incentivization, and the types of green appliances and construction systems that they promote. It is together that technological artifacts, subsidies, and regulations define sustainability in architecture, and this issue was explored in the two chapters that make Part 2 – Mechanics.

The first chapter of the second part, Chapter 5 – Quid pro Quo, focused on the technics of incentivization employed to popularize specific green building standards, by promoting associated with them technological artifacts. The overall objective in the first section was to revisit the critique of growth-based economy focusing on the role of technology as a matrix for socioeconomic choices, and a tool in the hands of the market. Although green economy, and its clever interpretation of the sustainable discourse was already mentioned in the previous chapter, here the aim was to better understand (though the writings of Gorz, Illich, Ellul, and Mumford) the mechanisms that enabled this success, and determined the failure of other alternative technologies, such as those promoted by the Appropriate Technology movement. What was emphasized in this section was the tendency to favor planned obsolescence, relentless innovation, and artificially-stimulated consumption, tendency still evident in the present-day green construction standards, and in the technics of incentivization used to promote products that comply with them. While the first section tried to understand the puzzling double role of technology – an engine of growth, and a means used to curb it, the second section concentrated on the consequences of using a market tool (financial incentives) to address a market failure. The objective was to examine the reasons for the choice of incentives rather than regulations, and to understand the impact of this decision. The goal in the third section was to identify the exact alternative solutions that authorities subsidize, and to understand the significance of the tools and channels that are used to distribute funding, in terms of social, environmental, and economic results, and for a better understanding of the underlying agendas. A quick analysis of two databases confirmed the predominance of energy-related programs, and prevalence of active mechanical solutions. The side effects of this approach to sustainability were the topic of the last section. The goal here was to understand the consequences of an attitude that promotes specific artifacts rather than environmental objectives, and favors an isolated aspect of sustainability, specifically energy efficiency coupled with reduction of greenhouse gas emissions.

In the last chapter of the second part, Chapter 6 – *The Meta-Code*, the focus was on the meta-architecture of the building code. In each section, a particular aspect of the environment – insulation materials, water management, air quality, and vegetation – helped explore a facet of the regulatory landscape – the network of rule-makers; the internal structure of the code; and the meta-rules that define how each individual prescription is written. The first section which focused on foam plastic

insulation highlighted the inevitable conflicts triggered by the complex architecture of the code authored by multiple and disconnected authors and authorities. In the second section, the complex geography of rule-making was juxtaposed against the boundaries of watersheds to explore the structural reasons for poor coordination between the human needs and ecological challenges. The third section focused on standards that control air quality, to explore how the structure and connections between individual parts of the code reflect interactions between different, and at times conflicting interests of various professions, trades, and state authorities. The last section re-examined the previously addressed issues, this time concentrating on the way in which individual standards are expressed to limit the agency of involved actors and reduce risk. This deeper analysis of the regulations applied to shading, insulation, water treatment, and air quality demonstrated how the meta-code precisely defines and restricts the involvement of certain actors: it minimizes user engagement, and simply dreads vegetation.

The internal rules – be it prescriptive or performance-oriented, product- or process-driven – clearly determine what is admissible, and how it can be achieved. In the meantime, the *unsustainable* is difficult to locate, it resides at a deeper level, is more dispersed, and cannot be fixed by amending a specific regulation. The crystalized structure of the building code, and the circuits from which it originates affect our capacity to transform new environmental ideas and programs into new forms of sustainable practice. Not only does the core of the green apparatus determine the limits of sustainability in construction, but it also supports the technological artifacts promoted with economic incentives, an instrument of the same market responsible for environmental degradation. Ultimately, conceived in circuits deeply engrained in the regulatory landscape, embodiments of technological assemblages embraced by the real-estate market, American houses are frenetically built, flipped, and demolished, but the American house resists change. Only a colossal event can reconfigure such a crystalized landscape, and project the house into another less prescriptive circuit. The trouble is that it is hard to tell whether one should fear or hope for such a revolutionary quake.

7.4. Expressions: Implications and Further Research.

Meanwhile, *underwritten* by science and technology, codes administer space, and ultimately redesign it. Cedric Price once said: "Technology is the answer – but what was the question?"[2] The question, most of

[2] Quoted by John Frazer in "Computing without Computers," an essay which appeared in a 2005 issue of AD: *The 1970s is Here and Now* (Frazer 2005, 43).

us now think, should be concerned with restraint in the use of environmental resources, and preservation of living communities. However, it cannot be separated from questions regarding the regulations which norm these issues, simultaneously defining and obliterating the environment. In other words, the codes may not be the answer, but they are definitely part of the question that we are faced with as designers. If we wish to minimize buildings' disruptive impact on the environment, and above all, strengthen our relationship with living systems, we need to interrogate the warp and woof of regulatory mechanisms which alter the way in which we perceive them, and *pre-design* the way we act upon them. The overarching ambition of this study was to expose how the technological imperative – the one embraced by western societies – affects our judgment of what is environmentally appropriate, good, and beautiful, and to show how its mechanisms redefine our valuation of nature. The objective was to understand how the "ecofascism" that Gorz saw hidden in the basic premises behind *The Limits to Growth* has redefined our relationship with the environment through an interface called green technology, and ultimately how this redefinition has been subsidized with federal incentives and legitimated by green building standards. Standards that consider trees, users, and *passive* design solutions as inconvenient, unpredictable, and inefficient. A grammar which limits human operations and does not allow *vegetative expressions*. The fact that neither a tree, nor a form-based, energy-conserving system designed by an architect will receive a tax write-off, is simply because neither the latter nor the former stimulate economic growth the way a solar panel does it. Neither a tree, nor an ingenious building envelope generate enough megawatts of renewable energy to compete with it. "Shading shall not cast a shadow," a prescription found in the *Green Building Standards Code*, best reflects this bias. It exemplifies how construction standards support a specific technological interface powered by active mechanical devices and driven by a one-dimensional quest for energy efficiency. An interface that serves the economy and relies on a range of techniques - building regulations and financial incentives first among them.

