Extracting Reparative Power

redistributing power in post-mining transition

A Thesis Submitted to the Department of Landscape Architecture,

Harvard University Graduate School of Design

by

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In Partial Fulfillment of the Requirements for the Degree of

MASTER IN LANDSCAPE ARCHITECTURE

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Niall Kirkwood

EXTRACTING REPARATIVE POWER

redistributing power in post-mining transition

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Prof. Craig Douglas | TA: Bert De Jonghe

by: Pavin Banternghansa

Advisor: Niall Kirkwood

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Harvard Graduate School of Design

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Thesis Advisor
Niall Kirlwood

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Abstract

This thesis explores landscape as a medium for ecological reparation in the energy transition by pairing renewable energy infrastructure with regenerative agriculture.

The project's goal is to visualize the reorganization of energy infrastructure through Just Transition, with an emphasis on agroecology, the welfare of vulnerable communities, and post-mining intervention. It is an inquiry into the efficacy of landscape architects in the contemporary challenges of energy transition. First, the project explores how Thailand's fossil fuel 'empire' is depleting, triggering geopolitical issues, and contributing to climate change. Second, it models Thailand's fundamental infrastructure shift to renewable energy, exploring the potential placements, connections, and storage capabilities. Third, it deploys bottom-up, decentralization, and permaculture strategies to redistribute electrical and sociopolitical power. Finally, it imagines how Mae Moh Lignite Mine in Lampang, Thailand, could terraform into Pump Storage Hydroelectricity (PSH) through lignite extraction and serve as the region's battery, critical to the intermittent renewable system.

This thesis explores the potential of landscape as **medium for ecological reparation in the energy transition by pairing renewable energy infrastructure with regenerative agriculture.**

The project's goal is to visualize this **synergic relationship between renewable and hydrological infrastructure, from decentralize planning, bottom-up community networks, agrivoltaic practices, and post-mining landscape intervention.**

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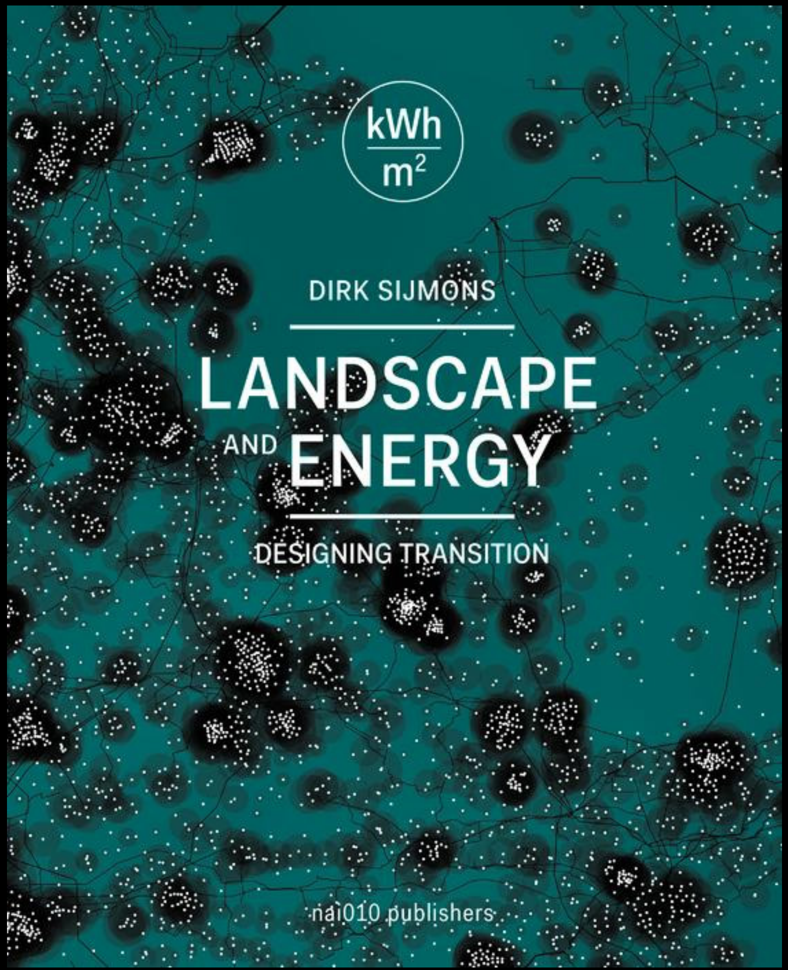
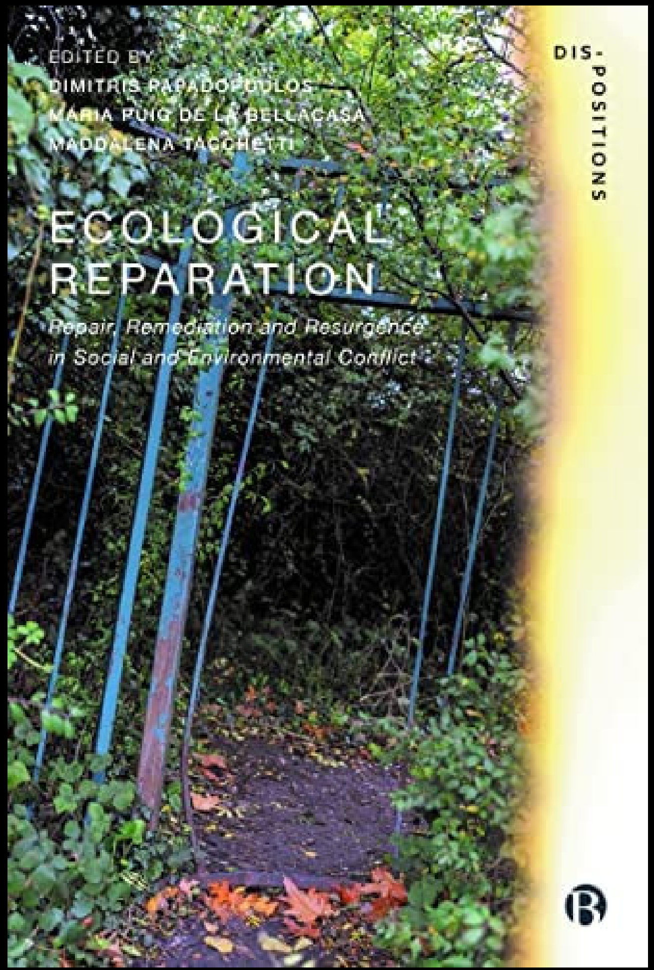
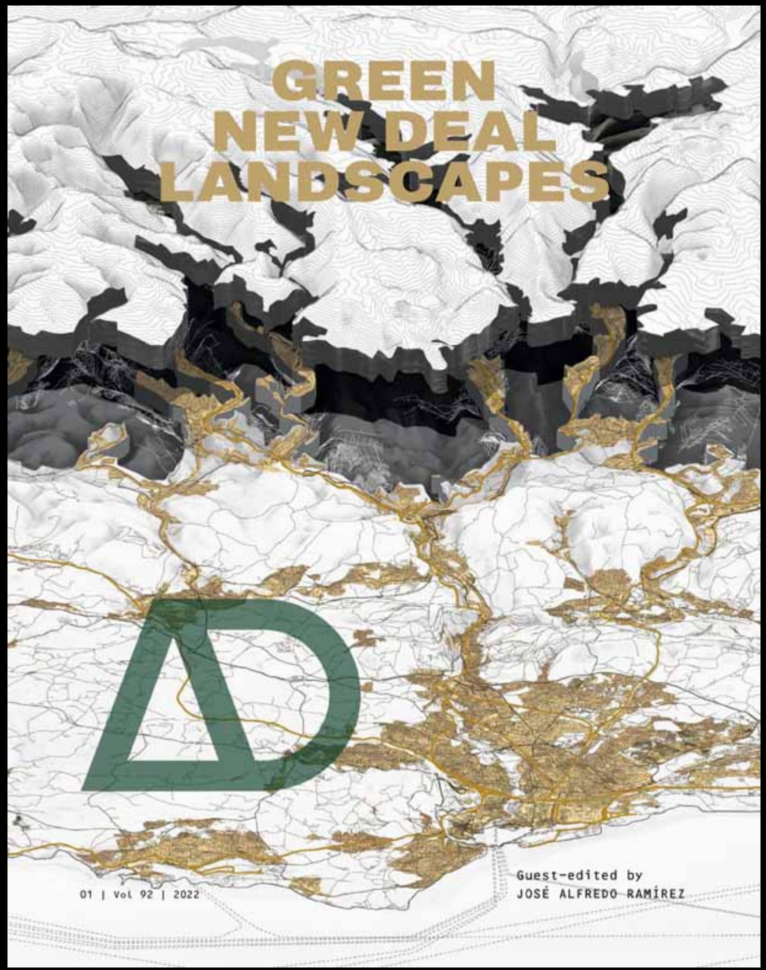
It is an inquiry into the efficacy of landscape architects amidst vital challenges of energy transition.



Landscape and Energy
Dirk Sijmons



Ecological Reparation
Dimitris Papadopoulos

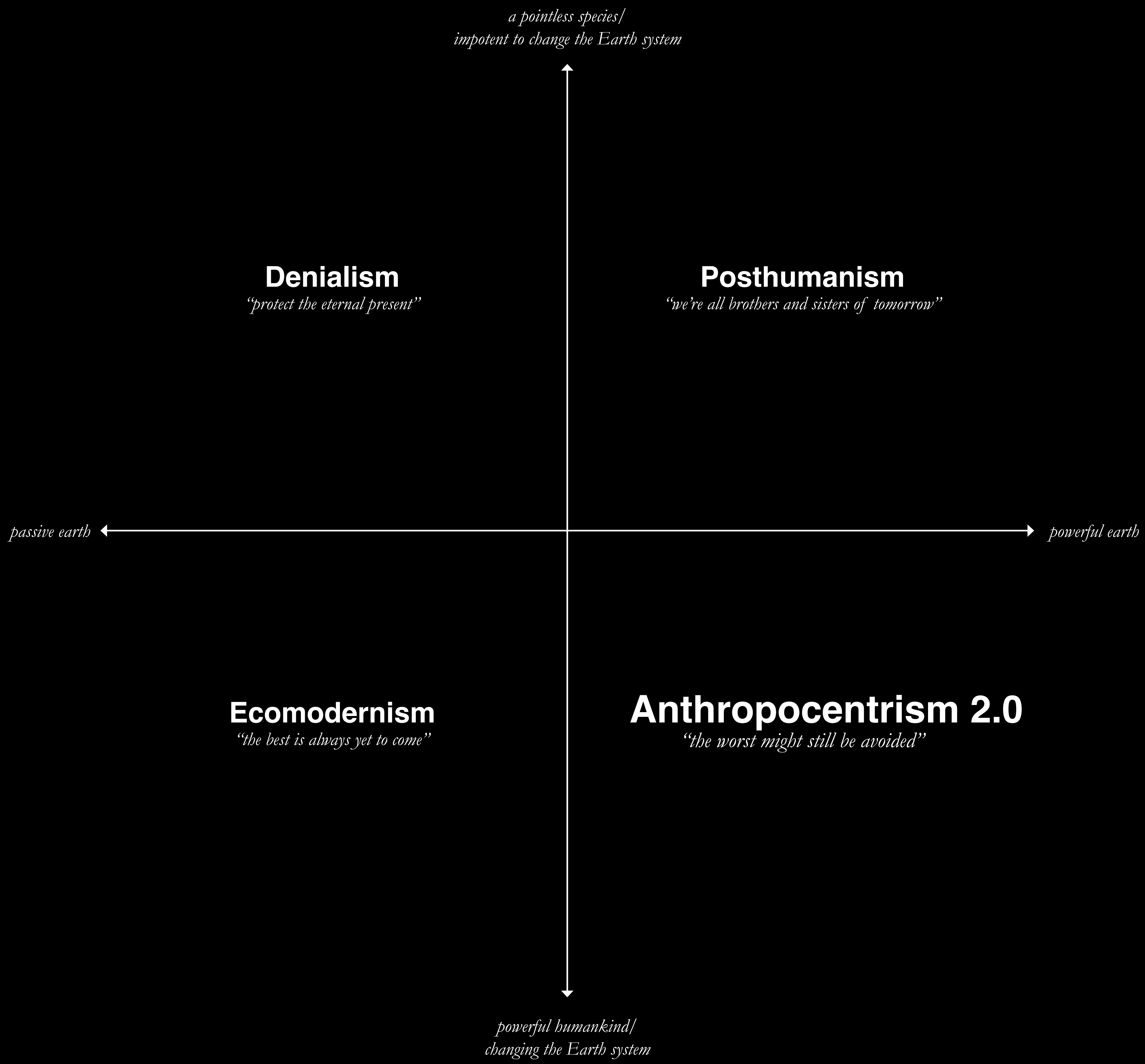


Green New Deal Landscapes (Architectural Design)
Jose A. Ramirez

The thesis proposed the marriage between Dirk Sijmon's discourse on **energy transition** and Papadopoulos's **ecological reparation**, exploring the **"reorganization"** of the new energy infrastructure that **"does justice to all of the landscape's ingredients."**

Landscape and Energy, Dirk Sijmon (2014)

Ecological Reparation, Papadopoulos D., Puig de la Bellacasa, M., & Tacchetti, M., (Eds.). (2023).

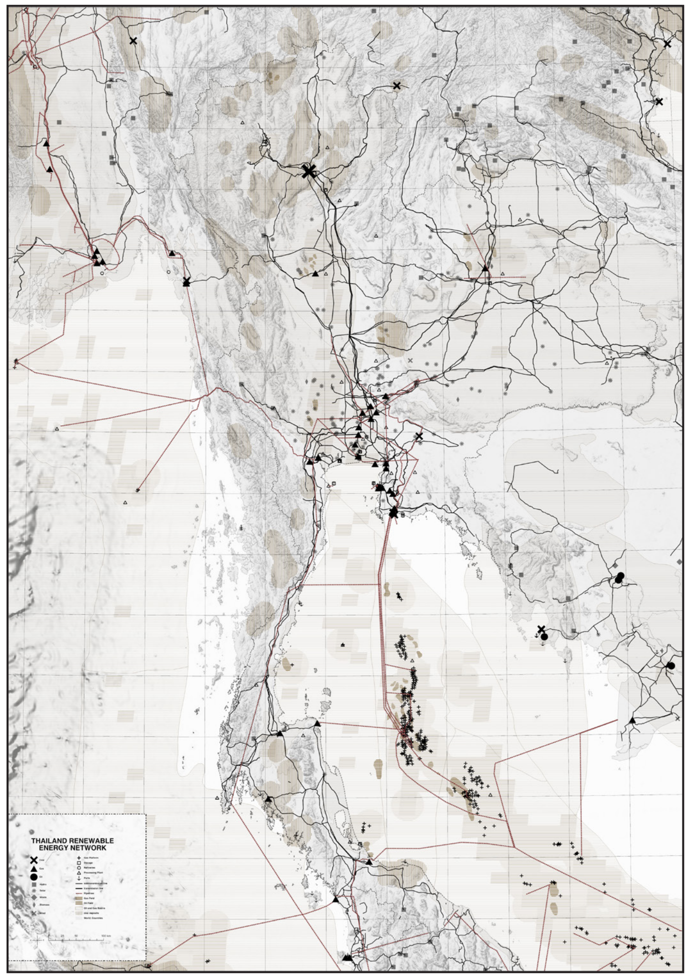


Different positions in the Anthropocene – The Age of Humankind.
Adapted from the unpublished manuscript of Mobilis in Mobile
by Dutch Lanscape Architect Dirk Sijmons (2021)

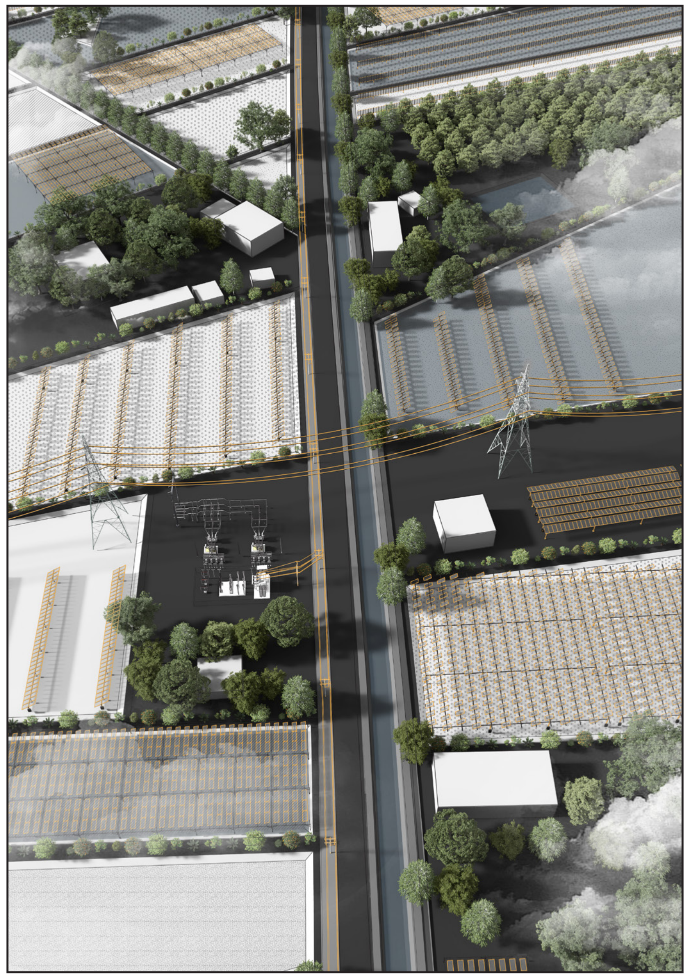
Ecological Reparation

Reparation -Thus positioning itself (continued from b) in Anthropocentrism 2.0, the project accepts that we are living on a damaged planet and acknowledges our ability and obligation to take responsibility. Recognizing both the earth and man as powerful, the project proposes a synergic relationship with renewable energy apparatus to not only think about economic growth but allows the diversity of ecosystems surrounding us to grow, evolve and transition into reparative relations.

The project reconfigures the energy grid, shifting power relations, to address issues of inequality through our relationship to the land

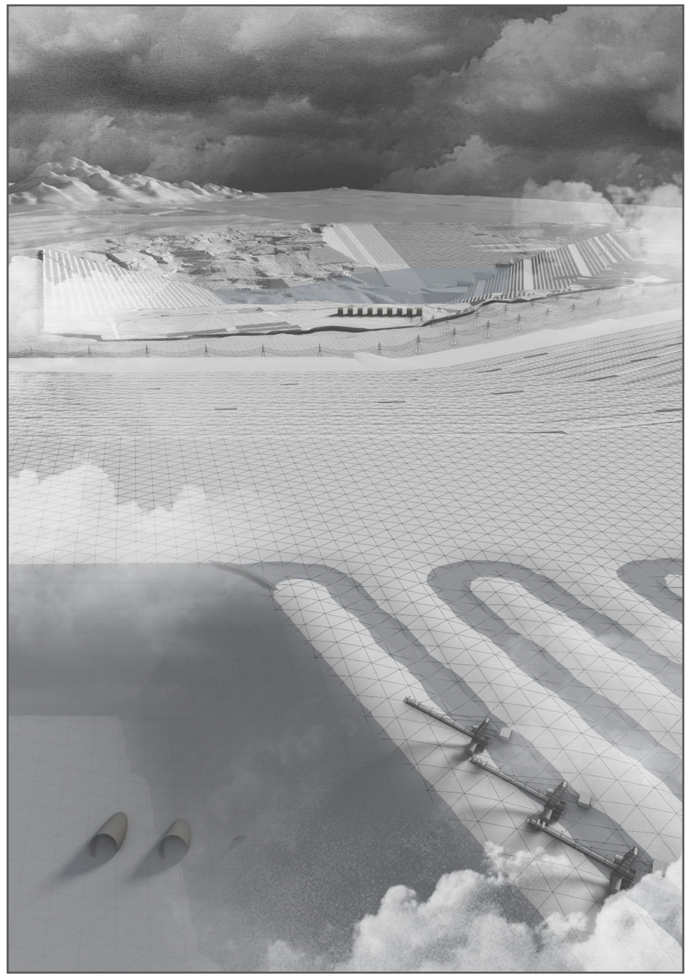


fossil fuel infrastructures



renewable infrastructure

agroenergy



post-mining intervention

The project's goal is to visualize the **reorganization of energy infrastructure through Just Transition**, **with an emphasis on agroecology, the welfare of vulnerable communities, and post-mining intervention**. It is an inquiry into the efficacy of landscape architects in the contemporary challenges of energy transition.

source: Pavin Banternghansa

Multi-scalar Landscape Operation

First, the it explores how the depletion of Thailand's fossil fuel 'empire' triggers geopolitical issues, which further contributes to climate change. Secondly, it models the reorganization of Thailand's fundamental infrastructure shift to renewable energy, exploring synergy between energy and water storage. Third, it deploys decentralization and permacultural strategies to redistribute electrical and socioeconomic power. Finally, it imagines how Mae Moh Lignite Mine in Lampang, could terraform into Pump Storage Hydropower (PSH) through lignite extraction and serve as reservoir and the region's battery.

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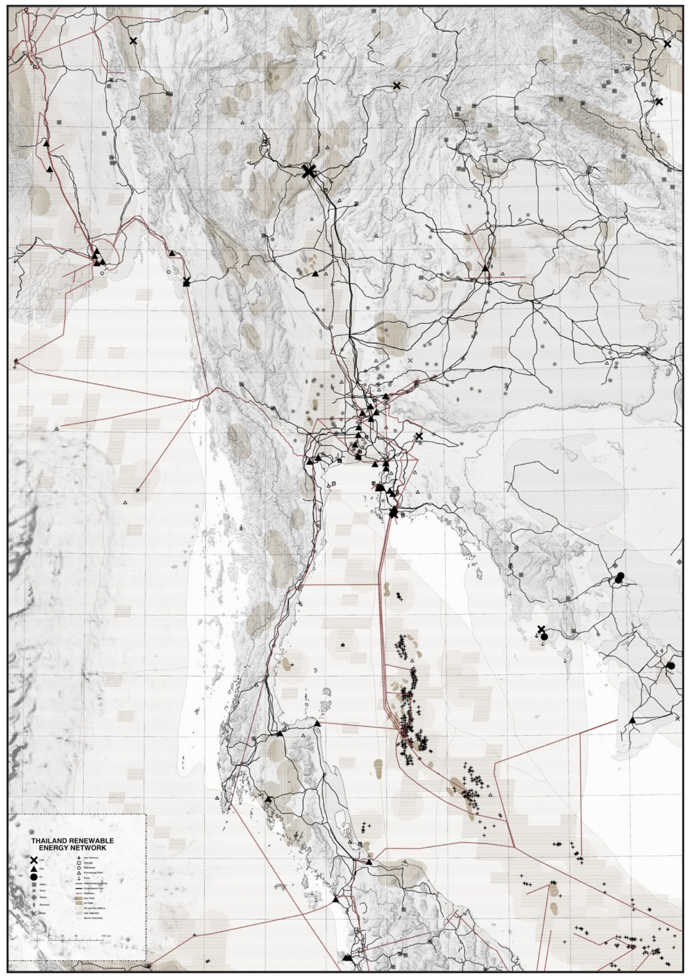
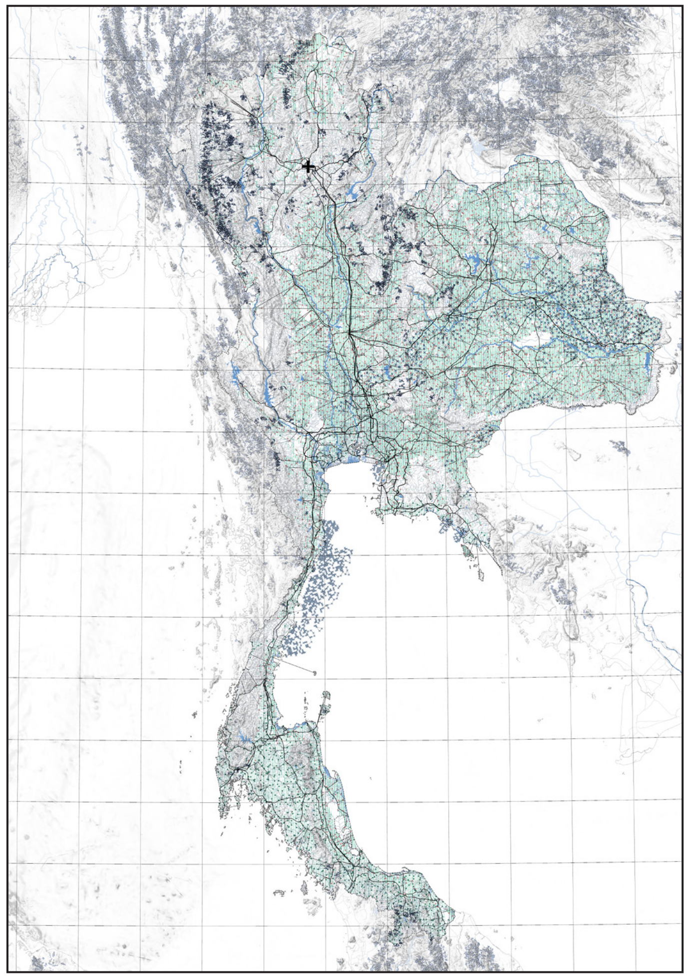
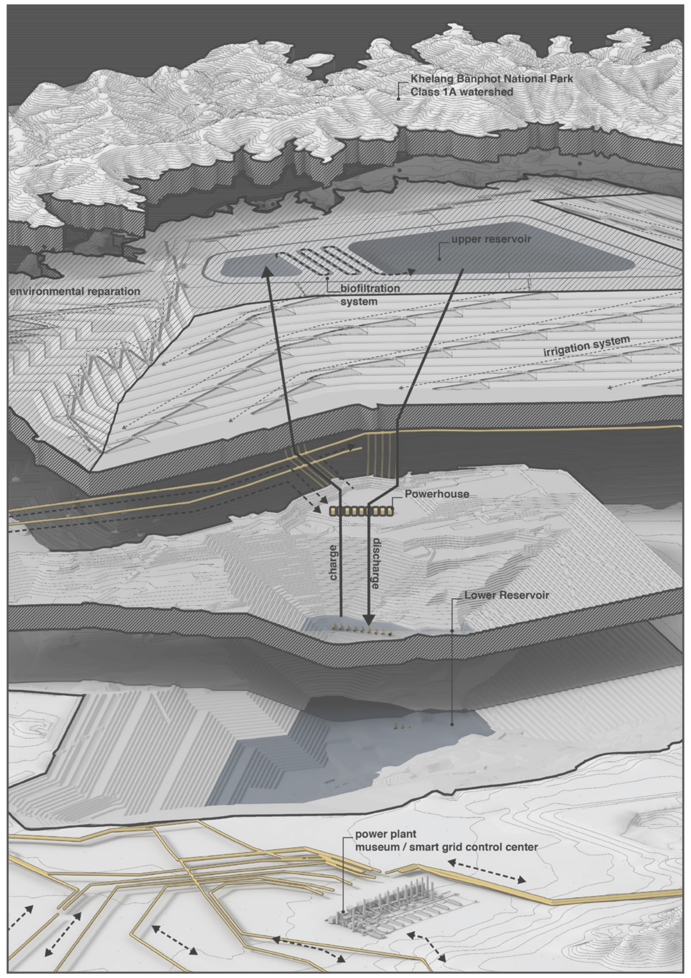


1. Understanding Existing Energy Infrastructure



2. New National Renewable Energy Model

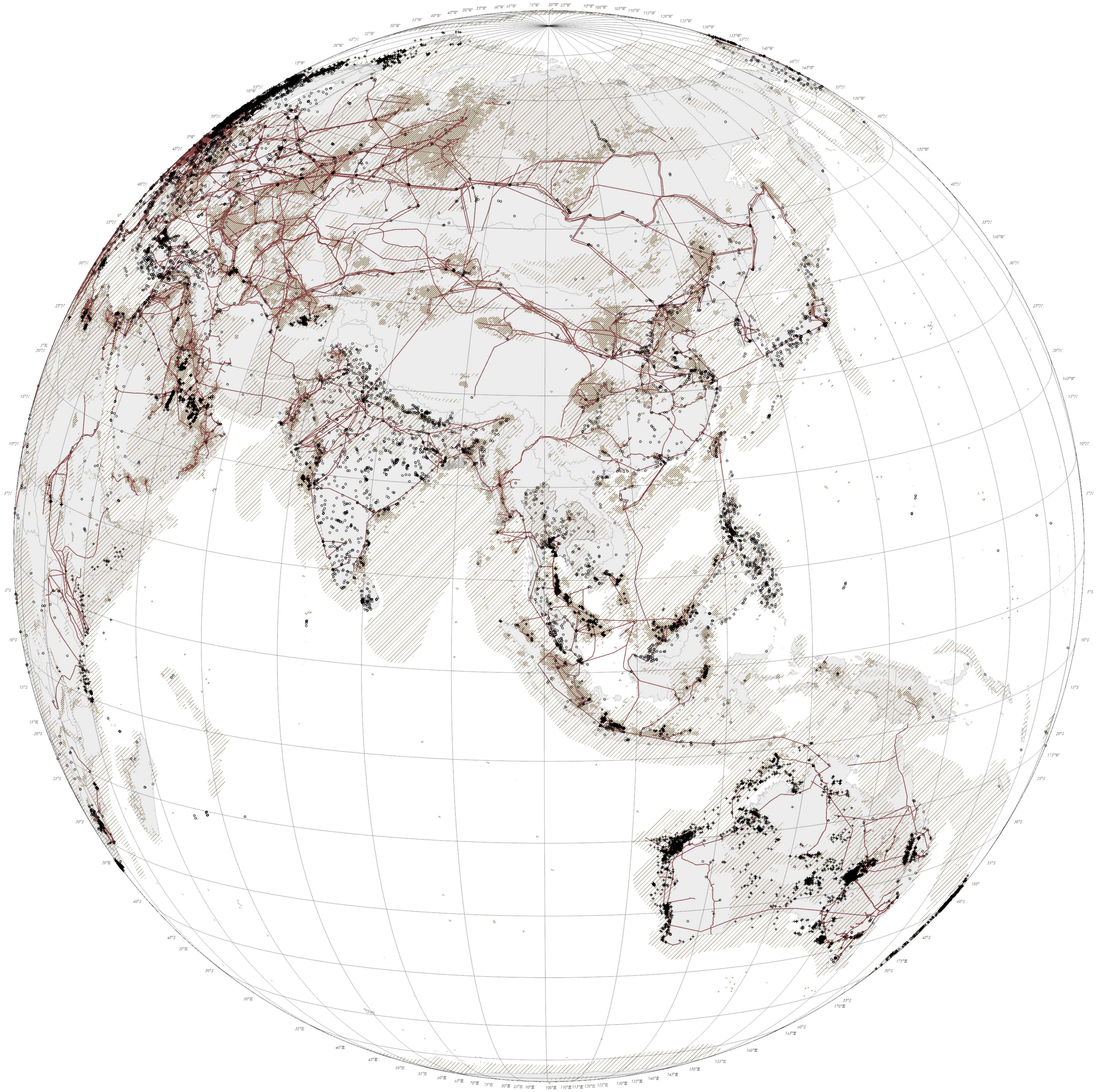
3. Bottom-up Agrivoltaic Practices

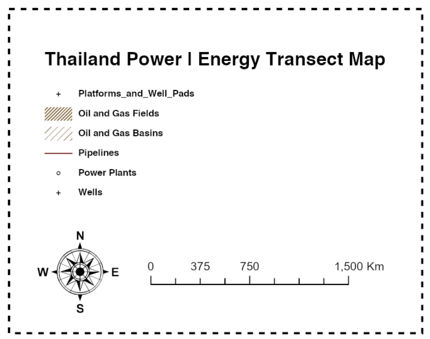


4. Post-mining Reclamation as Regional Pump Storage Hydropower

source: Pavin Banternghansa

Design Principles





Extractive Empire

In the current landscape, our energy supply has been discreetly concealed, embedded in a global system that fails to recognize the origin or effects of its sourcing.

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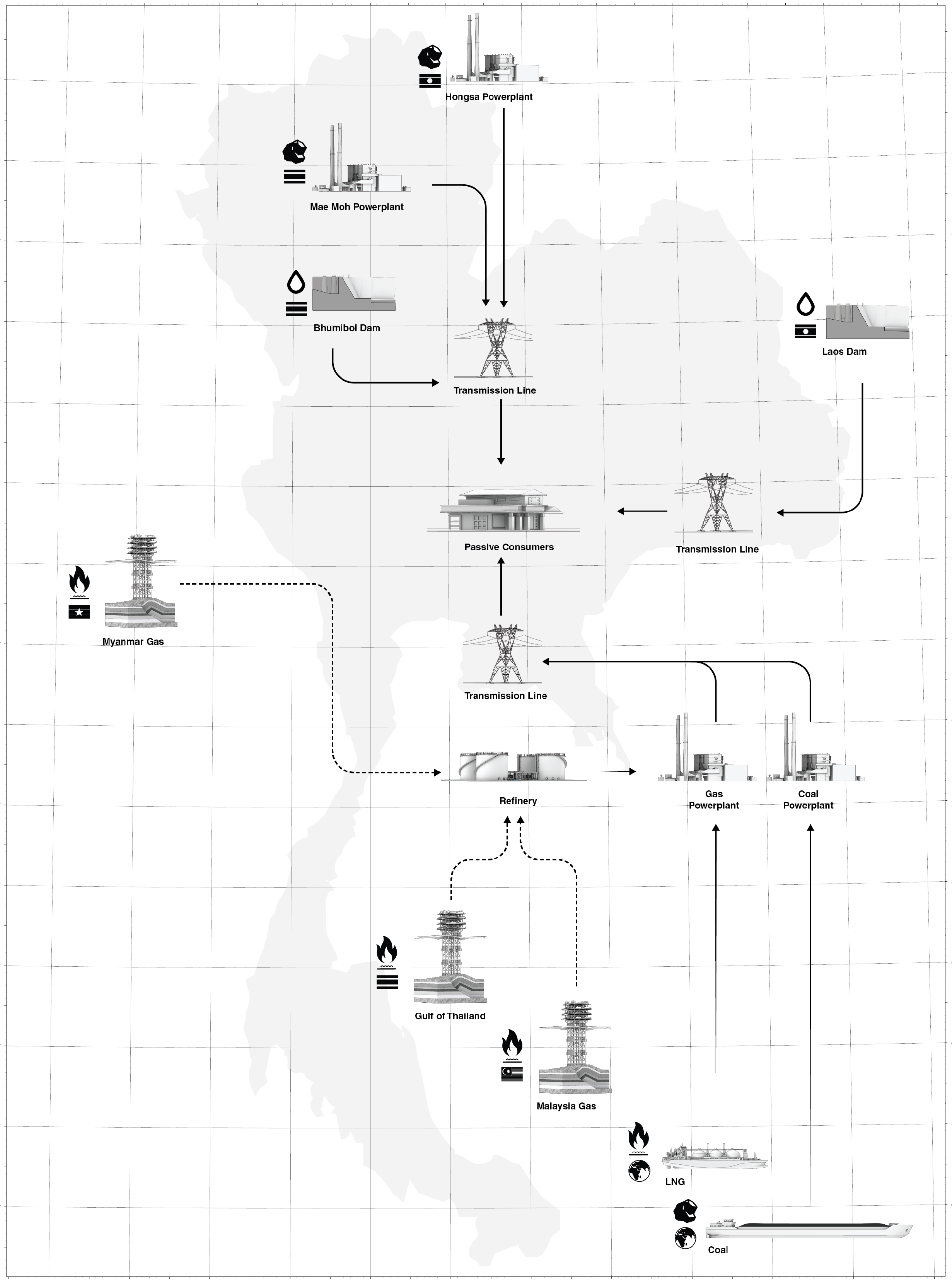

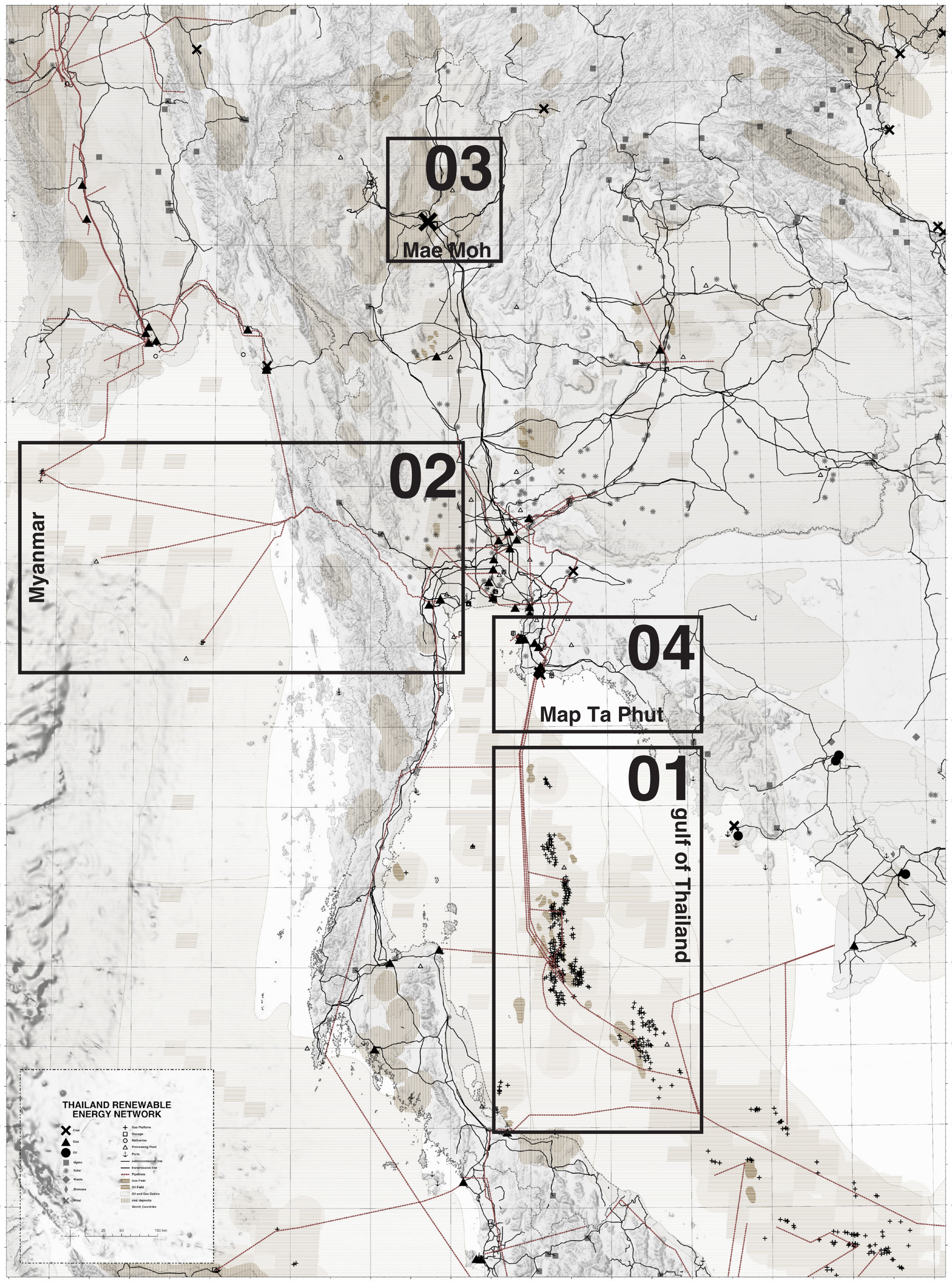

Thailand Extractive Empire

In Thailand, the energy infrastructure spans across multiple terrains, bringing gas from the gulf of Thailand and Malaysia from the South, running pipes from Myanmar on the west, importing LNG from across the world, and extracting coal from the north at Mae Moh.