Several possible themes for future research emerge from this analysis of the *greening* of the rule-making circuits. Firstly, an interrogation of the impact of construction that goes beyond the operations, through embodied energy and water footprint; into the politics of material extraction, transportation, and disposal of construction waste. While these issues have been subject of research, practice, and recently also code-

making,[3] the topic, when addressed within the context of code-making, requires a telescopic lens capable of capturing both the meta-rules, and the *mega-landscape*. Rather than quantitative, such research should be cartographic, it should go beyond energy budgets, into map-making. Secondly, an examination of the excessive permissiveness towards material and financial obsolescence as affected by, on one hand tax depreciation rates and mortgage terms, and on the other hand the life of materials as expressed in manufacturer warranties.[4] Thirdly, an inquiry into the impact of zoning ordinances on the way in which individual house lots affect the structure and functioning of urban landscapes, can support biodiversity, and provide habitat, stepping stones, and corridors for urban wildlife. Last but not least, what awaits to be addressed in creative and joyful terms, is a long-overdue breach in the code which will allow *vegetative expression* back in. As it became clear in the last section of the closing chapter, this type of inquiry will have to address the very limits of the regulatory language, its meta-code. Hopefully, to paraphrase Reyner Banham, it would not be filed under Gardening.[5] A final word of warning to those who will eventually take up these challenges. In his *Tools for Thought*, Waddington succinctly stated: "'Reductionism is a recipe for action: (…) it is the belief that if you are confronted with a complex situation, for instance a living system, your best bet to get some sort of pay-off or other is to look for the physical or chemical factors which can influence the phenomenon in question." He then adds: "Undoubtedly, the 'thing' view 'works', up to a point (…)" (1977, 23). Yet, beyond the 'thing' there are ecological 'processes', and since we are part of them, we should not underestimate, among other 'things', the operations performed by users, the minds of code-makers, and the landscapes from which we extract materials.

The code imposes spatial organizations, determines design solutions, and limits material choices. It striates space, and punctuates time to augment efficiency, reduce risk, and maintain order. It regulates how architects act upon the environment and shapes our notions of sustainability and ecology. Together with economic incentives and green technologies, building regulations determine the character of the American house, and the nature of environmental awareness. Together with voluntary guidelines,

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[3] Among recent scholarship that follows in on H.T. Odum's steps, and addresses energy systems in architecture, one should mention: *Architecture and Systems Ecology: Thermodynamic Principles of Environmental Building Design, in Three Parts* (Braham 2016); and *The Hierarchy of Energy in Architecture: Emergy Analysis.* (Srinivasan and Moe 2015). Jane Hutton's forthcoming book *Reciprocal Landscapes* explores the connections between specification of materials and transformation of extraction landscapes and has been an inspiration in the course of this study. The *CALGreen Code* extensively discussed in this research contains the **Division 4.4. Material Conservation and Resource Efficiency**.

[4] Again, this issue has been extensively discussed - *Obsolescence: An Architectural History* (Abramson 2016) tackles this issue, also in relation to sustainability - but without addressing the role of building regulations.

[5] The closing sentence in Banham's *The Architecture of the Well-Tempered Environment* is: "This book must no longer be filed under Technology" ([1969] 1984, 312).

mandatory codes and ordinances standardize lives of households, and normalize the daily activities of their dwellers. They define minute details of the apparatuses in which we are captured. It is the precise regulation of the most banal and seemingly insignificant details that constitutes the substrate of architectural praxis, and determines the way we build, and interact with the environment. This substrate must be constantly questioned for the sake of the health of ecology, and the joy of architectural praxis. The ambition of this research was to reopen this conversation.

BIBLIOGRAPHY

Books, Essays, Articles, and Papers:

Ábalos, Iñaki. 2001. *The Good Life*. Barcelona, Spain: Editorial Gustavo Gili.

Adshead, Julie, and International Council for Research and Innovation in Building, and Construction. 2011. *Green Buildings and the Law.* London; New York: Spon Press.

Agamben, Giorgio. 2009. "What is an Apparatus?" In *What is an Apparatus? And Other Essays.* Stanford, CA: Stanford University Press.

———. 2005. *State of Exception.* Chicago: University of Chicago Press.

Alexander, Christopher. 1964. *Notes on the Synthesis of Form*. Cambridge, MA: Harvard University Press.

Anielski, Mark.2007. *The Economics of Happiness.* Gabriola Island, B.C.: New Society Publisher.

Baer, William C. 2011. "Customs, Norms, Rules, Regulations and Standards in Design Practice." In Companion to Urban Design, edited by Tridib Banerjee, and Anastasia Loukaitou-Sideris. New York: Routledge.

Banham, Reyner. (1969) 1984. *The Architecture of the Well-Tempered Environment.* Chicago, ILL: University of Chicago Press.

———. 1965. "A Home is not a House." *Art in America*, vol.2: 70-79.

Bateson, Gregory. (1972) 2000. *Steps to an Ecology of Mind.* Chicago, ILL: University of Chicago Press.

———. (1979) 2002. *Mind and Nature: A Necessary Unity.* Creskill, NJ: Hampton Press.

Braham, William W. 2016. *Architecture and Systems Ecology: Thermodynamic Principles of Environmental Building Design in Three Parts.* Abingdon, UK; New York, NY: Routledge.

Beck, Ulrich. (2007) 2009. *World at Risk*. Cambridge, UK: Polity Press.

———. (1991) 1995. *Ecological Enlightenment*. Amherst, NY: Humanity Books.

———. (1986) 1992. *Risk Society.* London, UK; Newbury Park, CA; New Delhi: SAGE Publications.

Ben-Joseph, Eran. 2012. *Rethinking a Lot: The Design and Culture of Parking*. Cambridge, MA: The MIT Press.

———. 2005. *Code of the City: Standards and the Hidden Language of Place Making.* Cambridge, MA: The MIT Press.

Benyus. Janine. (1997) 2002. *Biomimicry: Innovation Inspired by Nature.* New York, NY: Harper Perennial.

Bergdoll, Barry, Peter Christensen, Ron Broadhurst, and Modern Art Museum of. 2008. *Home Delivery: Fabricating the Modern Dwelling*. New York, NY: Museum of Modern Art.

Berger, Alan. 2007. *Drosscape: Wasting Land in Urban America.* Princeton, NJ: Princeton Architectural Press

Bijker, Wiebe E., Hughes, Thomas, and Tevor J. Pinch, eds. 1987. *The Social Construction of Technological Systems*. Cambridge, MA: MIT Press.

Botkin, Daniel B. 1990. *Discordant Harmonies: A New Ecology for the 21st Century.* New York, NY; Oxford, UK: Oxford University Press.

Canguillhem, Georges. 1994. *A Vital Rationalist: Selected Writings*, edited by Francois Delaporte. New York: Zone Books.

Caradonna, Jeremy L. 2014. *Sustainability.* New York, NY: Oxford University Press.

Carson, Rachel. (1962) 2002. *Silent Spring.* Boston, MA: Houghton Mifflin.

Chang, Ha-Joon. 2010. *23 Things They Don't Tell You about Capitalism.* London, UK: Penguin Books.

Circo, Carl. 2008. "Using Mandates and Incentives to Promote Sustainable Construction and Green Building Projects in the Private Sector: A Call for More State Land Use Policy Initiatives." *Pen State Law Review*, vol. 112, no. 3: 731-782. Retrieved April 15, 2017. http://www.pennstatelawreview.org/articles/112%20Penn%20St.%20L.%20Rev.%20731.pdf

"Contrasting Concepts of Harmony in Architecture," debate between Christopher Alexander and Peter Eisenman. Accessed September 24, 2016: http://www.katarxis3.com/Alexander_Eisenman_Debate.htm

Commoner, Barry. 1972. *The Closing Circle.* New York, NY: Alfred A. Knopf.