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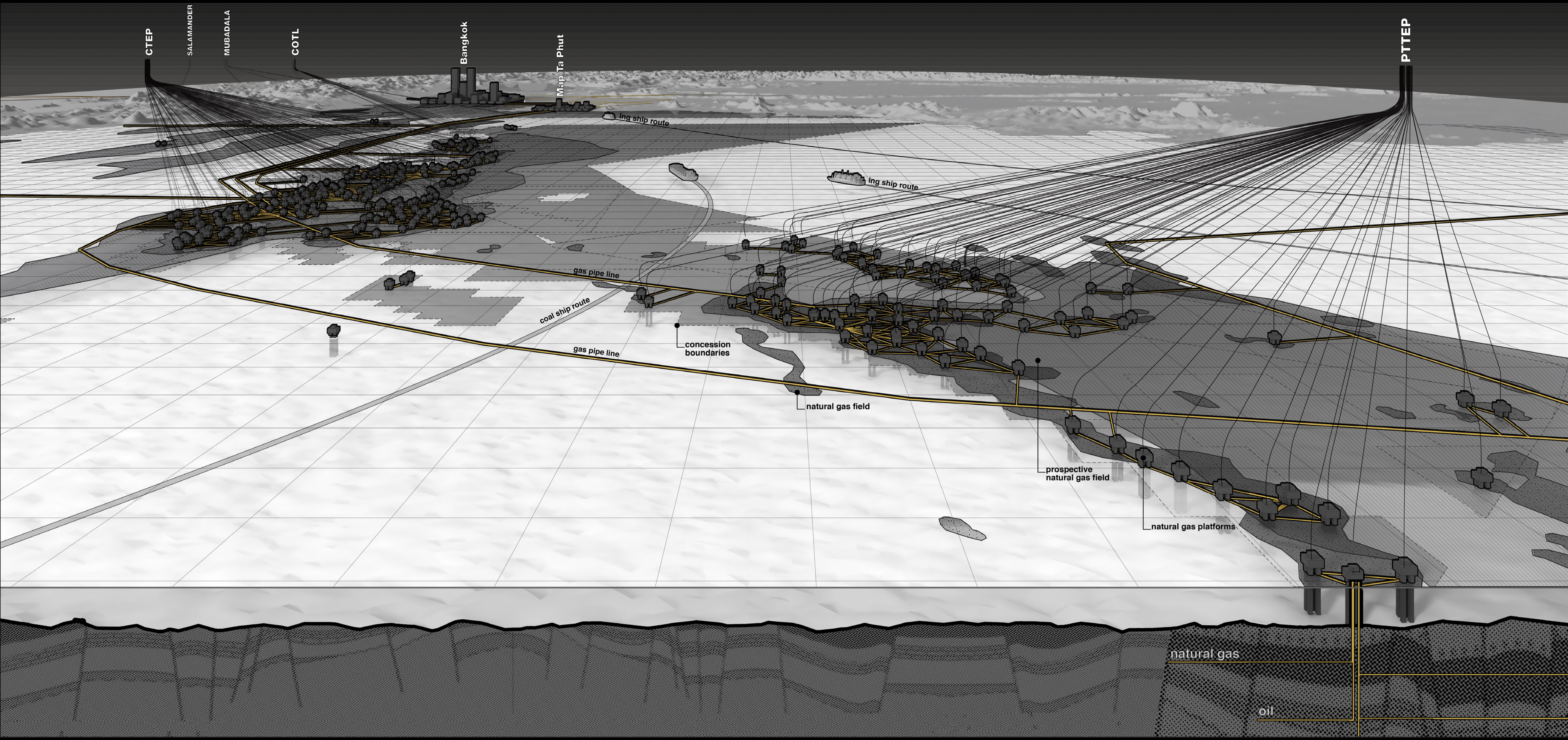

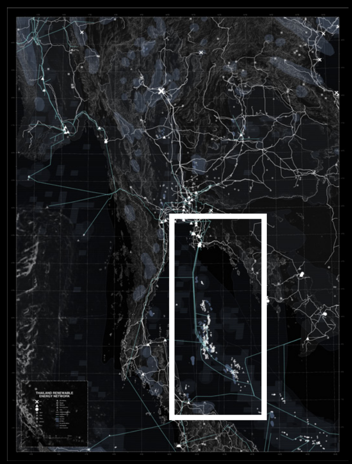

Depletion

300 platforms are draining gas and oil in the middle of the gulf that will become obsolete within the next decade.

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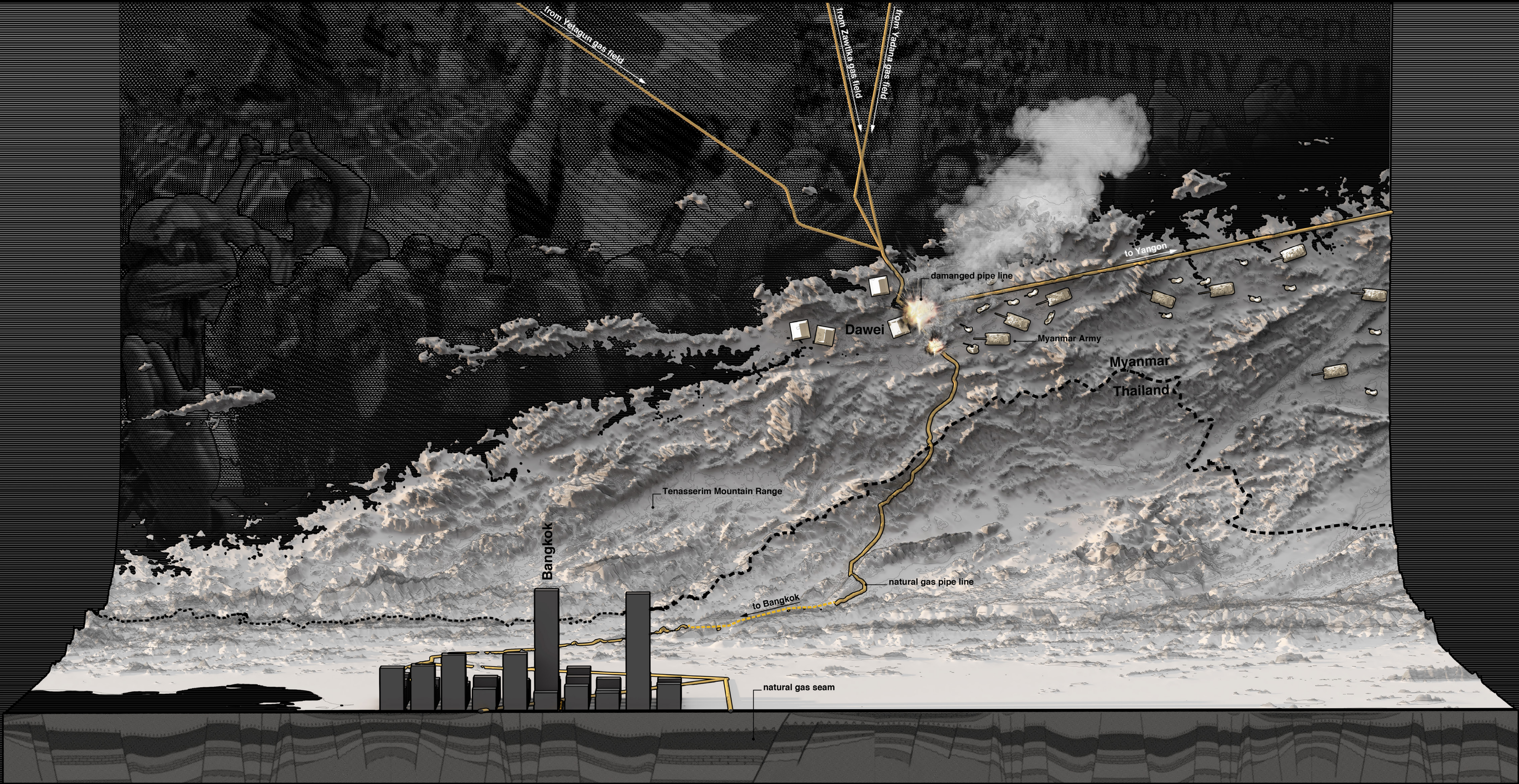

Geopolitical Issues

To the west, 15% of the gas supply was disrupted in the August of last year after an attack by the Myanmar military on Dawei following a coup d'etat. Foreign investments pulled out their investments due to human rights issues.

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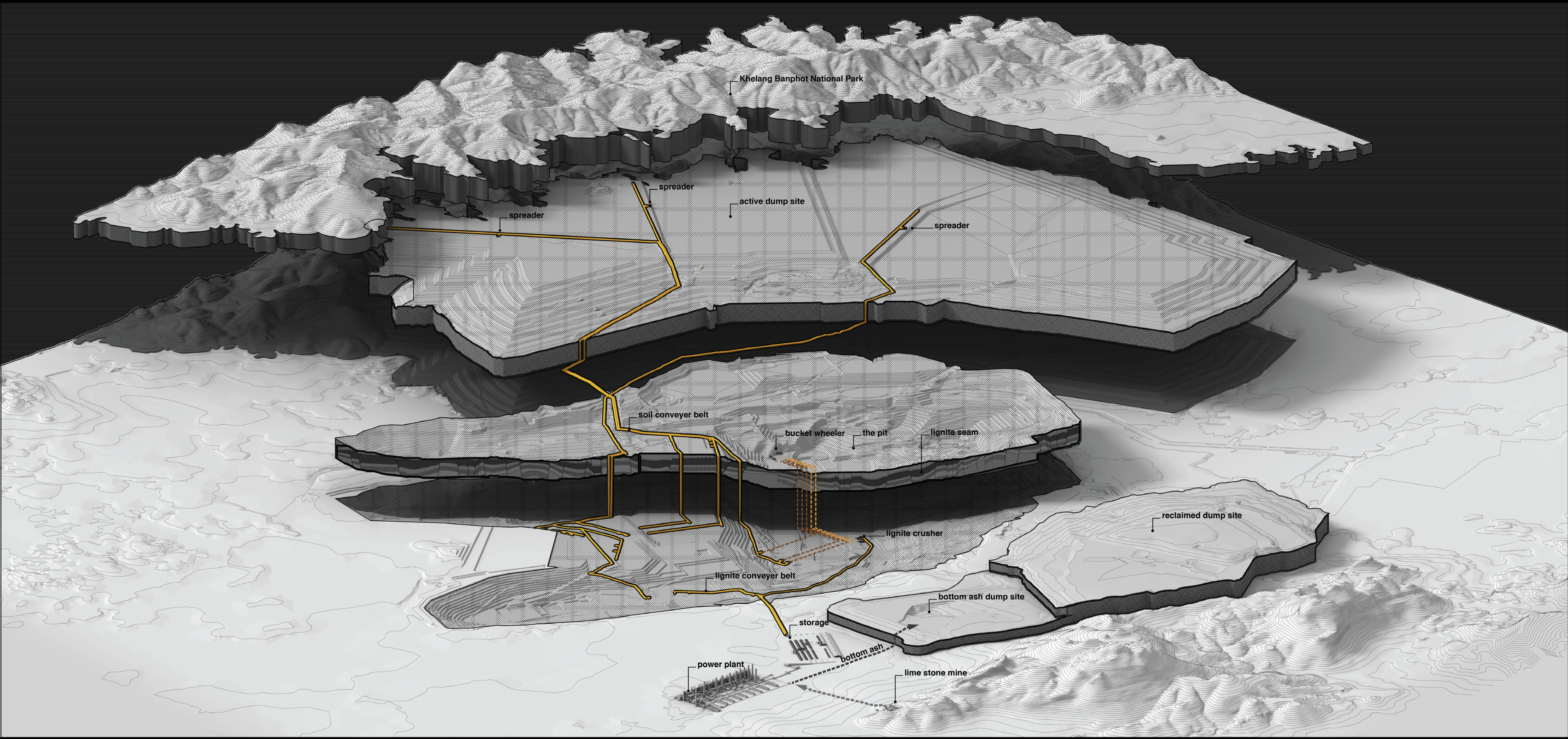

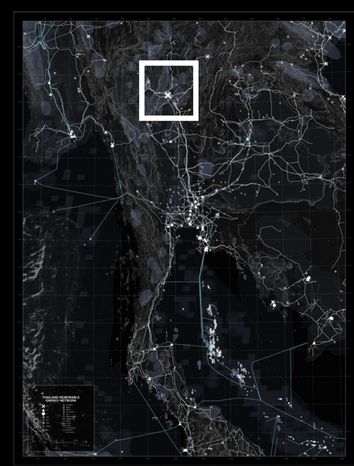

Altering the Landscape

From the North, in Mae Moh, Lignite Mine, the size of Cambridge is actively altering the landscape.

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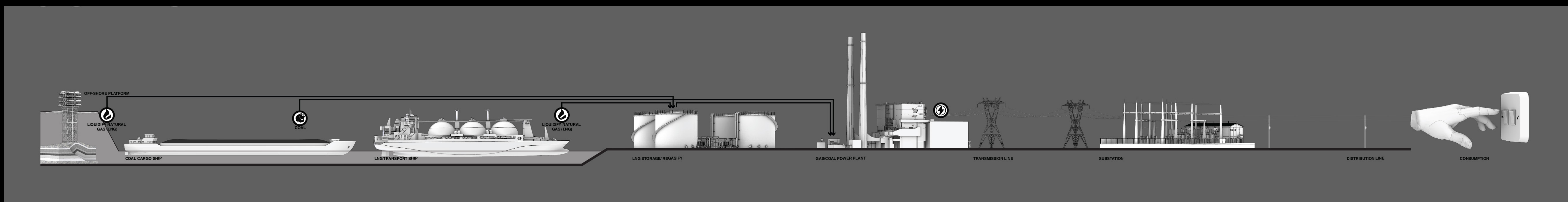

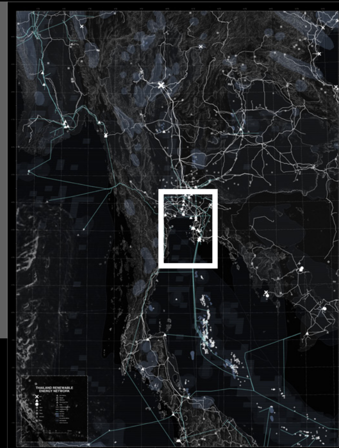

Contributing to Climate Crisis

Out of all that, 40% of energy is imported from all across the world, contributing to the climate crisis. Thailand is subservient to other countries for energy. This has to change.

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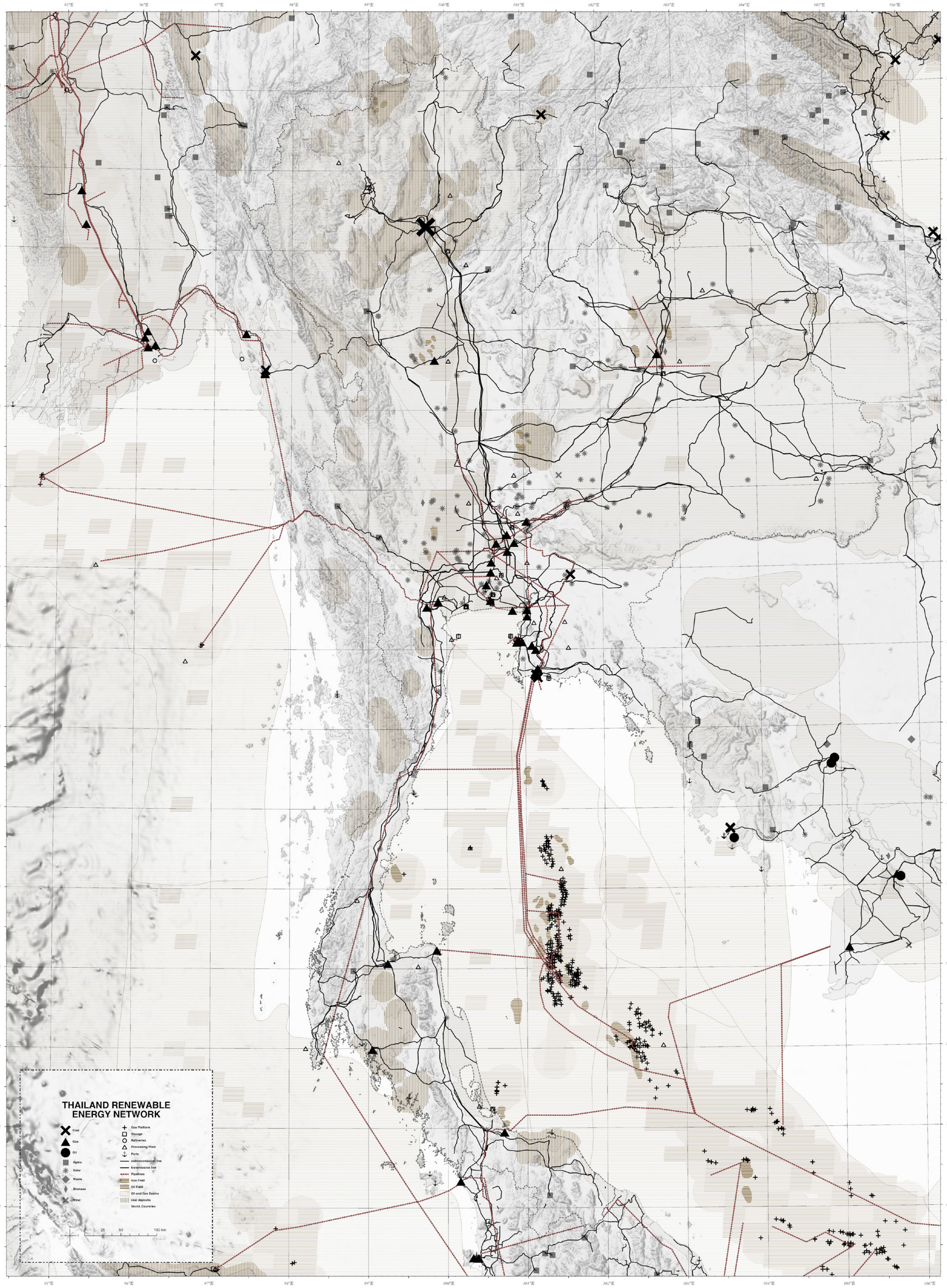