Crist, Eileen. 2007. "Beyond the Climate Crisis: A Critique of Climate Change Discourse." *Telos 141* (Winter 2007): 29–55.

Craul Philip J. 1992. *Urban Soils. Applications and Practices.* New York, NY: John Wiley.

Cushing, Lara J., Madeline Wander, Rachel Morello-Frosch, Manuel Pastor, Allen Zhu, and James Sadd. 2016. *A Preliminary Environmental Equity Assessment of California's Cap-And-Trade Program.* Retrieved January 28, 2017. http://dornsife.usc.edu/assets/sites/242/docs/Climate_Equity_Brief_CA_Cap_and_Trade_Sept2016_FINAL2.pdf

DeKay, Mark, and G. Z. Brown. (1985) 2014. *Sun, Wind, and Light: Architectural Design Strategies*. Hoboken, NJ: John Wiley & Sons.

De Landa, Manuel. 2000. *A Thousand Years of Nonlinear History.* New York, NY: Zone Books, Swerve Editions.

Daly, Herman. 1996. *Beyond Growth: The Economics of Sustainable Development.* Boston, MA: Beacon Press.

———. (1977) 1991. *Steady-State Economics.* Washington, D.C.: Island Press.

Daniels, Thomas L. 2009. "A Trail across Time: American Environmental Planning from City Beautiful to Sustainability." *Journal of the American Planning Association*, vol. 75, no. 2 (Spring 2009): 178-192

Davis, Mike. (1990) 2006. *City of Quartz: Excavating the Future in Los Angeles*. London, UK; New York, NY: Verso.

———. 1998. *Ecology of Fear: Los Angeles and the Imagination of Disaster.* New York, NY: Metropolitan Books.

Deleuze, Gilles. (1986) 1988. *Foucault*. Minneapolis: University of Minnesota Press.

Deleuze, Gilles, and Félix Guattari. (1980) 1987. *A Thousand Plateaus: Capitalism and Schizophrenia.* London, UK: Athlone Press.

Easterling, Keller. 1999. *Organization Space: Landscapes, Highways, and Houses in America.* Cambridge, MA: MIT Press.

Eichler, Ned. 1982. *The Merchant Builders.* Cambridge, MA: MIT Press.

Elliott, Donald L. 2008. *A Better Way to Zone: Ten Principles to Create More Livable Cities*. Washington, DC: Island Press.

Ellul, Jacques. (1954) 1964. *The Technological Society*. New York: Vintage Books.

Faber, Daniel A. 2012. "Pollution Markets and Social Equity: Analyzing the Fairness of Cap and Trade," *39 Ecology L.Q.* 1. Retrieved January 28, 2017. http://scholarship.law.berkeley.edu/cgi/viewcontent.cgi?article=3047&context=facpubs

Farah, Paolo Davide, and Cima Elena. 2015. "World Trade Organization, Renewable Energy Subsidies and the Case of Feed-In Tariffs: Time for Reform toward Sustainable Development?" *Georgetown International Environmental Law Review*, vol. 27, no.1 (2015):515-537. Retrieved February 26, 2017. https://papers.ssrn.com/sol3/papers2.cfm?abstract_id=2704398

Forman, Richard T.T. 2014. *Urban Ecology: Science of Cities.* New York, NY: Cambridge University Press.

Foucault, Michel. (1975) 1995. *Discipline and Punish: The Birth of the Prison*. New York: Vintage Books

Frampton, Kenneth. 2008. *American Masterworks: Houses of the 20th and 21st Centuries.* Rev. Ed. New York, NY: Rizzoli.

Gartland, Lisa. 2008. *Heat Islands: Understanding and Mitigating Heat in Urban Areas*. London, UK: Earthscan.

Givoni, Baruch. (1969) 1981. *Man, Climate and Architecture.* New York, NY: Van Nostrand Reinhold.

Gorz, André. (1975) 1987. *Ecology as Politics.* London: Pluto Press

Grant, George Parkin. 1998. "Technology and Modernity." In *The Grant Reader,* edited by William Christian, and Sheila Grant. Toronto, Canada: University of Toronto Press.

———. 1986. "Thinking about Technology." In *Technology and Justice*. Toronto, Canada: Anansi.

Grober, Ulrich. 2012. *Sustainability. A Cultural History*. Devon, UK: Green Books.

Guattari, Félix. (1992) 1995. "Machinic Heterogenesis." In *Chaosmosis, an Ethico-Aesthetic Paradigm.* Indianapolis, IN: Indiana University Press.

———. (1989) 2008. *The Three Ecologies.* London, UK: Continuum.

———. 1984. *Molecular Revolution: Psychiatry and Politics*. Harmondsworth, UK; New York, NY: Penguin.

Hardt, Michael, Antoni Negri. 2001. *Empire*. Cambridge, MA: Harvard University Press.

Hawken, Paul, Amory Lovins, and L. Hunter Lovins. 1999. *Natural Capitalism: Creating the Next Industrial Revolution*. New York, NY; Boston, MA; London, UK: Little, Brown and Company.

Hayden, Dolores. (1984) 2002. *Redesigning the American Dream*. New York, NY: W.W. Norton & Company

———. 1981. *The Grand Domestic Revolution: A history of feminist designs for American Homes, Neighborhoods, and Cities.* Cambridge, MA: MIT Press.

Heinberg, Richard. 2011. *The End of Growth. Adapting to our New Economic Reality.* Gabriola Island, BC: New Society Publisher.

Hight, Christopher. 2014. "Designing Ecologies." In *Projective Ecologies*, edited by Chris Reed, and Nina-Marie E. Lister. Cambridge, MA; New York, NY: Harvard GSD, Actar.

Hise, Greg. 1997. *Magnetic Los Angeles: Planning the Twentieth-Century Metropolis.* Baltimore, MD: Johns Hopkins University Press.

Hise, Greg, and William Deverell. 2000. *Eden by Design: The 1930 Olmsted-Bartholomew Plan for the Los Angeles Region*. Berkeley: University of California Press.

Hornstein, Jeffrey M. 2005. *A Nation of Realtors. A Cultural History of the Twentieth-Century American Middle Class*. Durham, NC: Duke University Press.

House Housing: An Untimely History of Architecture and Real Estate. Hoyne Buell Center for the Study of American Architecture at Columbia University Research Project, 2013-16. Accessed October 13, 2016: http://www.house-housing.com/

Huge, Elijah, and Stephanie Tuerk, eds. 2004. *Perspecta 35: Building Codes*. New Haven, CT: MIT Press.

Hughes, Thomas. 1994. "Technological Momentum." In *Does Technology Drive History?* edited by Merritt Roe Smith, and Leo Marx. London, UK; Cambridge, MA: MIT Press.