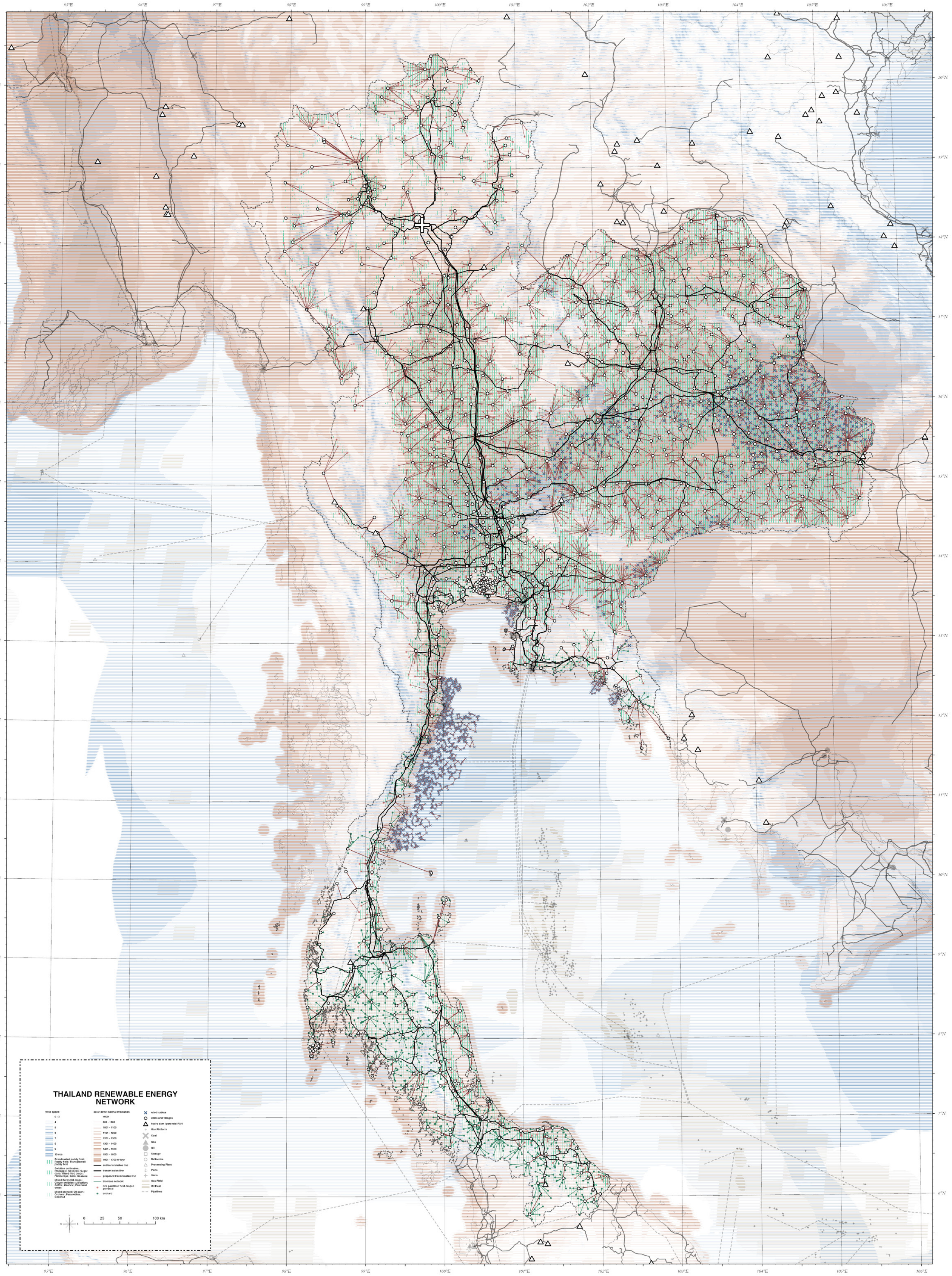

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Prof. Craig Douglas

Transition to Renewable Energy

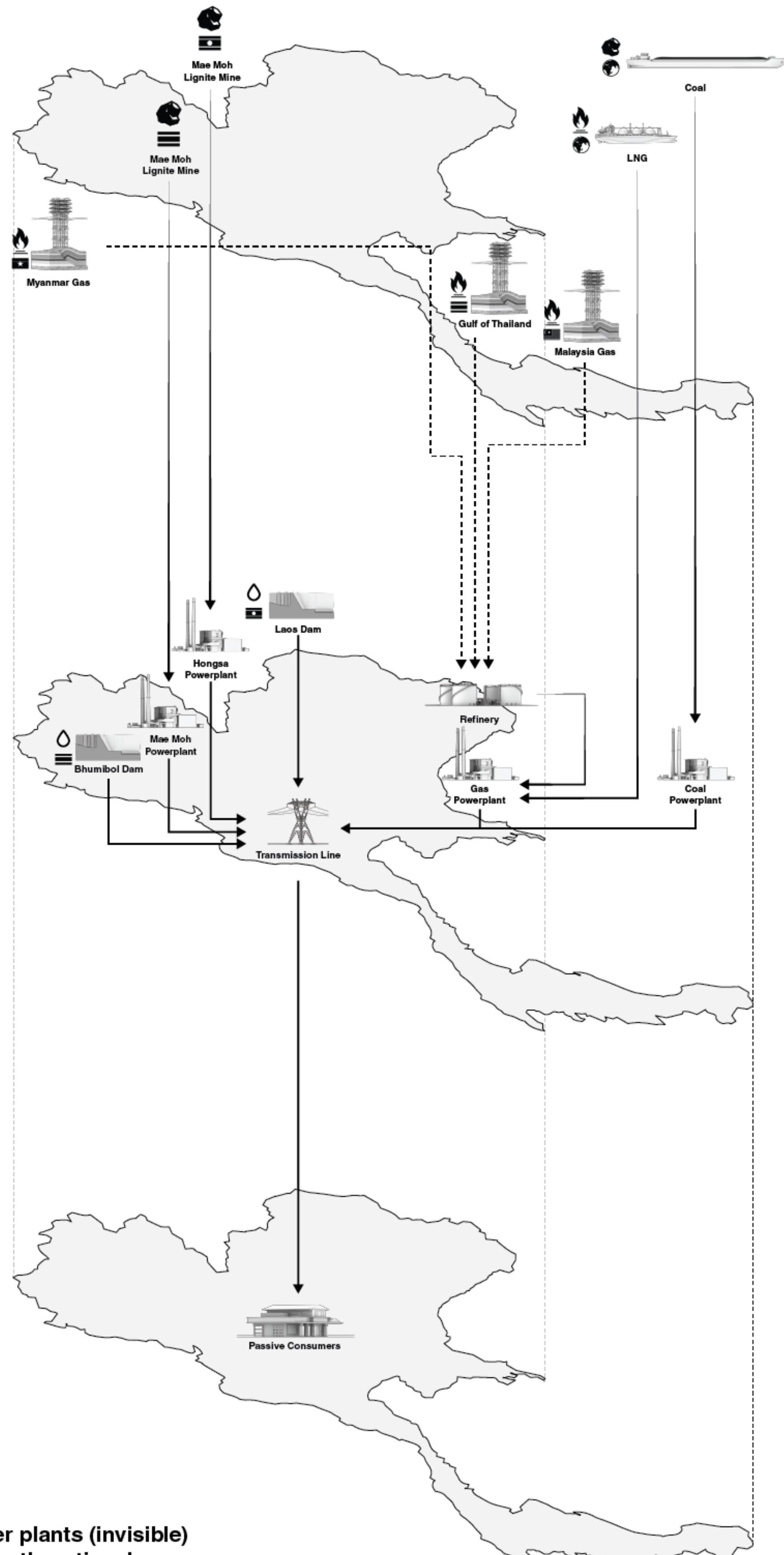
by: Pavin Banternghansa
Advisor: Niall Kirkwood

Where fossil fuel infrastructure is concealed, one-way, and exploitative. Renewable energy infrastructure is visible, encourages robust exchange, and is distributed. Extending energy transition beyond its technical operation, the project recognizes energy transition not as a separate task but as interdependencies embedded in the network of society, culture and the economy.

Extraction

Production

Consumption



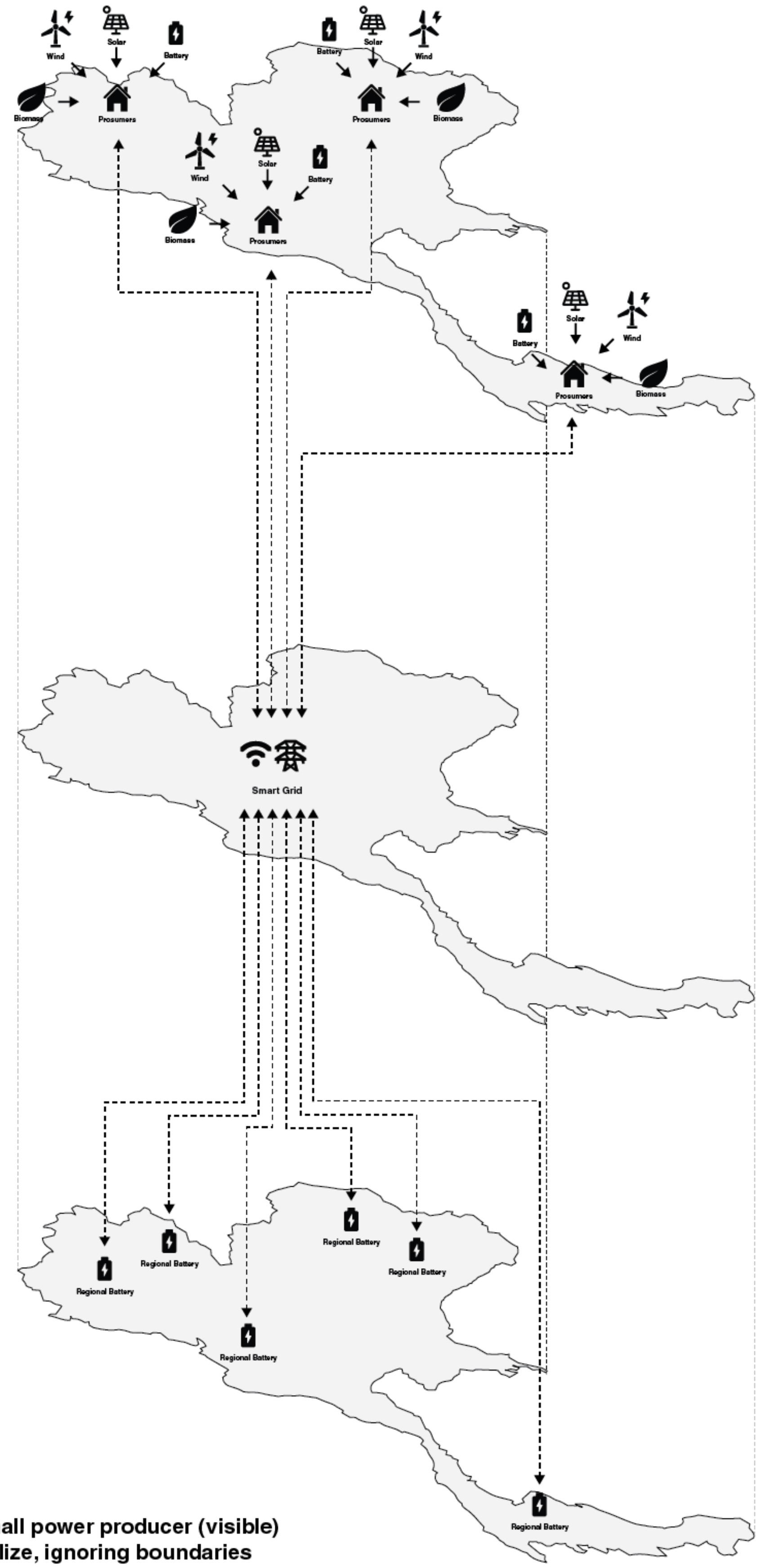
Yesterday

1. few large power plants (invisible)
2. centralized, mostly national
3. top to bottom/one-way
4. base on large power lines and pipelines
5. passive, only paying consumer

Prosumption

Transmission Network

Storage



Tomorrow

1. many small power producer (visible)
2. decentralize, ignoring boundaries
3. robust exchange
4. small-scale transmission and regional competition
5. active participating prosumer

Transition to Renewable Energy

The current fossil fuel empire consists of a few power plants connected to large pipes and power lines that flow one-way, in a linear centralized market, with passive energy consumers. I am proposing a renewable energy infrastructure that will be decentralized into a network of small power producers, encouraging robust exchange and active participating prosumers.

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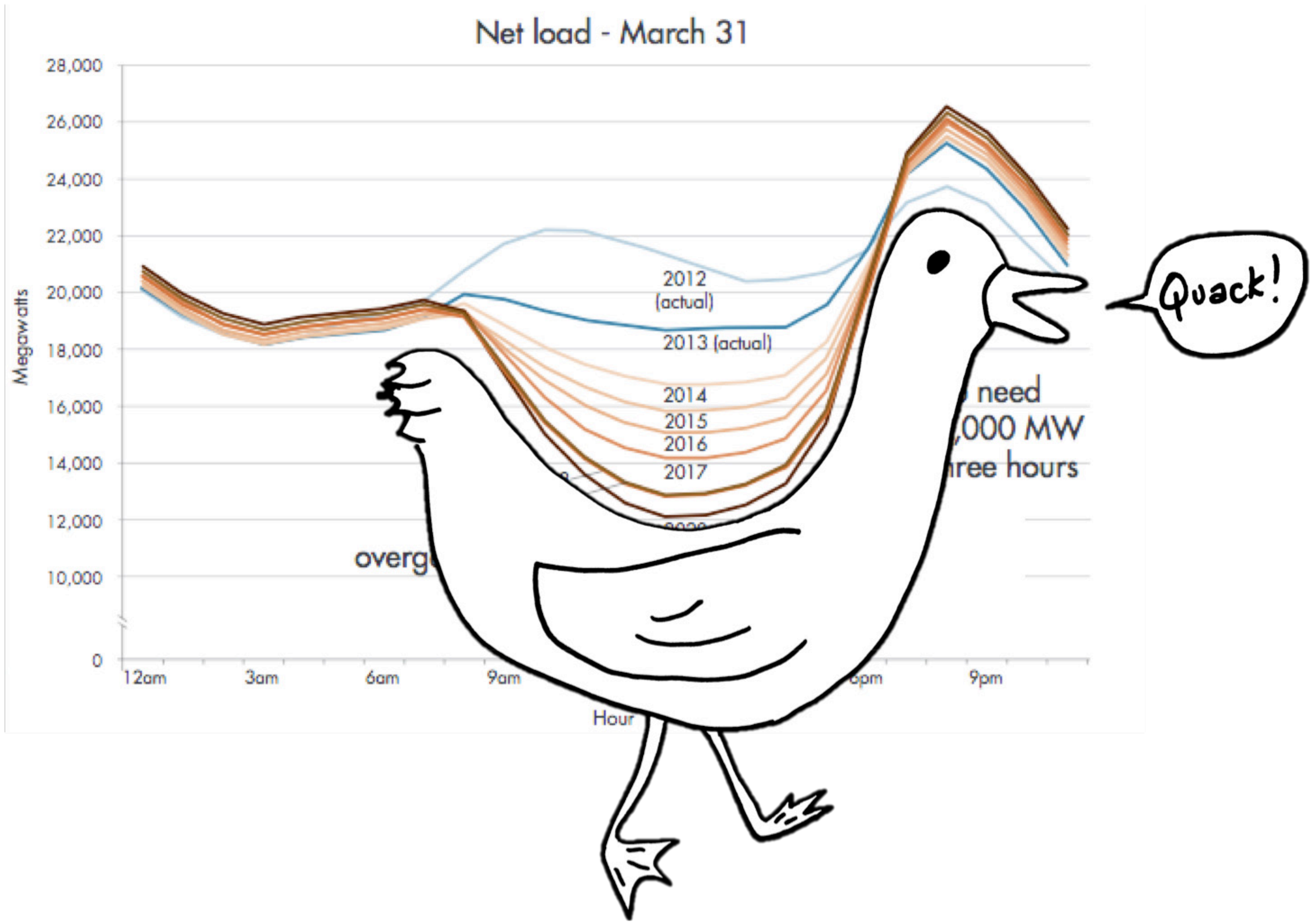
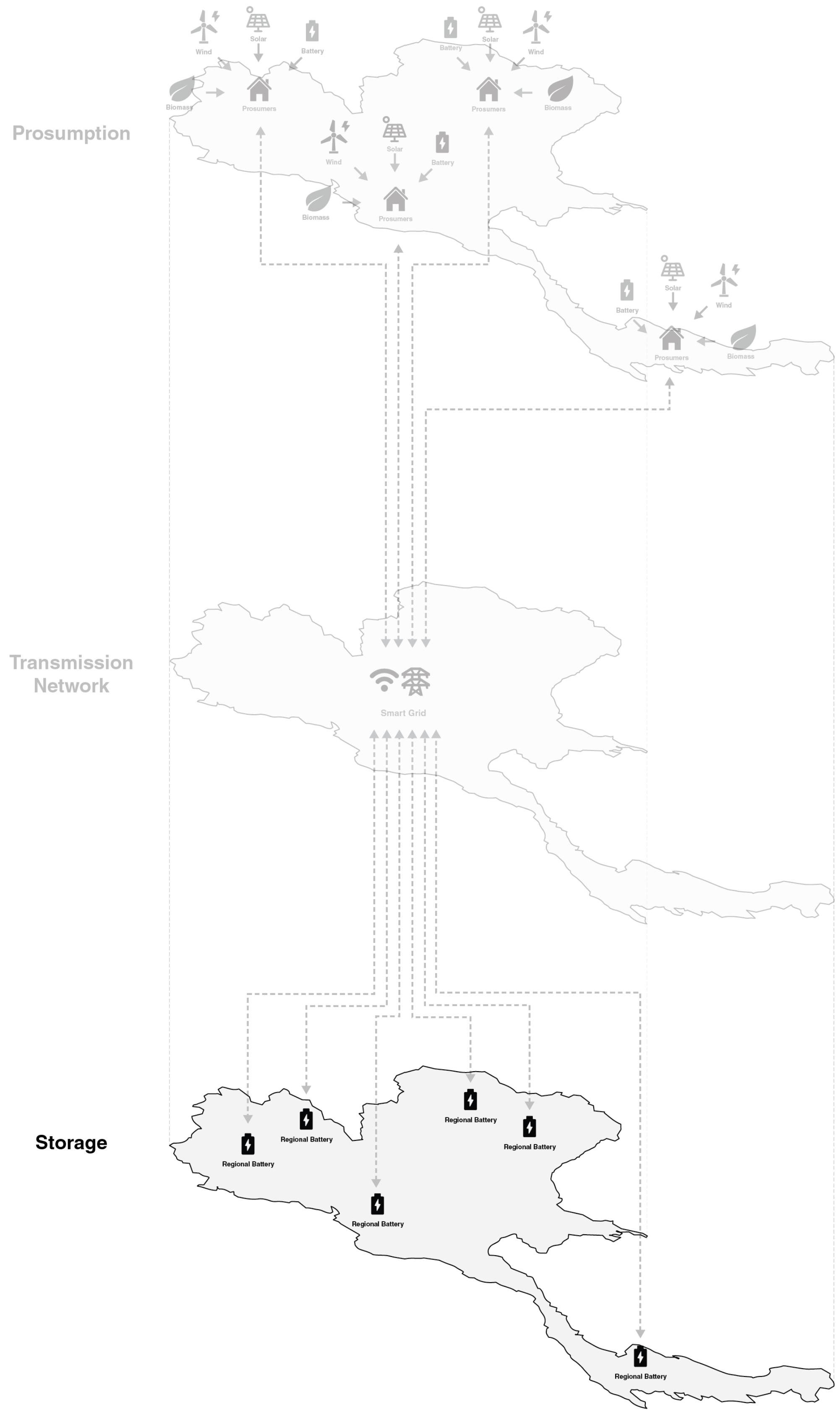


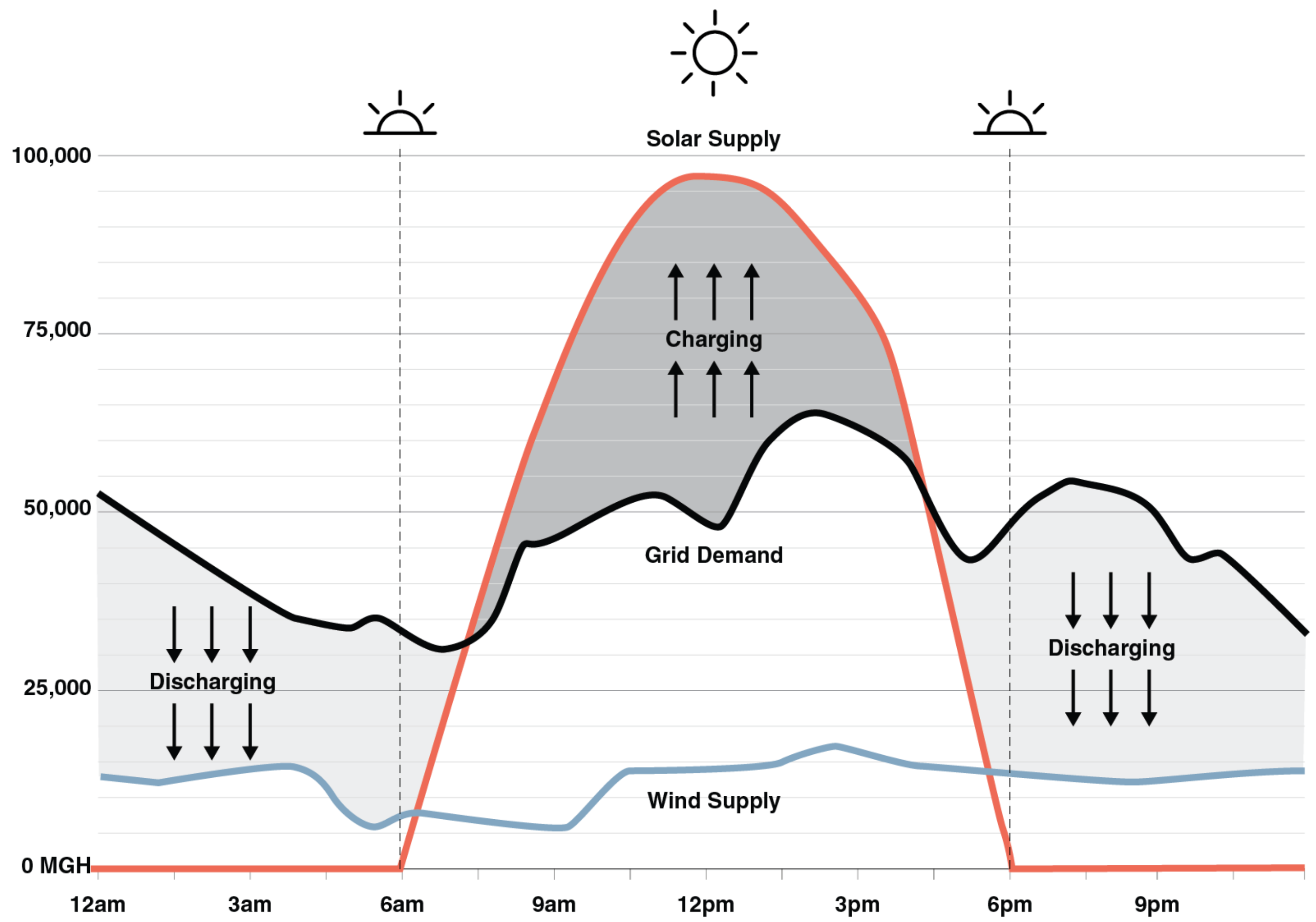
source: California ISO / Jordan Wirfs-Brock

Production Intermittency



Storage is the Key

because renewable energy is intermittent storage becomes the key to the energy transition



Daily Charging and Discharging

A considerable amount of excess energy needs to be charged and discharged daily

Moss Landing Vistra Battery (Lithium)

generation capacity **400 MW**
storage capacity **4 hours (1,600 MWh)**
13,333 homes for 1 days

Country	*United States*
Location	*Moss Landing, California*
Coordinates	*36°48'17.54"N 121°46'55.19"W*
Opening date	*Late 2020*
Owner(s)	*Dynegy, a subsidiary of Vistra Corp*

Bath County Pumped Storage Station x60

generation capacity **3,003 MW**
storage capacity **10 hours (24,000 MWh)**
800,000 homes for 1 day

Country	*United States*
Location	*Bath County, Virginia*
Coordinates	*38°13'50"N 79°49'10"W*
Opening date	*December 1985*
Owner(s)	*Dominion Generation (60%), LS Power (40%)*

95% of storage today is embeded in the landscape

Today the largest battery is not lithium but pump storage hydropower(PSH). 95% of the energy in the world is stored within and embedded into the landscape. Bath County Pumped storage station can store 60 times more energy than Moss Landing Lithium Storage facility.

policy
4D1E

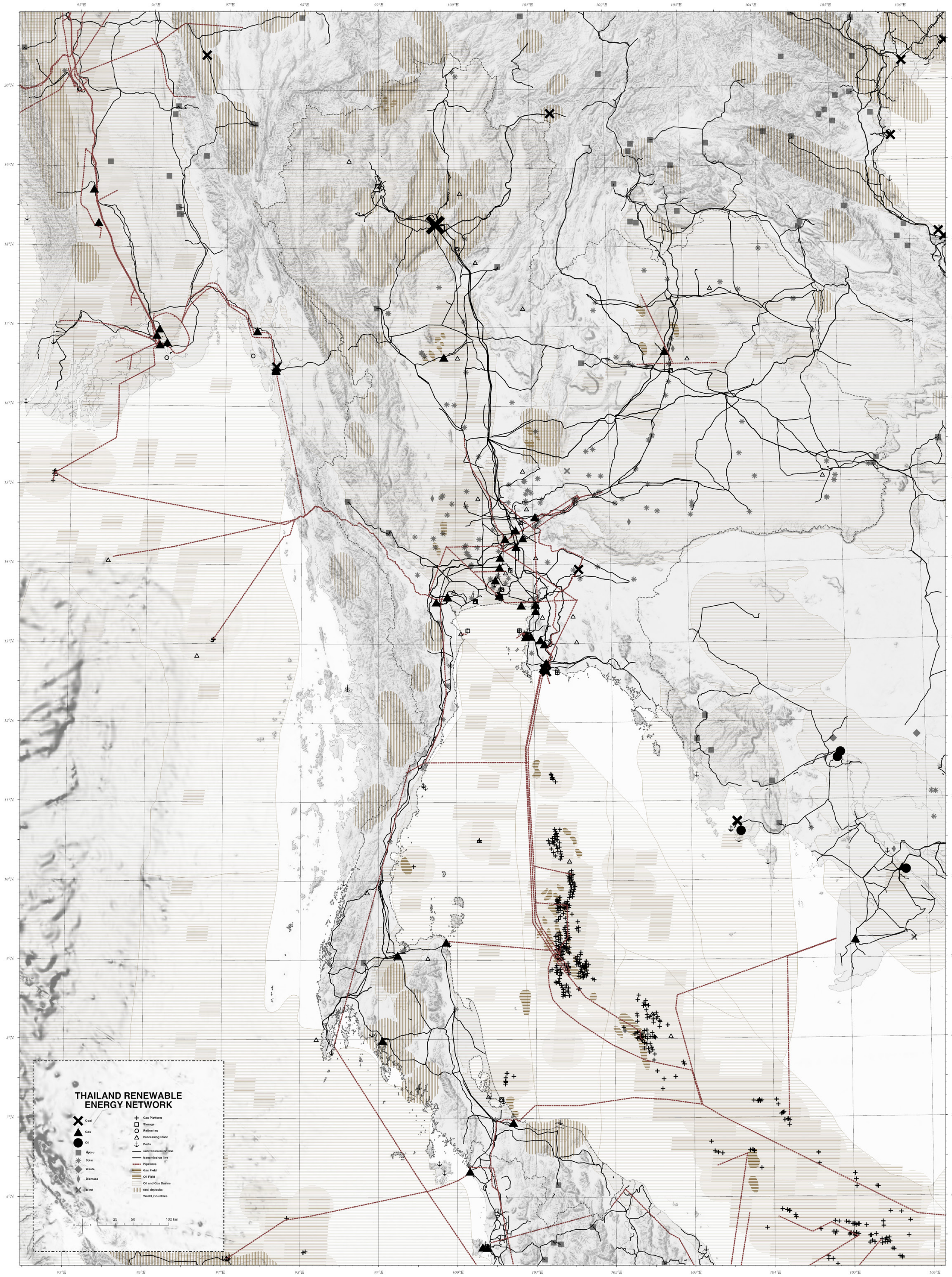
Decarbonization
increasing renewable energy mix

Digitization
smart grid infrastructure

Decentralization
expand power transmission connection

Deregulation
support community powerplant investment

Electrification
use electricity as main form of energy



Supporting Energy Transition Policy

The Thai government supports the energy transition. Their 4D1E policy aims to decarbonize, digitalize, decentralize, deregulate, and use electricity as the primary form of energy. This encourages communities-initated renewable energy operation. How then would this bottom-up initiatives look like?

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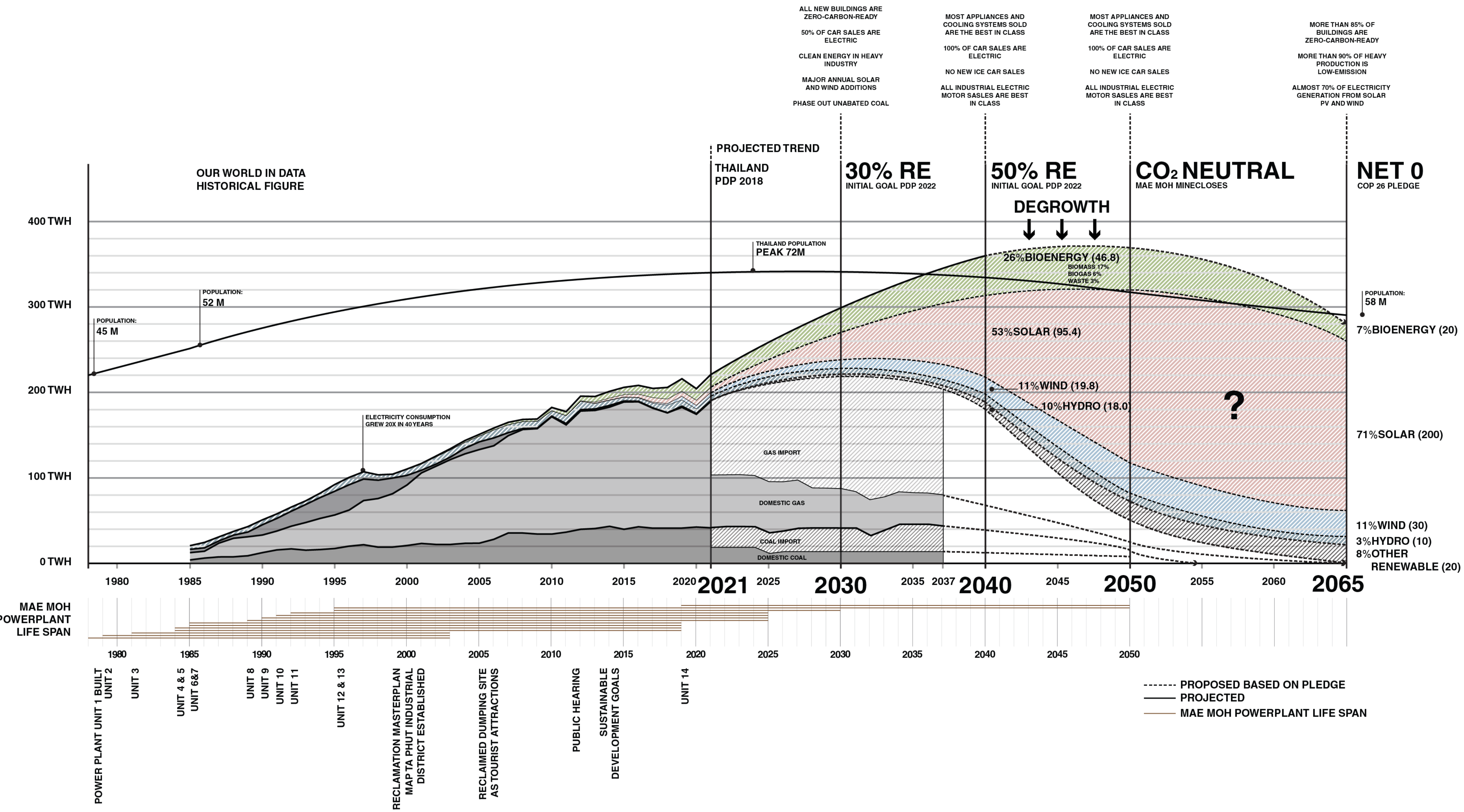

Modelling the Road Towards Net Zero

With limited data, I've compiled and projected energy sources based on pledges at COP26 and the 2018 Power Development Plan up until 2040, as well as projected decrease in population and the road map plan to Net 0 in 2065.

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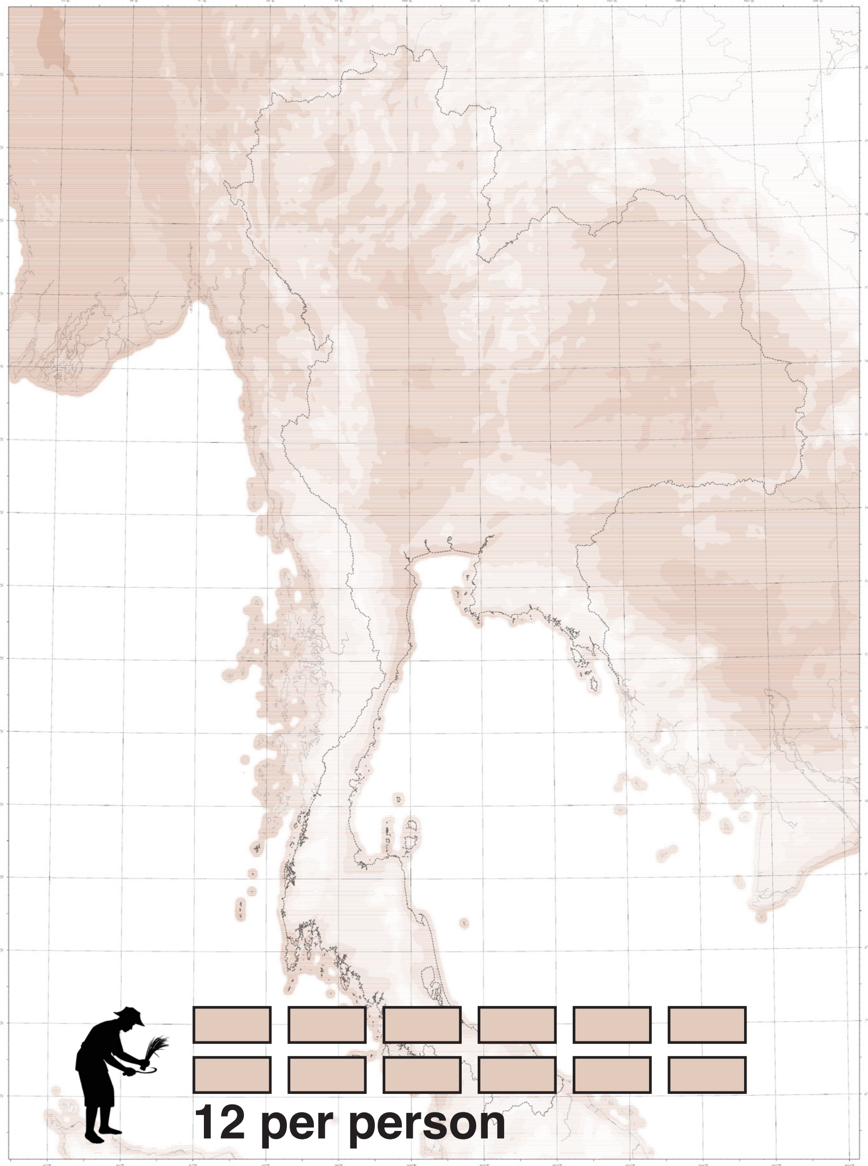
Solar

Direct Normal Irradiance (DNI)



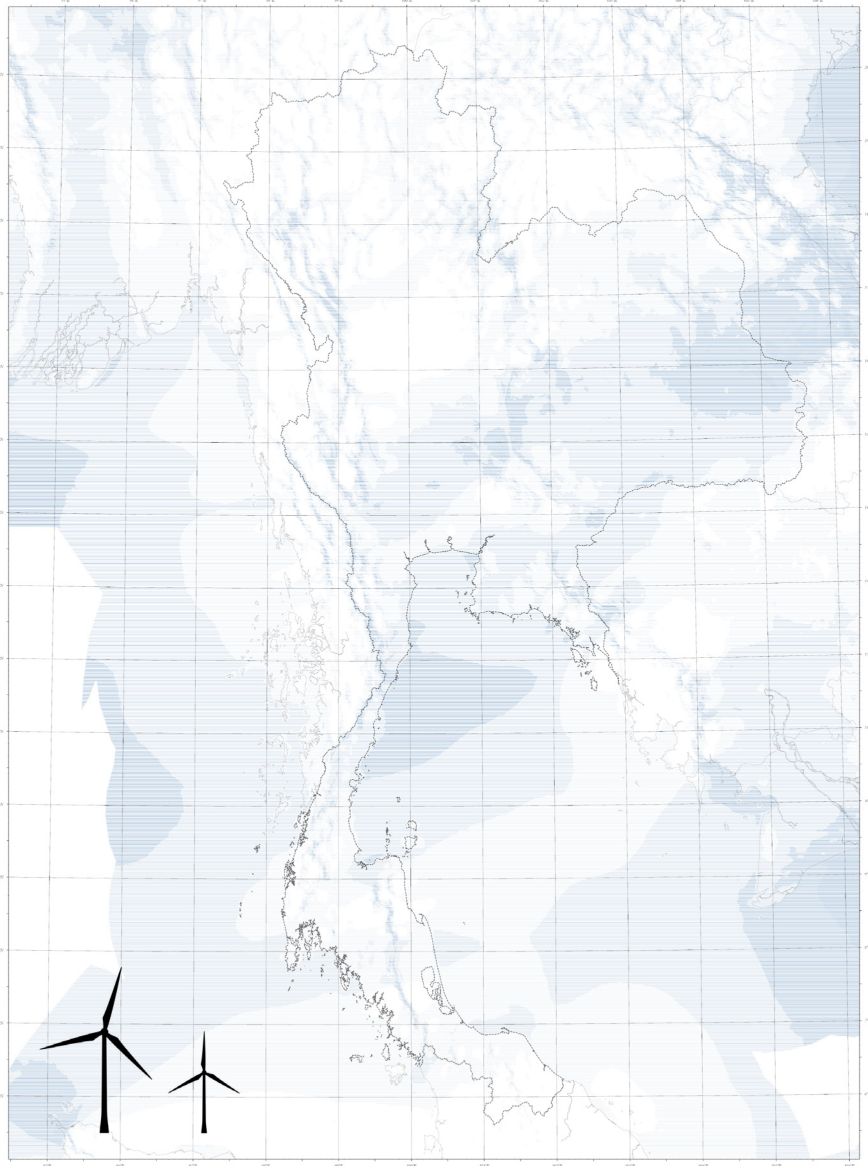
702,548,717 panels

solar ~ 200,000,000,000 kwh/year
thailand avg peak sun hour: 1,300 PSH/year
Solar system size required: kwh/year / 1,300 PSH/year
existing: 4,290,000,000 kwh
system loss: 23% (same as multiplying energy needs by 1.4
total additional energy require: 273,994,000,000
additional require: 273,994,000,000 kwh / 1,300 PSh = 210,764,615 kw (99,438 mw)

require: 702,548,717 panels
require land: 1,405,097,435 m2 (1,405 km2)

Wind

Wind Speed



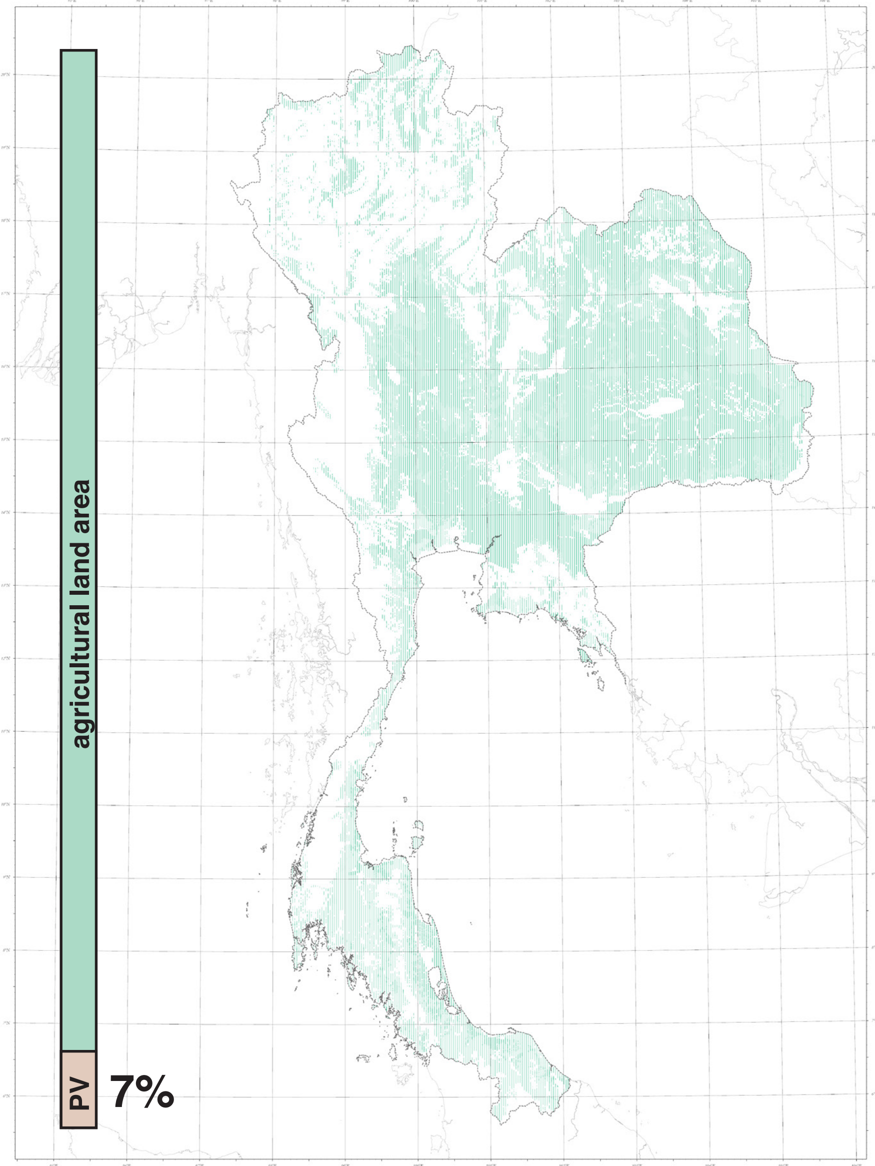
1,702 units of V150-4.2 MW

2065 wind ~ 30,000,000,000 kwh/year
area with suitable avg wind speed@100m: 6m/s
vestas V150-4.2 MW wind turbine required: 30,000,000,000 kwh/year / 15,100,000 kwh/year
existing: 4,300,000,000 kwh
additional require: 25,700,000,000 kwh/year / 15,100,000 kwh/year

1,702 units of vestas V150-4.2 MW
land require 2,052 km2

Biomass

Agricultural Area



waste potential: 14,600,000,000 kwh/year

2065 wind ~ 30,000,000,000 kwh/year
area with suitable avg wind speed@100m: 6m/s
vestas V150-4.2 MW wind turbine required: 30,000,000,000 kwh/year / 15,100,000 kwh/year
existing: 4,300,000,000 kwh
additional require: 25,700,000,000 kwh/year / 15,100,000 kwh/year

1,702 units of vestas V150-4.2 MW
land require 2,052 km2

2065 Renewable Resources

I then translate that into the amount of solar, wind, and agricultural waste apparatus required to get us off fossil fuel. 12 pv panels per citizen, 1702 units of utility-scale wind turbines which will be deployed on 7% of agricultural land where the resources are.