Hyde, Timothy, and Aggregate Group, eds. 2014. *Governing by Design*. Pittsburgh: University of Pittsburgh Press, Project MUSE. Retrieved January 28, 2015. http://muse.jhu.edu.ezp-prod1.hul.harvard.edu/books/9780822977896/

Illich, Ivan. 1973. *Tools for Conviviality*. New York, NY: Harper and Row.

Immergluck, Dan. 2009. *Foreclosed. High-Risk Lending, Deregulation, and the Undermining of America's Mortgage Market.* Ithaca, NY: Cornell University Press.

Imrie, Rob, and Emma Street. 2011. *Architectural Design and Regulation.* London: Wiley-Blackwell.

Jacobs, Jane. (1961) 1992. *The Death and Life of Great American Cities.* New York, NY: Vintage Books.

Jackson, Tim. (2010) 2017. *Prosperity without Growth.* London, UK; New York, NY: Routledge.

Klein, Naomi. 2015. *This Changes Everything: Capitalism vs. the Climate*. New York, NY: Simon & Schuster.

Knowles, Ralph. 2003. "The Solar Envelope: Its Meaning for Energy and Buildings." *Energy and Buildings* 35 (2003): 15–25.

———. 1974. *Energy and Form; an Ecological Approach to Urban Growth.* Cambridge, MA: MIT Press.

Lamprecht, Barbara. 2000. Neutra: Compete Works. Koln: Taschen.

Lemonier, Aurelien, and Frederic Migayrou, eds. 2015. Frank Gehry. Munich, London, New York, NY: Prestel

Leopold, Aldo. 1949. *A Sand County Almanac, and Sketches Here and There.* New York NY: Oxford University Press.

Lewyn Michael, and Kristoffer Jackson. 2014. "How Often Do Cities Mandate Smart Growth or Green Building?" *Mercatus Working Paper*, Mercatus Center, George Mason University. Retrieved February 16, 2017. https://www.mercatus.org/system/files/Lewyn-Mandating-SmartGrowth.pdf

Lovins B. Amory. 1977. *Soft Energy Paths: Towards a Durable Peace.* New York, NY: Harper Colophon

MacKenzie, Donald, and Judy Wajcman, eds. [1985] 1999. *The Social Shaping of Technology*. Buckingham, UK; Philadelphia, PA: Open University Press.

Marsh, George P. 1864. *Man and Nature; or, Physical Geography as Modified by Human Action.* New York, NY: Charles Scribner.

Massey, Jonathan. 2012. "Risk and Regulation in the Financial Architecture of American Houses." In *Governing by Design: Architecture, Economy, and Politics in the Twentieth Century,* edited by Timothy Hyde, and Aggregate Group. Pittsburgh, PA: University of Pittsburgh Press, Project MUSE. Accessed January 28, 2015. http://muse.jhu.edu.ezp-prod1.hul.harvard.edu/books/9780822977896/

McAlester, Virginia, Savage. 2015. *A Field Guide to American Houses.* Rev. Ed. New York, NY: Alfred A. Knopf.

McCoy, Esther. 1977. *Case Study Houses,* 1945-1962. 2d Ed. Los Angeles, CA: Hennessey & Ingalls.

McDonnell, M. J. 2011. "The History of Urban Ecology: An Ecologist's Perspective." In Urban Ecology: Patterns, Processes and Applications, edited by Jari Niemelä, Jürgen H. Breuste, Thomas Elmqvist, Glenn Guntenspergen, Philip James and Nancy E. McIntyre. Oxford, UK: Oxford University Press.

McHarg, Ian L. 1969 (1992). *Design with Nature.* New York, NY: J. Wiley.

McKenzie, Evan. 1994. *Privatopia. Homeowner Associations and the Rise of Residential Private Government*. New Haven, CT; London, UK: Yale University Press.

McLuhan, Marshall. 1964. *Understanding Media*. New York, NY: The New American Library.

Mishan, Ezra J. 1967. *The Cost of Economic Growth.* New York, NY: F.A. Praeger

Moore, Steven A., and Barbara B. Wilson. 2014. *Questioning Architectural Judgment: The Problem of Codes in the United States.* London. UK; New York, NY: Routledge.

Morton, Timothy. 2013. *Hyperobjects: Philosophy and Ecology after the End of the World.* Minneapolis, MN: University of Minnesota Press.

———. 2010. *The Ecological Thought.* Cambridge, MA: Harvard University Press.

Mumford, Lewis. 1970. *The Pentagon of Power*. New York, NY; London, UK: A Harvest/HBJ Book, Harcourt Brace Jovanovich.

———. 1964. "Authoritarian and Democratic Technics." *Technology and Culture,* Vol. 5, No. 1, (Winter, 1964): 1-8

———. (1934) 2010. *Technics and Civilization.* Chicago, ILL: University of Chicago Press.

———. 1927. "Regionalism and Irregionalism." *The Sociological Review*, Vol.19 (4): 277-288.

Nadel, Steven. 2012. "Energy Efficiency Tax Incentives in the Context of Tax Reform." An ACEE Working Paper. New York, NY: American Council for an Energy-Efficient Economy. Retrieved April 15, 2017. http://aceee.org/files/pdf/white-paper/energy-efficiency-tax-incentives.pdf

Odum, Howard T. (1983) 1994. *Ecological and General Systems: An Introduction to Systems Ecology.* Rev. Ed. Niwot, CO: University Press of Colorado.

———. 1973. "Energy, Ecology and Economics." *AMBIO: A Journal of the Human Environment* 2 (6): 220-227

———. 1971. *Environment, Power, and Society.* New York, NY: John Wiley & Sons.

Olgyay, Victor. 1963. *Design with Climate: Bioclimatic Approach to Architectural Regionalism*, edited by Aladar Olgyay. Princeton, NJ: Princeton University Press.

Pasquinelli, Matteo. 2015. *What An Apparatus Is Not: On the Archeology of the Norm in Foucault, Canguilhem, and Goldstein.* Parrhesia; no.22: 79-89.

Pearce, David. 1992. "Green Economics." *Environmental Values* 1 (1992): 3-13. doi: 10.3197/096327192776680179

Pearce, David, Anil Markandya, Edward Barbier. 1989. *Blueprint for a Green Economy.* London, UK: Earthscan Publications Ltd.

Perrow, Charles. 1984. *Normal Accidents: Living with High-Risk Technologies.* Princeton, NJ: Princeton University Press.

Pfaffenberger, Bryan. 1992. "Technological Dramas." *Science, Technology, & Human Values,* Vol. 17, No. 3, (Summer, 1992): 282-312.

Pimm, Stuart L. 1991. *The Balance of Nature? Ecological Issues in the Conservation of Species and Communities.* Chicago, ILL: University of Chicago Press.

Pollan, Michael. 2001. *The Botany of Desire: A Plant's Eye View of the World.* New York, NY: Random House.

———. (1997) 2008. *A Place of My Own: The Architecture of Daydreams*. New York, NY: Penguin Group.

———. 1991. *Second Nature: A Gardener's Education*. New York: Grove Press.