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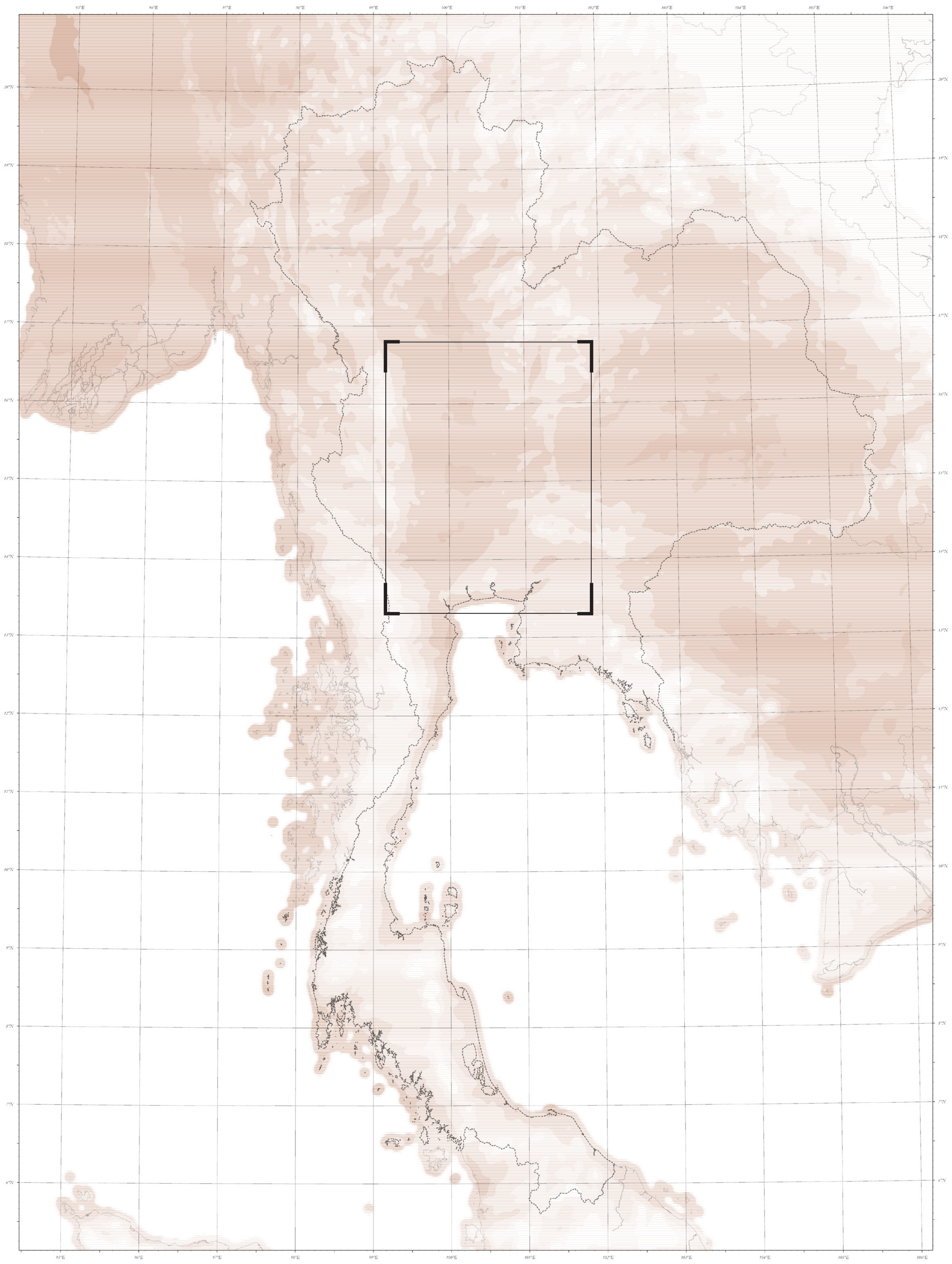
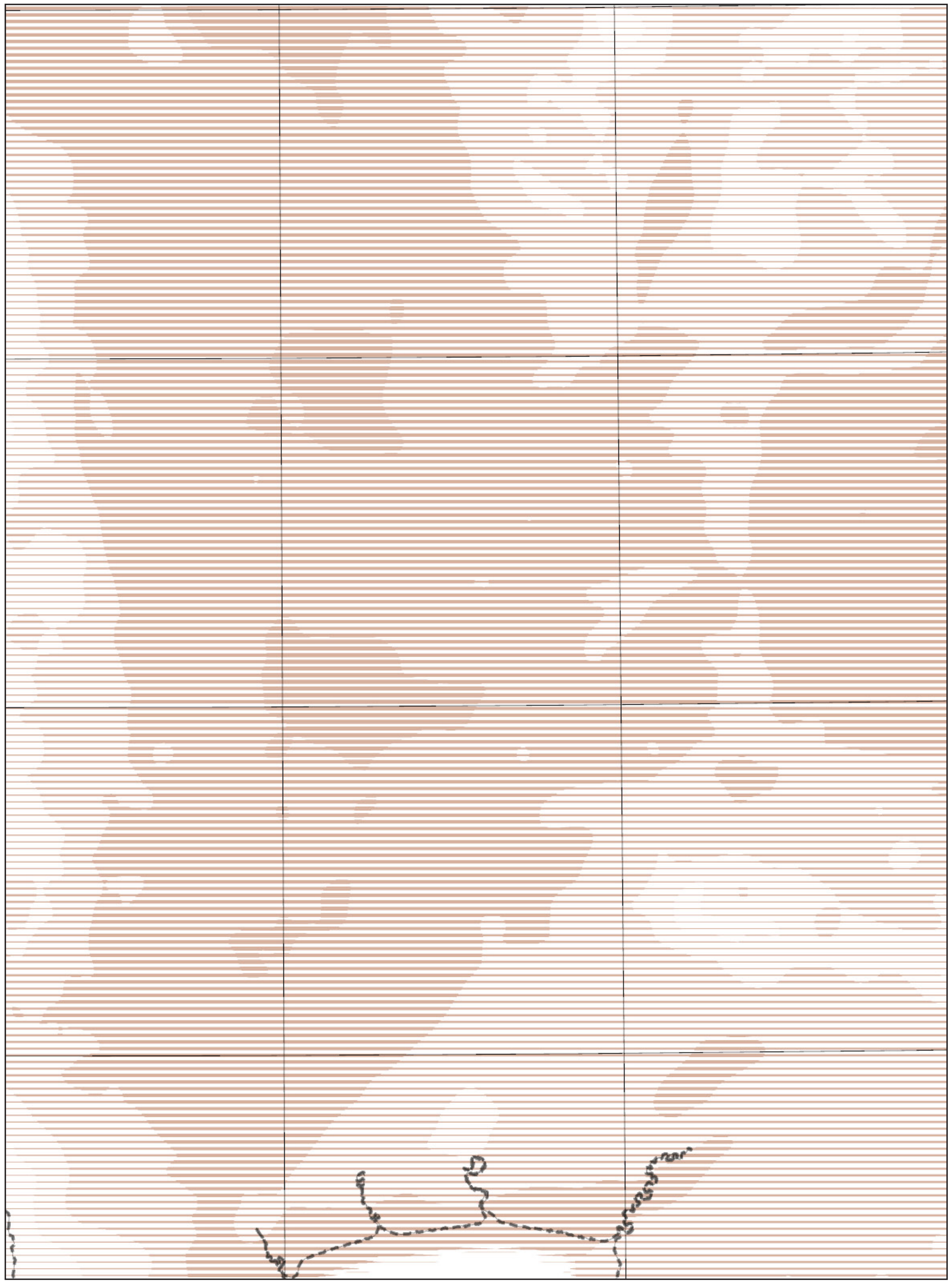
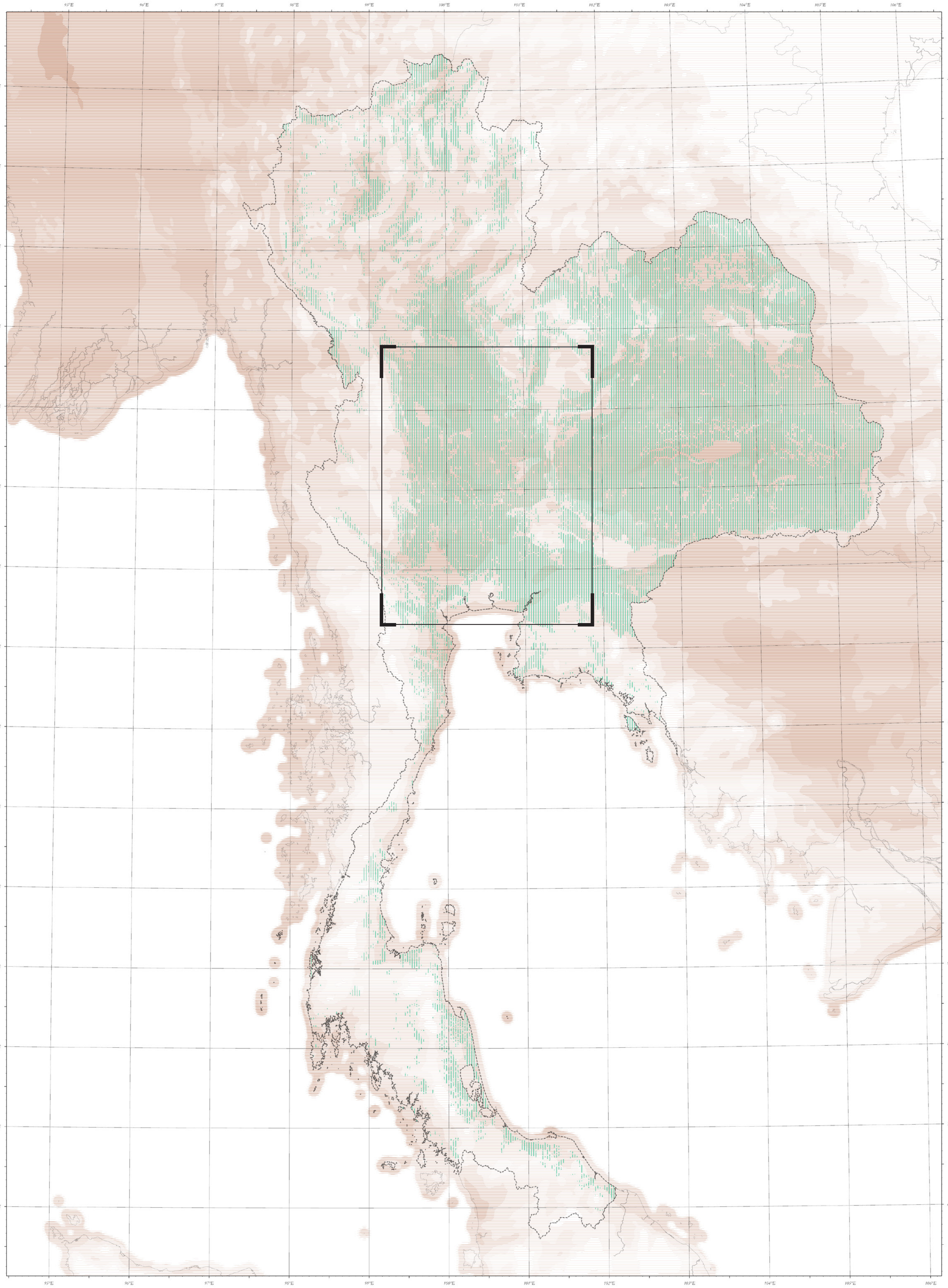
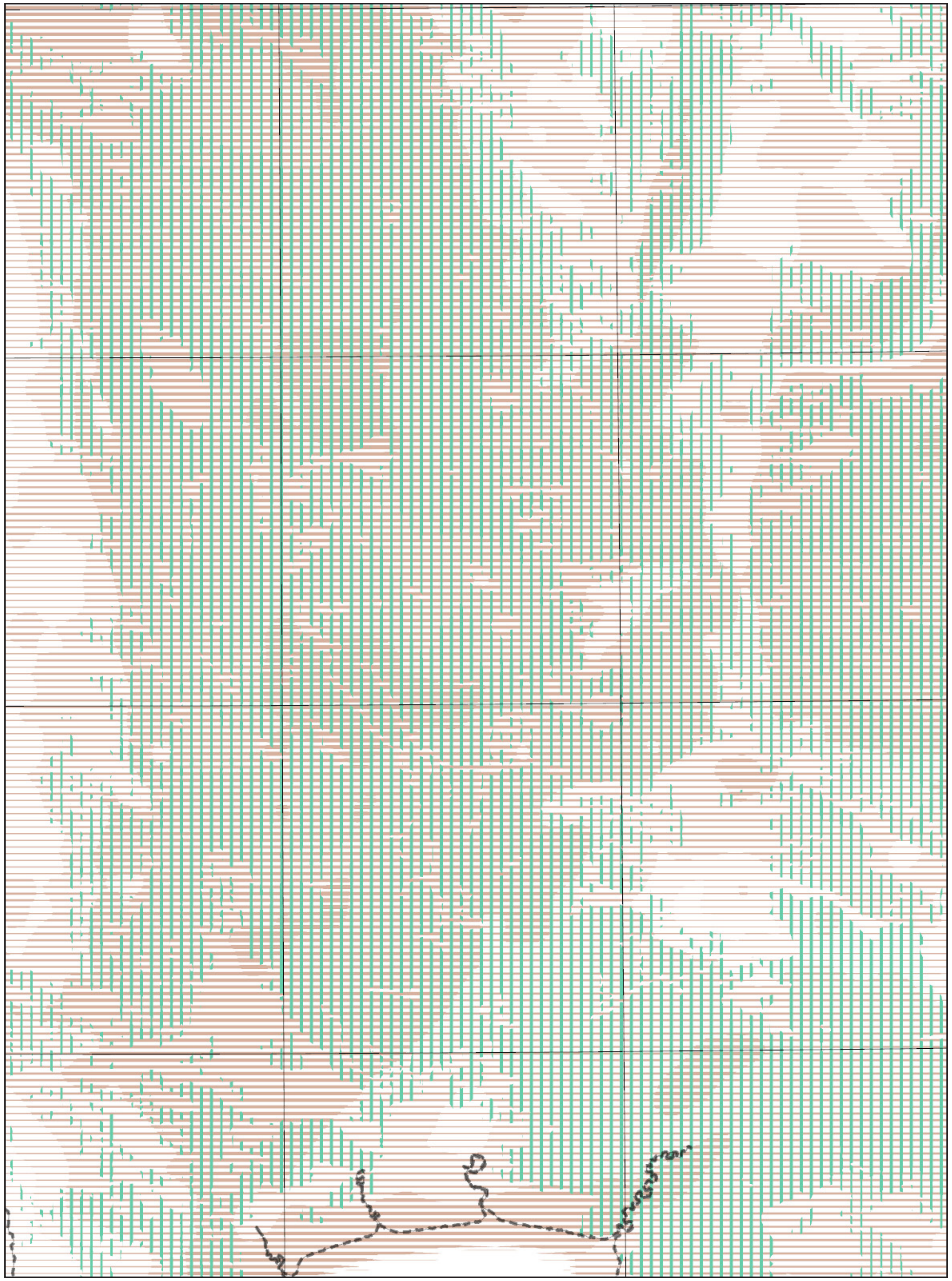




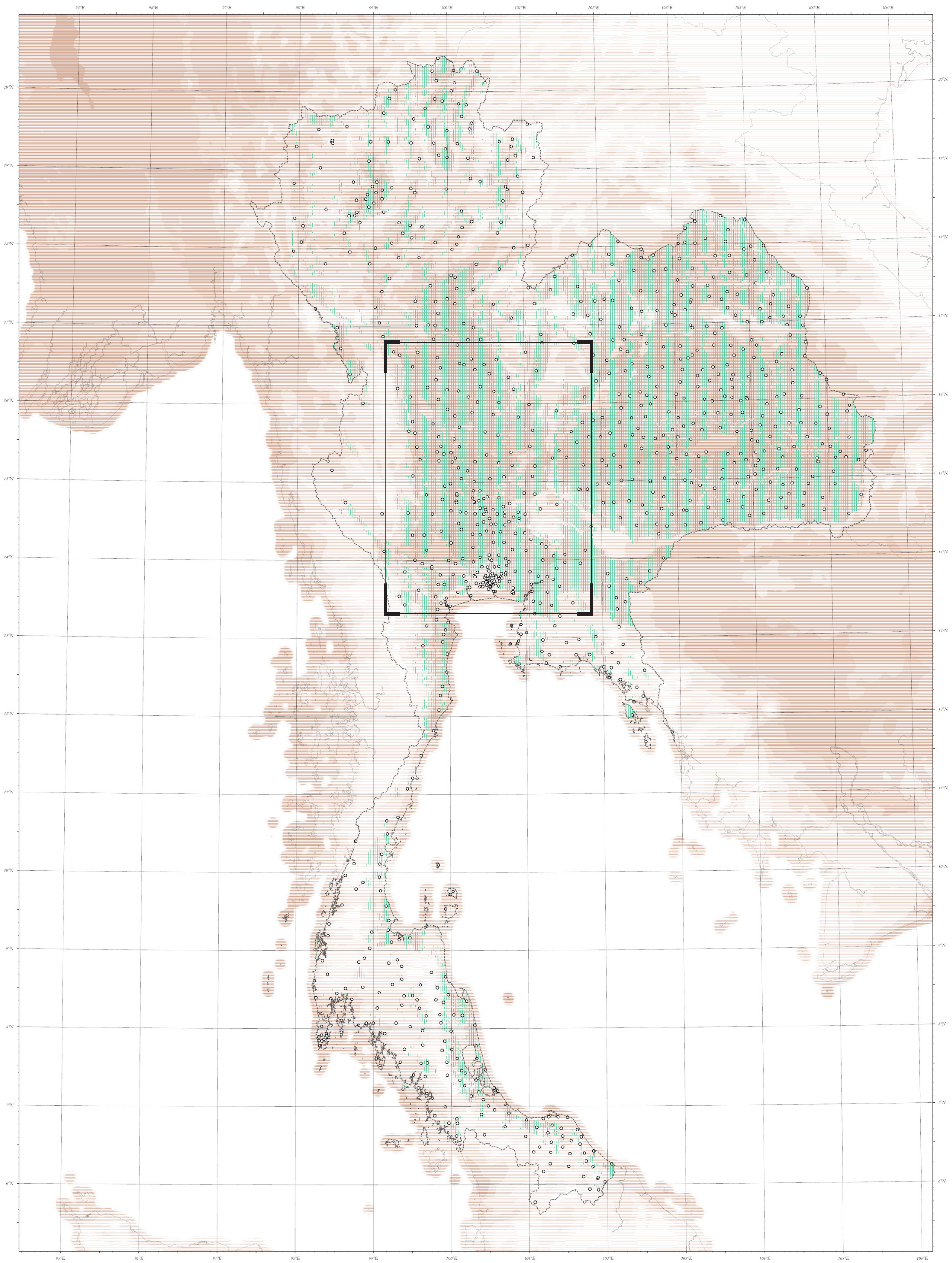
Spatializing Solar PV and Biomass Network (Direct Solar Irradiance)

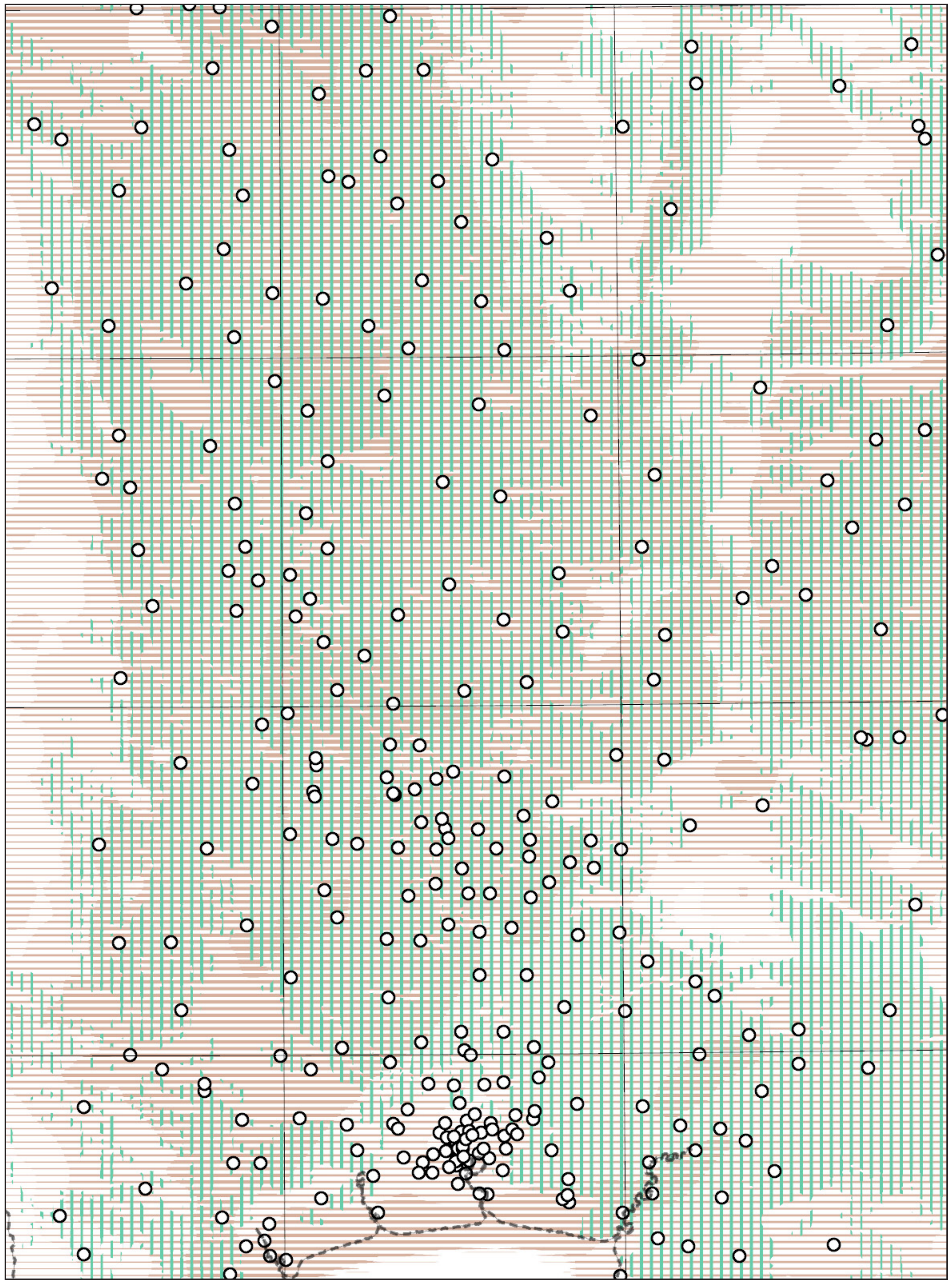
by: Pavin Banternghansa
Advisor: Niall Kirkwood