Prigogine, Ilya, and Isabelle Stengers. 1984. *Order out of Chaos: Man's New Dialogue with Nature.* New York, NY: Bantam Books.

Reisner, Marc. 1993. *Cadillac Desert: The American West and its Disappearing Water.* New York, NY: Penguin Books.

Rittel, Horst W. J., and Melvin M. Webber. 1973. "Dilemmas in a General Theory of Planning." *Policy Sciences*, vol. 4, no. 2 (June, 1973): 155-169.

Rybczynski, Witold. 1986. *Home: A Short History of an Idea.* New York, NY: Viking.

———. (1980) 1991. *Paper Heroes.* New York, NY: Penguin Books.

Schumacher, E.F. 1973. *Small is Beautiful, Economics as if People Mattered.* New York, NY: Perennial.

Simon, Herbert A. 1962. "Architecture of Complexity." *Proceedings of the American Philosophical Society* 106 (6): 467-82.

———. (1969) 1996. *The Science of the Artificial.* Cambridge, MA: MIT Press.

Srinivasan, Ravi, and Kiel Moe. 2015. *The Hierarchy of Energy in Architecture: Emergy Analysis.* Abingdon; New York, NY: Routlede.

Tabb, Phillip, and A. Senem Deviren. 2013. *The Greening of Architecture: A Critical History and Survey of Contemporary Sustainable Architecture and Urban Design*. Burlington, VT: Ashgate.

Talen, Emily. 2012. *City Rules: How Regulations Affect Urban Form.* Washington, DC: Island Press.

Timmermans, Stefan, and Steven Epstein. 2010. "A World of Standards but not a Standard World: Toward a Sociology of Standards and Standardization." *Annual Review of Sociobiology* 36: 69–89.

Uexküll, Jakob von. (1934) 2010. *A Foray into the Worlds of Animals and Humans: With a Theory of Meaning.* Minneapolis: University of Minnesota Press.

Victor, Peter. 2008. *Managing without Growth: Slower by Design, Not Disaster.* Cheltenham, UK; Northampton, MA: Edward Elgar Publishing

Wackernagel, Mathis, and William Rees. 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth.* Gabriola Island, BC: New Society Publisher.

Waddington, C. H. 1977. *Tools for Thought.* London, UK: Jonathan Cape.

Waldie, D. J. 1996. *Holy Land: A Suburban Memoir.* New York, NY: W.W. Norton.

Weber, Max. 1905 (1993). *The Protestant Ethic and the Spirit of Capitalism*. London, UK; New York: Rutledge.

Weiss, Marc A. 1987. *The Rise of the Community Builders: The American Real Estate Industry and Urban Land Planning.* New York, NY: Columbia University Press.

Whitehead, Alfred North. (1925) 1997. *Science of the Modern World.* New York, NY: The Free Press.

Wilson, Edward O. 1984. *Biophilia*. Cambridge, MA: Harvard University Press.

Winner, Langdon. (1985) 1999. "Do Artifacts Have Politics?" In *The Social Shaping of Technology*, edited by Donald MacKenzie and Judy Wajcman. Buckingham, UK; Philadelphia, PA: Open University Press.

———. 1977. *Autonomous Technology.* Cambridge, MA; London, UK: MIT Press.

Wolfson, Mariel. 2012. "The Ecology of a Healthy Home: Energy, Health, and Housing in America, 1960-1985." Ph.D. diss., Harvard University. Retrieved January 15, 2017. http://search.proquest.com.ezp-prod1.hul.harvard.edu/docview/1170999152?accountid=11311 PDF

Worster, Donald. (1977) 1996. *Nature's Economy: A History of Ecological Ideas*. Cambridge, MA; New York, NY: Cambridge

University Press.

Wright, Frank Lloyd. 1954. *The Natural House.* New York, NY: Horizon Press.

Wu, Jianguo, Chunyang He, Ganlin Huang, and Deyong Yu. 2013. "Urban Landscape Ecology: Past, Present, and Future." In *Landscape Ecology for Sustainable Environment and Culture*, edited by B. Fu and K. B. Jones. Dordrecht, Netherlands: Springer Science+Business Media. doi: 10.1007/978-94-007-6530-6_3

Reports:

Aquacraft, Inc. Water Engineering and Management. 2011. *California Single Family Water Use Efficiency Study*. Retrieved November 18, 2017. http://www.irwd.com/images/pdf/save-water/CaSingleFamilyWaterUseEfficiencyStudyJune2011.pdf

Alliance Commission on National Energy Efficiency Policy. 2013. *The History of Energy Productivity.* Retrieved October 13, 2016: https://www.ase.org/sites/ase.org/files/resources/Media%20browser/ee_commission_history_report_2-1-13.pdf

Alliance for Water Efficiency. 2016. *The Status of Legislation, Regulation, Codes & Standards on Indoor Plumbing Water Efficiency.* Retrieved February 16, 2017. http://www.allianceforwaterefficiency.org/WorkArea/DownloadAsset.aspx?id=9538

Anders Scott, Grigsby, Kevin, Adi Kuduk, Carolyn, Day, Taylor, Frost, Allegra, and Joe Kaatz, 2014. *California's Solar Rights Act: A Review of the Statutes and Relevant Cases.* San Diego, CA: The Energy Policy Initiatives Center (EPIC) University of San Diego School of Law. Retrieved April 14, 2017. https://lib.sandiego.edu/law/documents/centers/epic/Solar%20Rights%20Act-A%20Review%20of%20Statutes%20and%20Relevant%20Cases.pdf

Anders Scott, Grigsby, Kevin, Adi Kuduk, Carolyn, and Taylor Day. 2010. *California's Solar Shade Control Act: A Review of the Statutes and Relevant Cases*. San Diego, CA: The Energy Policy Initiatives Center (EPIC) University of San Diego School of Law. Retrieved April 14, 2017. https://lib.sandiego.edu/law/documents/centers/epic/100329_SSCA_Final_000.pdf

California Energy Commission (CEC). 2015a. *Reference Appendices*. Retrieved December 17, 2017. http://www.energy.ca.gov/2015publications/CEC-400-2015-032/CEC-400-2015-032-CMF.pdf

California Energy Commission (CEC). 2015b. *Residential Alternative Calculation Method Reference Manual*. Retrieved December 17, 2017. http://www.energy.ca.gov/business_meetings/2016_packets/2016-06-14/Item07_ACM%20Ref%20Manuals/2016%20Res%20ACM%20Ref%20Manual%20June%202016.pdf

California Energy Commission (CEC). 2015c. *Residential Compliance Manual.* Retrieved December 17, 2017. http://www.energy.ca.gov/2015publications/CEC-400-2015-032/CEC-400-2015-032-CMF.pdf

City of Los Angeles Department of Water and Power. 2015a. *Urban Water Management Plan.* Retrieved November 12, 2017. https://www.ladwp.com/cs/idcplg?IdcService=GET_FILE&dDocName=QOELLADWP005416&RevisionSelectionMethod=LatestReleased

City of Los Angeles Department of Water and Power (LADWP). 2015b. *Stormwater Capture Mast Plan.* Retrieved November 12, 2017. https://www.ladwp.com/ladwp/faces/wcnav_externalId/a-w-stormwatercapturemp?_afrLoop=51943077182146&_afrWindowMode=0&_afrWindowId=null#%40%3F_afrWindowId%3Dnull%26_afrLoop%3D51943077182146%26_afrWindowMode%3D0%26_adf.ctrl-state%3Dgcsqwlle3_4

Copeland, Claudia. 2016. *Clean Water Act: A Summary of the Law. CRS Report No. RL30030.* Washington, D.C.: Congressional Research Service. Retrieved October 13, 2016. https://fas.org/sgp/crs/misc/RL30030.pdf

County of Los Angeles Department of Public Works. 2017. *Water Resilience Plan: Rapid Assessment*. Retrieved November 13, 2017. https://dpw.lacounty.gov/wrp/docs/Rapid-Needs-Assessment.pdf

Crandall-Hollick, Margot L. and Molly F. Sherlock. 2016. *Residential Energy Tax Credits: Overview and Analysis*. *CRS Report No. R42089*. Washington, D.C.: Congressional Research Service. Retrieved April 13, 2016. https://fas.org/sgp/crs/misc/R42089.pdf

Cunningham, Lynn J. 2016. *Renewable Energy and Energy Efficiency Incentives: A Summary of Federal Programs*. *CRS Report No. R40913*. Washington, D.C.: Congressional Research Service. Retrieved April 13, 2016. https://fas.org/sgp/crs/misc/R40913.pdf

Davidson, Adam, and Alex Blumberg. 2009. "355: The Giant Pool of Money." *This American Life*, Chicago Public Media, and *Planet Money*, NPR. May 9, 2009. Radio. Accessed February 20, 2017. https://www.thisamericanlife.org/radio-archives/episode/355/the-giant-pool-of-money

Earth Charter Commission. 2000. *Earth Charter.* Retrieved January 27, 2017. http://earthcharter.org/invent/images/uploads/echarter_english.pdf

Global Footprint Network, Ronna Kelly, Susan Burns, Mathis Wackernagel. 2015. *State of the States.* Retrieved February 5, 2017. http://www.footprintnetwork.org/content/images/article_uploads/USAFootprintReport_final_lores.pdf

Global Footprint Network, Brad Ewing, David Moore, Steven Goldfinger, Anna Oursler, Anders Reed, Mathis Wackernagel. 2010. *The Ecological Footprint Atlas 2010.* Oakland, CA: Global Footprint Network. Retrieved February 5, 2017. http://www.footprintnetwork.org/content/images/uploads/Ecological_Footprint_Atlas_2010.pdf

Independent Commission on International Development. 1980. *North-South: A Program for Survival.* Cambridge, MA: MIT Press.

International Union for Conservation of Nature, and Willy Brandt. 1980. *World Conservation Strategy.* Retrieved January 3, 2017. https://portals.iucn.org/library/efiles/documents/wcs-004.pdf

Kubert and Sinclair. 2011. *State Support for Clean Energy Deployment: Lessons Learned for Potential Future Policy*. Golden, CO: National Renewable Energy Laboratory. Retrieved April 15, 2017. http://www.nrel.gov/docs/fy11osti/49340.pdf

McCarthy, James E., and Claudia Copeland. 2013. *Clean Air Act: A Summary of the Act and Its Major Requirements. CRS Report No. RL30853*. Washington, D.C.: Congressional Research Service. Retrieved October 13, 2016. http://www.lankford.senate.gov/imo/media/doc/Clean%20Air%20Act%20A%20Summary%20of%20the%20Act%20and%20Its%20Major%20Requirements.pdf

McDonough & Partners. 1992. *The Hannover Principles*. Retrieved February 26, 2017. http://www.mcdonough.com/wp-content/uploads/2013/03/Hannover-Principles-1992.pdf

Meadows, Dennis, Donella Meadows, Jørgen Randers, and William W. Behrens III. 1972. *The Limits to Growth. A Report of Rome's Project on the Predicament of Mankind*. New York, NY: Universe Books.

National Institute of Building Sciences. 2003. *Part 1 of a Study of the HUD Minimum Property Standards for One- and Two- Family Dwellings and Technical Suitability of Products Programs.* Retrieved October 13, 2016. https://www.huduser.gov/portal/publications/mps_report.pdf

Quilligan, James. *The Brandt Equation: 21st Century Blueprint for the New Global Economy.* Retrieved January 12, 2017. http://www.brandt21forum.info/brandtequation-19sept04.pdf

Schierow, Linda-Jo, and David M. Bearden. 2012. *Federal Programs Related to Indoor Pollution by Chemicals. CRS Report No. RL42620.* Washington, D.C.: Congressional Research Service. Retrieved January 13, 2017. https://fas.org/sgp/crs/misc/R42620.pdf

Sherlock, Molly F. 2011. *Energy Tax Policy: Historical Perspectives on and Current Status of Energy Tax Expenditures. CRS Report No. R41227.* Washington, D.C.: Congressional Research Service. Retrieved January 13, 2017. https://www.leahy.senate.gov/imo/media/doc/R41227EnergyLegReport.pdf

Sierra Club, Red Mexicana de Acción Frente al Libre Comercio, Institute for Policy Studies, and the Council of Canadians. 2014. *NAFTA: 20 Years of Costs to Communities and the Environment.* Retrieved January 26, 2017. https://content.sierraclub.org/creative-archive/sites/content.sierraclub.org.creative-archive/files/pdfs/0642-NAFTA%20Report_05_low.pdf

United Nations Conference on Environment & Development. 1992. *Agenda 21: Program of Action for Sustainable Development.* Retrieved January 27, 2017. https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf

United Nations Environment Program. 1972. *Declaration of the UN Conference on the Human Environment*. Accessed September 28, 2016. http://www.unep.org/documents.multilingual/default.asp?documentid=97&articleid=1503

U.S. Congressional Research Service. 2003. *A Chronology of Housing Legislation and Selected Executive Actions, 1892-2003.* Washington, D.C.: Congressional Research Service. Retrieved October 13, 2016. https://www.gpo.gov/fdsys/pkg/CPRT-108HPRT92629/html/CPRT-108HPRT92629.htm

Weiss, N. Eric, and Katie Jones. 2017. *An Overview of the Housing Finance System in the United States. CRS Report No. R42995.* Washington, DC: Congressional Research Service. Retrieved January 13, 2017. https://fas.org/sgp/crs/misc/R42995.pdf

World Commission on Environment and Development. 1987. *Report of the World Commission on Environment and Development: Our Common Future*. Retrieved January 12, 2017. http://www.un-documents.net/our-common-future.pdf

Codes, and Standards:

American Society of Heating, Refrigerating and Air-Conditioning Engineers. 1975. *ASHRAE Standard: Energy Conservation in New Building Design.* New York, NY: ASHRAE.

American Society of Heating, Refrigerating and Air-Conditioning Engineers. (1966) 1974. *ASHRAE standard: Thermal Environmental Conditions for Human Occupancy.* New York, NY: ASHRAE.

American Society of Heating and Ventilating Engineers. 1922. The American Society of Heating and Ventilating Engineers Guide. New York, NY: ASHVE.

California Energy Commission. 1978. *Regulations Establishing Energy Conservation Standards for New Residential and New Nonresidential Buildings.* Sacramento, CA: The Division.

California Building Standards Commission. 2016. *Guide to Title 24. Based on the 2016 edition of Title 24.* November 22, 2017. https://www.documents.dgs.ca.gov/bsc/Title_24/Guide-to-Title-24-2016.pdf

California Building Standards Commission. 2017. *Guide to the 2016 California Green Building Standards Code. Nonresidential*. Washington, D.C.: International Code Council. Retrieved February 26, 2017.

California Building Standards Commission (CBSC). 2016a. *2016 California Residential Code. California Code of Regulations, Title 24, Part 2.5.* Washington D.C.: International Code Council.

California Building Standards Commission (CBSC). 2016b. *2016 California Mechanical Code. California Code of Regulations, Title 24, Part 4.* Ontario, CA: International Association of Plumbing and Mechanical Officials.

California Building Standards Commission (CBSC). 2016c. *2016 California Plumbing Code. California Code of Regulations, Title 24, Part 5.* Ontario, CA: International Association of Plumbing and Mechanical Officials.

California Building Standards Commission (CBSC). 2016d. *2016 California Energy Code. California Code of Regulations, Title 24, Part 6.* Washington D.C.: International Code Council.

California Building Standards Commission (CBSC). 2016e. *2016 California Green Building Standards Code. California Code of Regulations, Title 24, Part 11.* Washington D.C.: International Code Council.

California Department of Housing and Community Development. 2014. *A Guide to California Housing Construction Codes.* Retrieved November 29, 2017. http://www.hcd.ca.gov/building-standards/state-housing-law/docs/HCDSHL600.pdf

California State Los Angeles Regional Water Quality Control Board (LARWQCB). 2012. *MS4 Discharges within the Coastal Watersheds of Los Angeles County, Order No. R4-2012-0175, as amended by R4-2012-0175-A01.* Retrieved November 16, 2017. https://www.waterboards.ca.gov/losangeles/water_issues/programs/stormwater/municipal/los_angeles_ms4/2016/OrderR4-2012-0175_corrected_120216.pdf

City of Los Angeles. 2017. *Municipal Code,* "Chapter I, General Provisions and Zoning." Accessed November 15, 2017. http://library.amlegal.com/nxt/gateway.dll/California/lapz/municipalcodechapteriplanningandzoningco?f=templates$fn=default.htm$3.0$vid=amlegal:lapz_ca

City of Los Angeles. 2016. *Low Impact Development Handbook.* Retrieved November 16, 2017. *http://www.lastormwater.org/green-la/low-impact-development/lid-documents/*

City of Los Angeles. 2011. *Irrigation Guidelines.* Retrieved November 11, 2017. https://planning.lacity.org/Forms_Procedures/2405.pdf

International Conference of Building Officials. 1927. *Uniform Building Code*. Los Angeles, CA: International Conference of Building Officials.

National Board of Fire Underwriters. 1905. *National Building Code Recommended by the National Board of Fire Underwriters an Ordinance Providing for Fire Limits, and Regulations Governing the Construction, Alteration, Equipment, or Removal of Buildings or Structures*. New York, NY: James Kempster Printing Company.

Southern Building Code Congress International, American Insurance Association, Building Officials and Code Administrators International, and International Conference of Building Officials. 1971. *One and Two-Family Dwelling Code: Under the*

Nationally Recognized Model Codes. Homewood, ILL: Building Officials and Code Administrators International.

Veiller, Lawrence. 1910. *The Model Tenement House Law.* New York, NY: Charities Publication Committee.

U.S. Bureau of Standards. 1932. *Recommended Minimum Requirements for Small Dwelling Construction.* Washington, D.C.: Government Printing Office.

U.S. Bureau of Standards. 1923. *Recommended Minimum Requirements for Small Dwelling Construction.* Report of Building Code Committee, July 20, 1922, Washington, D.C.: Government Printing Office.

U.S. Federal Housing Administration. 1958. *Minimum Property Standards for One and Two Living Units.* Los Angeles, CA: Federal Housing Administration.

U.S. Federal Housing Administration. 1952. *Minimum Property Requirements for Properties of One or Two Living Units Located in the Northern California district. Rev*. Washington, D.C.: U.S. Government Printing Office.

U.S. Federal Housing Administration. 1942. *Property Standards and Minimum Construction Requirements: for Dwellings Located in the Southern California District*. Los Angeles, CA: Federal Housing Administration.

U.S. Federal Housing Administration. 1935. *Property Standards: Requirements for Mortgage Insurance under Title II of the National Housing Act*. Washington, D.C.: U.S. Government Printing Office.

Websites & Online Databases:

Database of State Incentives for Renewables & Efficiency (DSIRE). Accessed March 8, 2017. http://www.dsireusa.org/

Funding Wizard. Accessed March 8, 2017. https://fundingwizard.arb.ca.gov/

U.S. Department of Energy. “Tax Credits, Rebates & Savings.” Accessed March 8, 2017. https://energy.gov/savings/search

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2. 18 Lakewood under construction (left), the cover of *The Man in the Gray Flannel Suit* by Sloan Wilson (right). Source: Garnett, William A, *Suburban development under construction in Lakewood, California, southeast of downtown Los Angeles*, 1950. Photograph. Estate of William A. Garnett, Getty Research Institute, Los Angeles. Didion, Joan. "Trouble in Lakewood." *New Yorker*. July 26, 1993. https://www.newyorker.com/magazine/1993/07/26/trouble-in-lakewood (left), Wilson, *The Man in the Gray Flannel Suit*, 1955: cover (right).

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2. 23 *ASHRAE Standard 55* (left), diagram of the "comfort envelope" included in the standard (right). Source: American Society of Heating, Refrigerating and Air-Conditioning Engineers, *ASHRAE standard: Thermal Environmental Conditions for Human Occupancy,* 1974: cover, 4 - Fig.1.

2. 24 Rachel Carson (top left), the cover of her book *Silent Spring* (bottom left), a crop-duster spreading DDT in 1948 (right). Source: Eisenstaedt, A. *Rachel Carson,* 1962. Photograph. *Life Magazine*. February 1962 (top left), Carson, *Silent Spring*, 1962: cover (bottom left), Associated Press, *A crop-duster spreading DDT on a ranch in Oregon,* 1948. Photograph. Koehn, Nancy. "From Calm Leadership, Lasting Change." *New York Times*. October 27, 2012. http://www.nytimes.com/2012/10/28/business/rachel-carsons-lessons-50-years-after-silent-spring.html (right).

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3.2 Environmental costs: Santa Barbara Spill, 1969 (bottom left), Herman Daly (top left), the cover of his book *Steady-State Economics* (right). Grad, Shelby. *The environmental disaster that changed California — and started the movement against offshore oil drilling*, 1969. Photograph. *Los Angeles Times*. April 28, 2017. http://www.latimes.com/local/lanow/la-me-santa-barbara-spill-20170428-htmlstory.html (bottom left), Daly, Herman. "Five Policy Recommendations for a Sustainable Economy." *FEASTA Review*

1, September 2001. http://www.feasta.org/documents/feastareview/daly2.htm (top left), Daly, *Steady-State Economics*, 1977: cover (right).

3.3 Diagrams from Odum's paper "Energy, Ecology, and Economics" (left), Howard T. Odum (middle), the cover of his book *Environment, Power, and Society* (right). Source: Odum, H.T. "Energy, Ecology, and Economics." *AMBIO: A Journal of the Human Environment* 2 (6), 1973: 223 - Fig. 4, 226 - Fig.6 (left), Uncredited. Photograph. University of Florida Archives. http://www.library.ufl.edu/spec/archome/odum.jpg (middle), Odum, *Environment, Power, and Society,* 1971: cover (right).

3.4 President Nixon signing the *National Environmental Policy Act* of 1969 (left), the emblem of the Environmental Protection Agency created in 1970 (right). Source: *President Richard Nixon Signing the National Environmental Policy Act of 1969*, 1/1/1970. Photograph 2713-11. Nixon White House Photographs, 1/20/1969 - 8/9/1974. Collection RN-WHPO: White House Photo Office Collection (Nixon Administration); Richard Nixon Library, Yorba Linda, CA. https://www.docsteach.org/documents/document/nixon-sign-nepa (left), U.S. Environmental Protection Agency (right), Environmental Protection Agency. https://www.epa.gov/ (right).

3.5 *ASHRAE Standard 90-75* (left), effects of the 1973 oil embargo (right). Source: American Society of Heating, Refrigerating and Air-Conditioning Engineers, *ASHRAE Standard: Energy Conservation in New Building Design*, 1975: cover (left), Roberts, H. Armstrong, ClassicStock, Getty. *The oil crisis of 1973 showed that Hubbert's key ideas were right,* 1973. Photograph. Strahan, David. "The Oracle of Oil: The man who predicted peak oil." *New Scientist*, Review 1, June 2016. https://www.newscientist.com/article/mg23030762-700-the-man-who-predicted-peak-oil/ (right).

3.6 Balcomb House by William Lumpkins, 1979 (left), the cover of Knowles's book *Energy and Form* (middle top), Ralph Knowles and his sun machine (left). Source: "Unit One: A Solar Adobe Home." *Motherearth News*. September/October 1979. https://www.motherearthnews.com/green-homes/solar-adobe-home-zmaz79sozraw (left), Knowles, *Energy and Form*, 1974: cover (middle top), Uncredited. Photograph. https://en.wikipedia.org/wiki/File:Ralph_Knowles_using_his_Heliodon_Sun_Machine.jpg (left).

3.7 *This Old House* team at work (left), *This Old House* team as depicted on the TV show poster (left). Source: "The naked truth." *This Old House*. October 5, 2009. http://oldhousemyhouse.thisoldhouse.com/2009/10/the-naked-truth.html (left), Arizona PBS. "Wire | Let 'This Old House' Remodel or Restore Your Home." *DPJ*, December 8, 2015. http://downtownphoenixjournal.com/2015/12/08/wire-let-this-old-house-remodel-or-restore-your-home/ (left).

3.8 The cover of the *Proceedings of the World Climate Conference* (left), the World Meteorological Organization and UN Environment Program establish the Intergovernmental Panel on Climate Change IPCC (right). Source: World Meteorological Organization, *Proceedings of the World Climate Conference*, 1979: cover (left), Intergovernmental Panel on Climate Change. Photograph. UNFCCC. http://unfccc.int/files/inc/graphics/image/jpeg/tl_ipcc_1988_650.jpg (right).

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3.10 The site of the Chernobyl disaster (left), the cover of Perrow's book *Normal Accidents* (right). Source: Supinsky, Sergei, AFP, Getty Images. *The 1986 disaster remains the world's worst nuclear accident*. Photograph. Embury-Dennis, Tom. "Scientists might

be wrong about cause of Chernobyl disaster, new study claims." *The Independent.* November 21, 2017. http://www.independent.co.uk/news/world/europe/chernobyl-disaster-cause-scientists-wrong-nuclear-power-plant-accident-ukraine-study-a8067026.html (left), Perrow, *Normal Accidents*, 1984: cover (right).

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4. 4 A selection of existing eco-labels (left), the cover of the 1999 book *Natural Capitalism* co-written by Hawken, Lovins and Lovins (right). Source: "As U.S. States Look To Add Food Labels, Denmark Looks To Subtract Some." *NPR.* October 29, 2012. https://www.npr.org/sections/thesalt/2012/10/29/163869580/as-u-s-states-look-to-add-food-labels-denmark-looks-to-subtract-some (left), Hawken et al., *Natural Capitalism*, 1999: cover (right).

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4. 8 A street of newly-built homes for sale due to foreclosure. Source: Carey, Nick, Reuters. Photograph. "New Face of the Housing Crisis: The Middle Class." *The Fiscal Times.* April 5, 2012. http://www.thefiscaltimes.com/Articles/2012/04/05/New-Face-of-the-Housing-Crisis-the-Middle-Class

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5. 3 The cover of *The Pentagon of Power* (top left), Lewis Mumford (top left), Jacques Ellul (bottom right), his book *The Technological Society* (right). Source: Mumford, *The Pentagon of Power*, 1970: cover (top left), https://en.wikipedia.org/wiki/File:Lewis_Mumford_portrait.jpg (top left), Jan van Boeckel, ReRun Productions. *Jacques Ellul,* 1992. Photograph. https://commons.wikimedia.org/wiki/File:Jacques_Ellul_crop.jpg (bottom right), Ellul, *The Technological Society*, 1964: cover (right).

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panel tax breaks." *Wholesale Solar Blog*. March 28, 2017. https://blog.wholesalesolar.com/category/local-incentives/ (bottom left), Felnagel, Sascha, Fotopedia. Photogrraph. "Greenhouse gas emissions? They can track that." Unspoiled.org http://www.unspoiled.org/greenhouse-gas-emissions-they-can-track-that/ (right).

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Green, Jetson. *Eco-Machine*. Pasolini, Antonio. “Clean Water from the Eco Machine.” *Energy Refuge.* July 12, 201. http://www.energyrefuge.com/blog/clean-water-from-the-eco-machine/ (right).

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