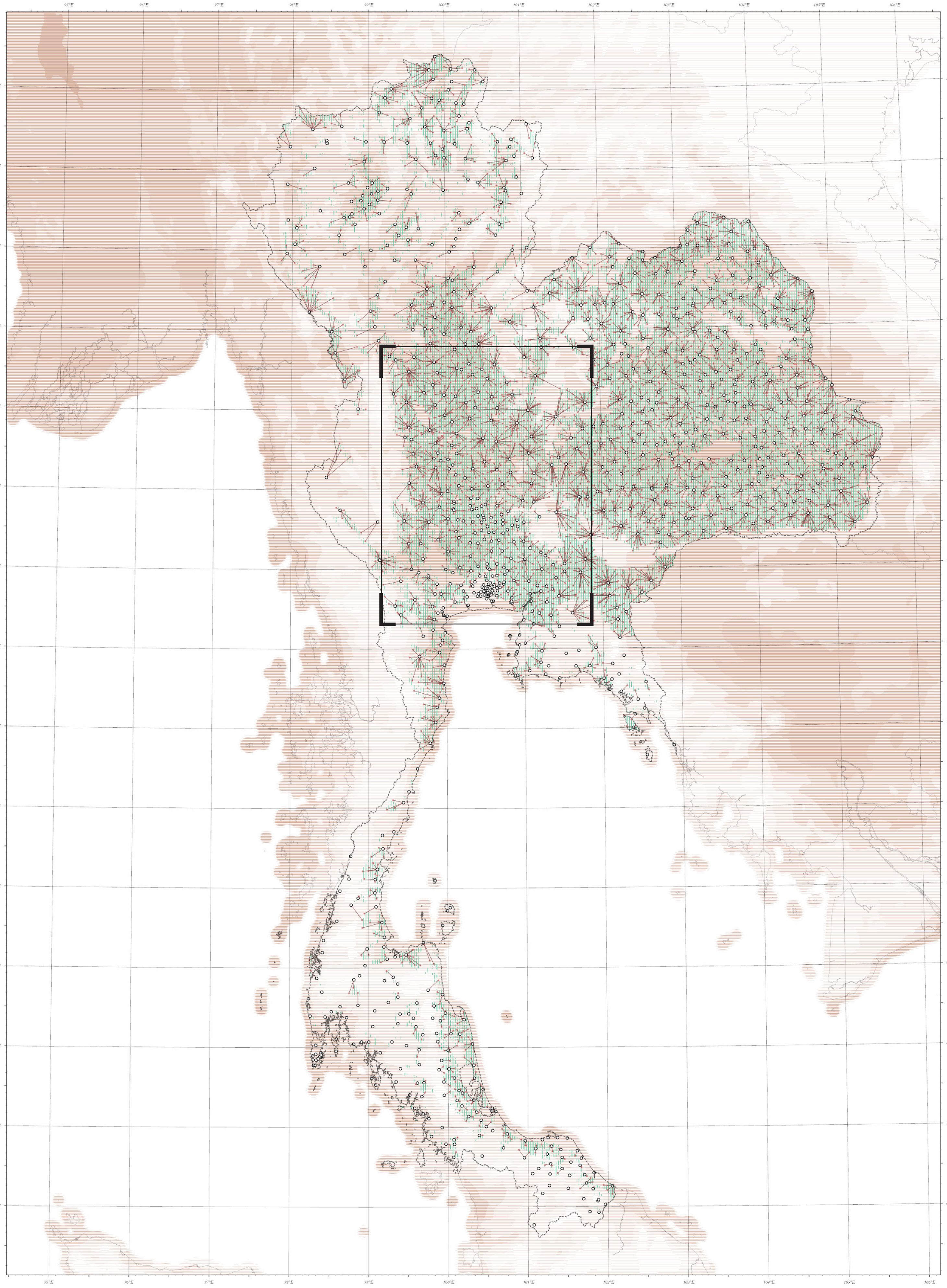


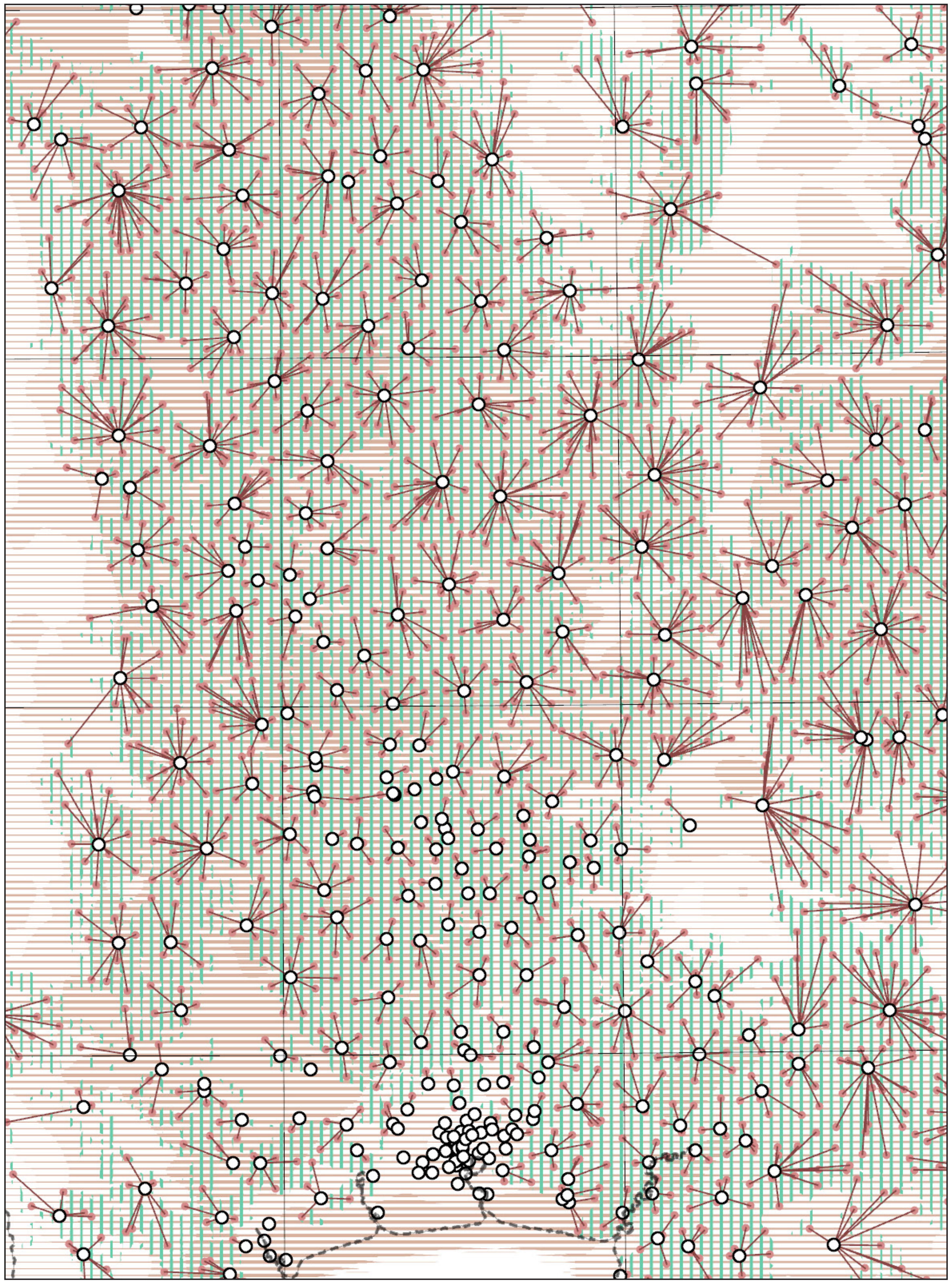
Rice Paddies and Field Crops





Existing Communities with 2,000+ population





Solar and Bioenergy Decentralized Infrastructure

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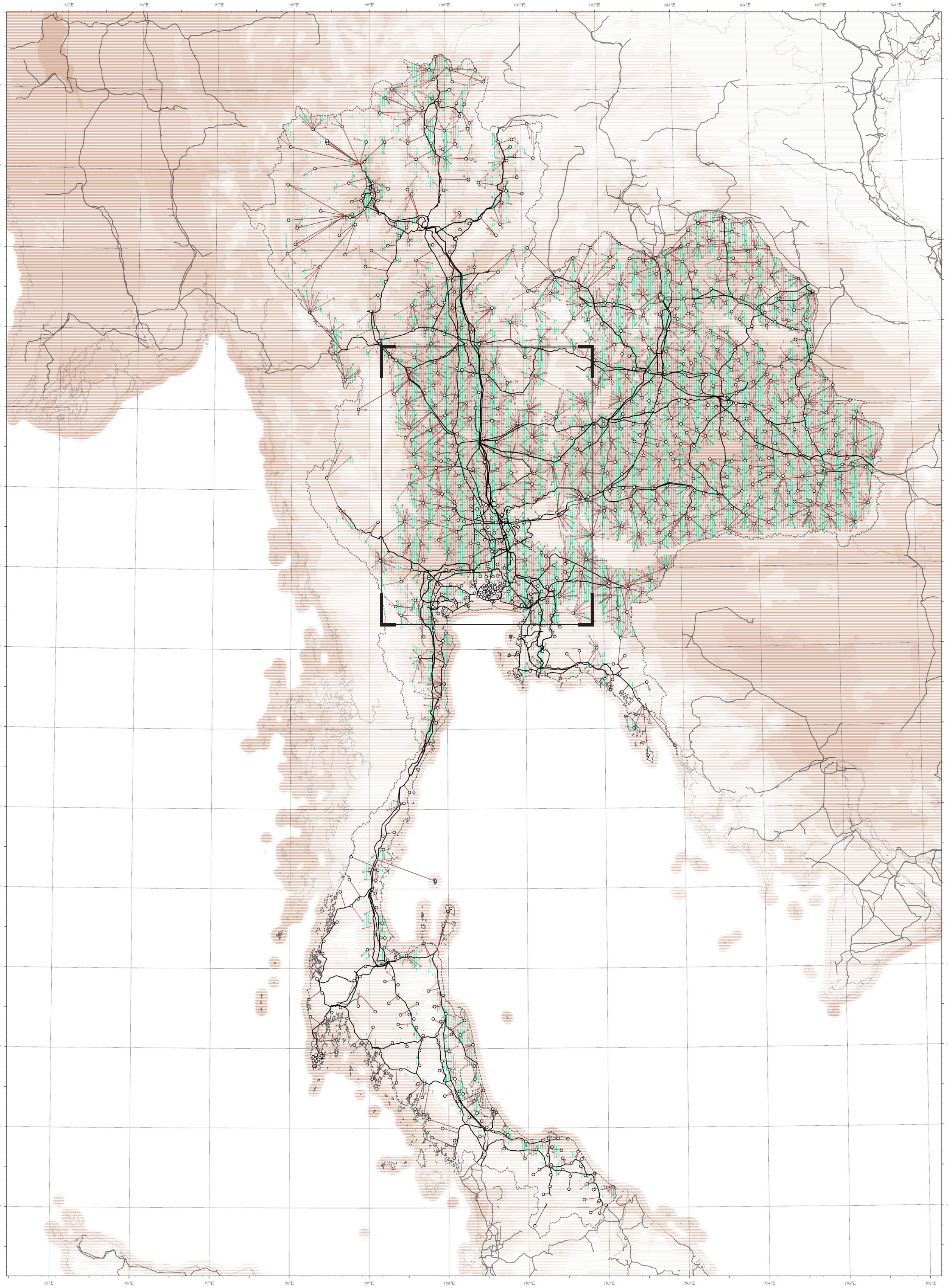
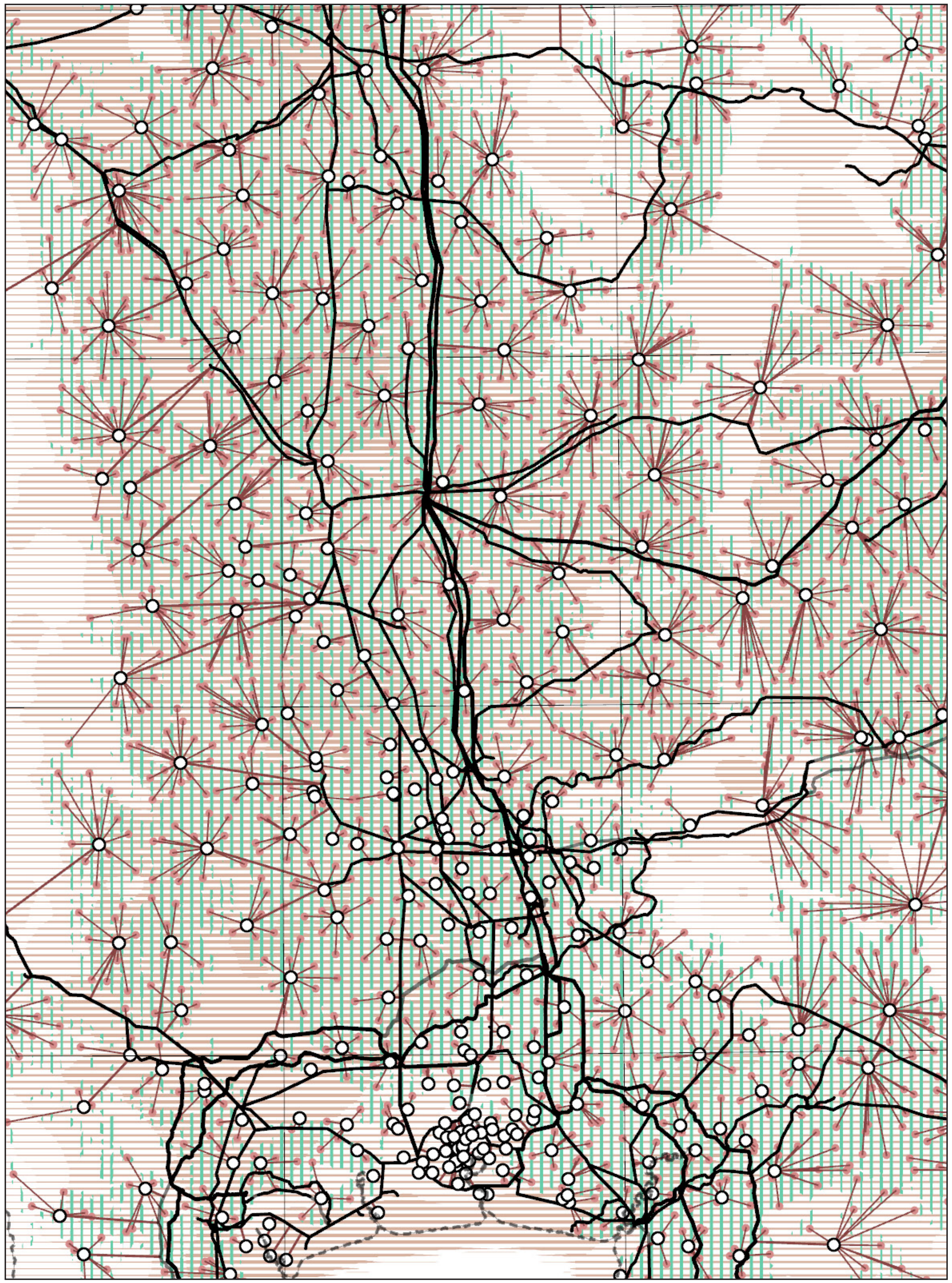
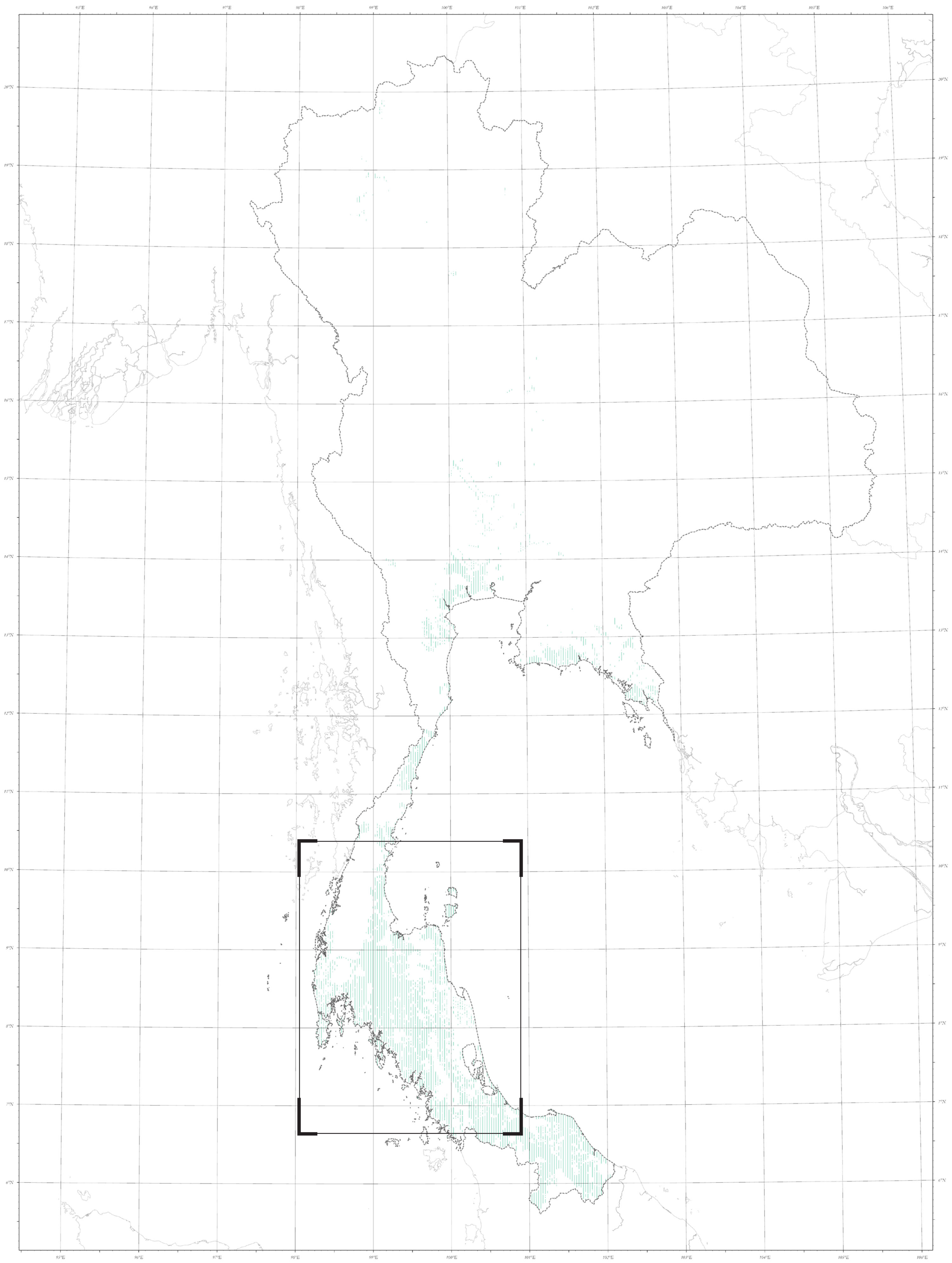
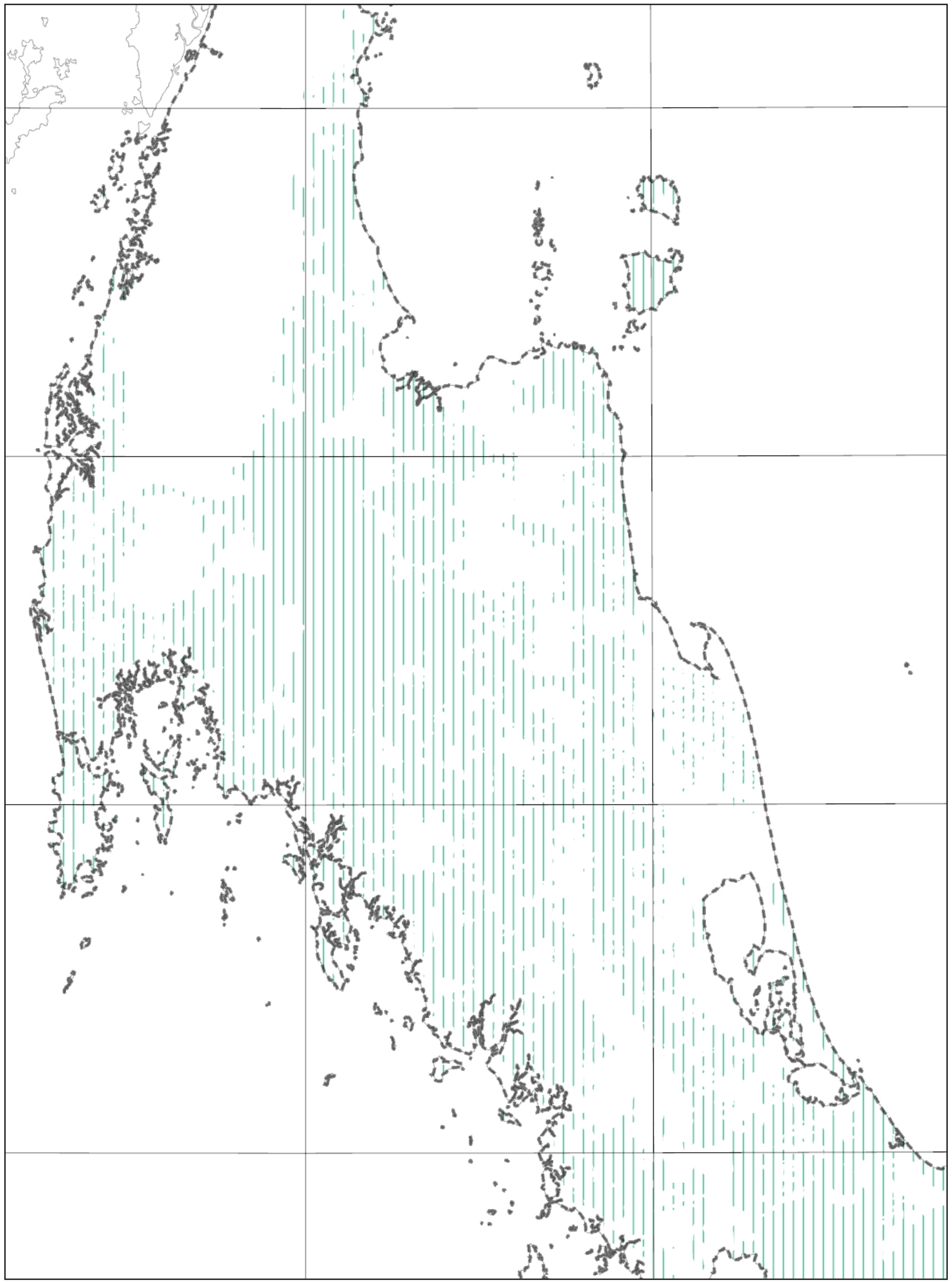
Advisor: Niall Kirkwood





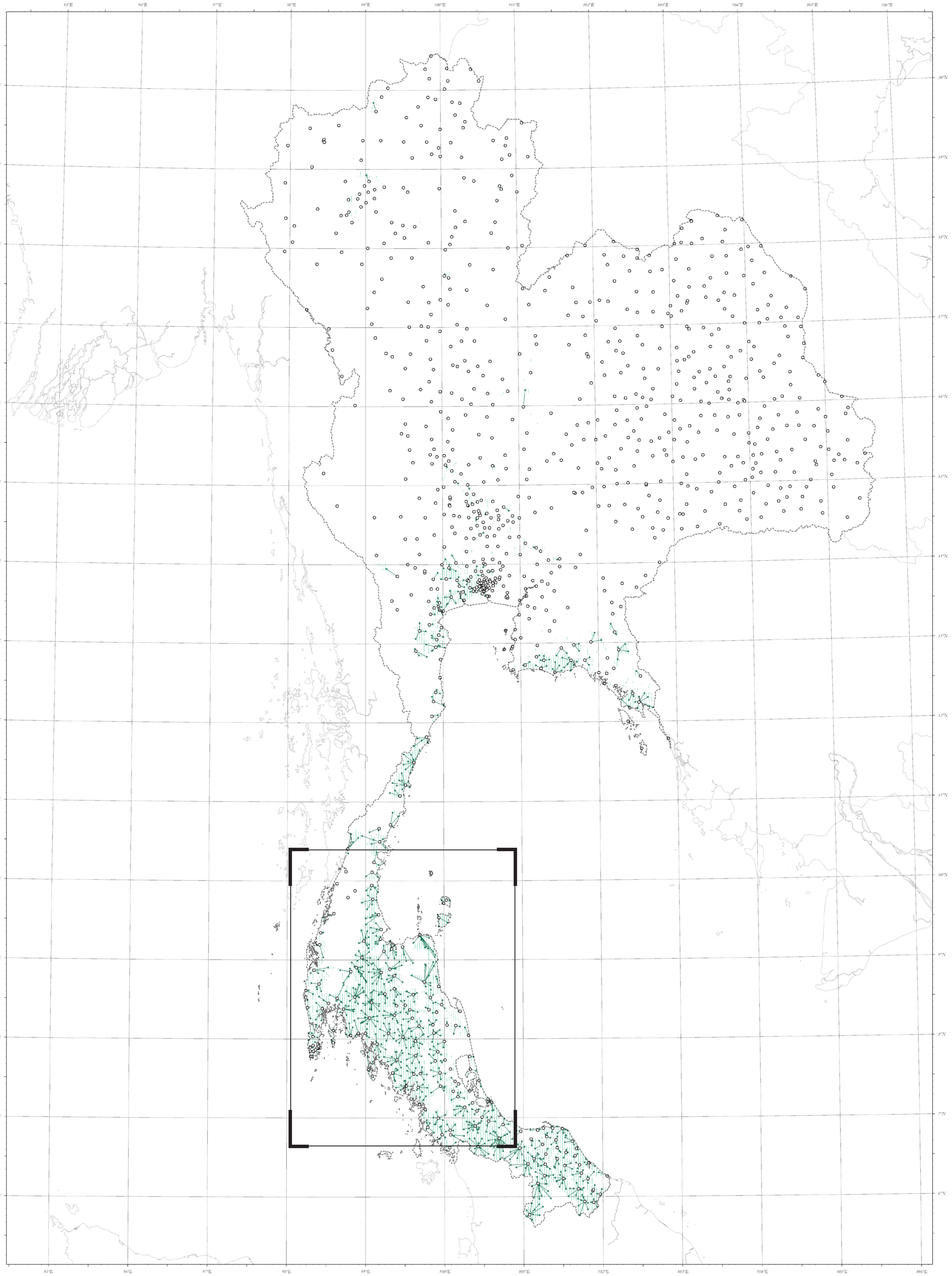
Connection to The Grid

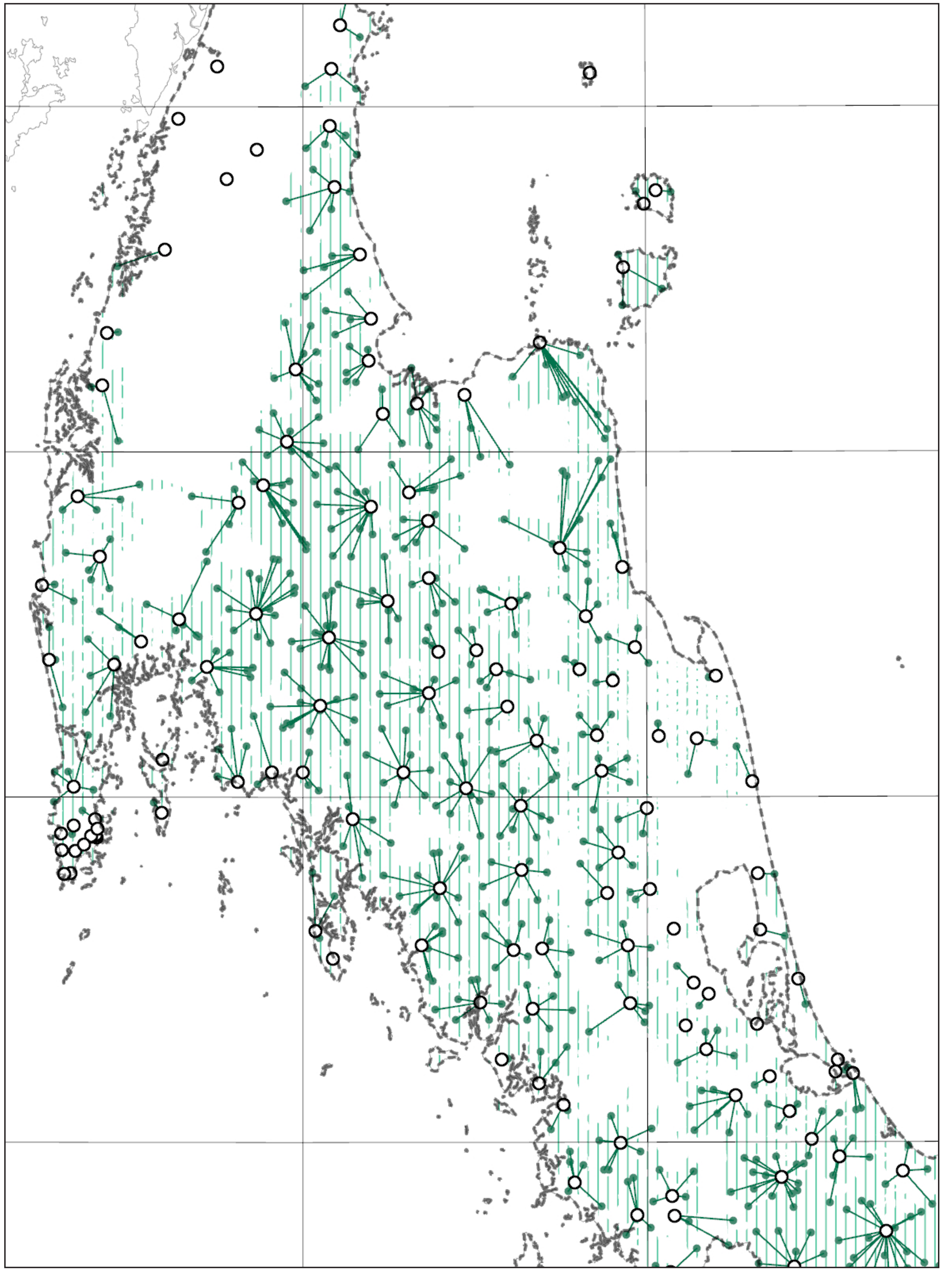




Rubber, Orchard, and Palm Oil Plantations

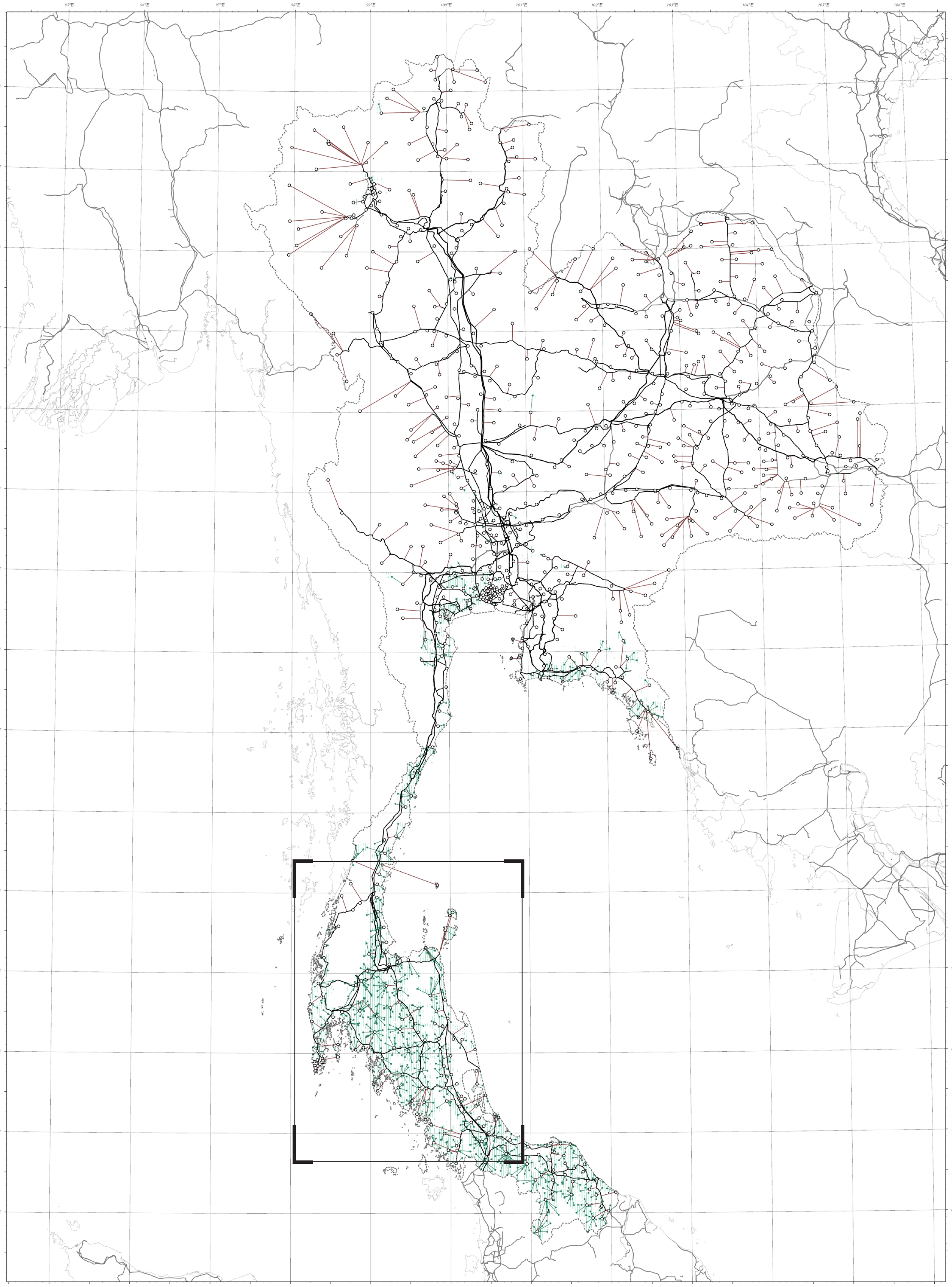
by: Pavin Banternghansa
Advisor: Niall Kirkwood

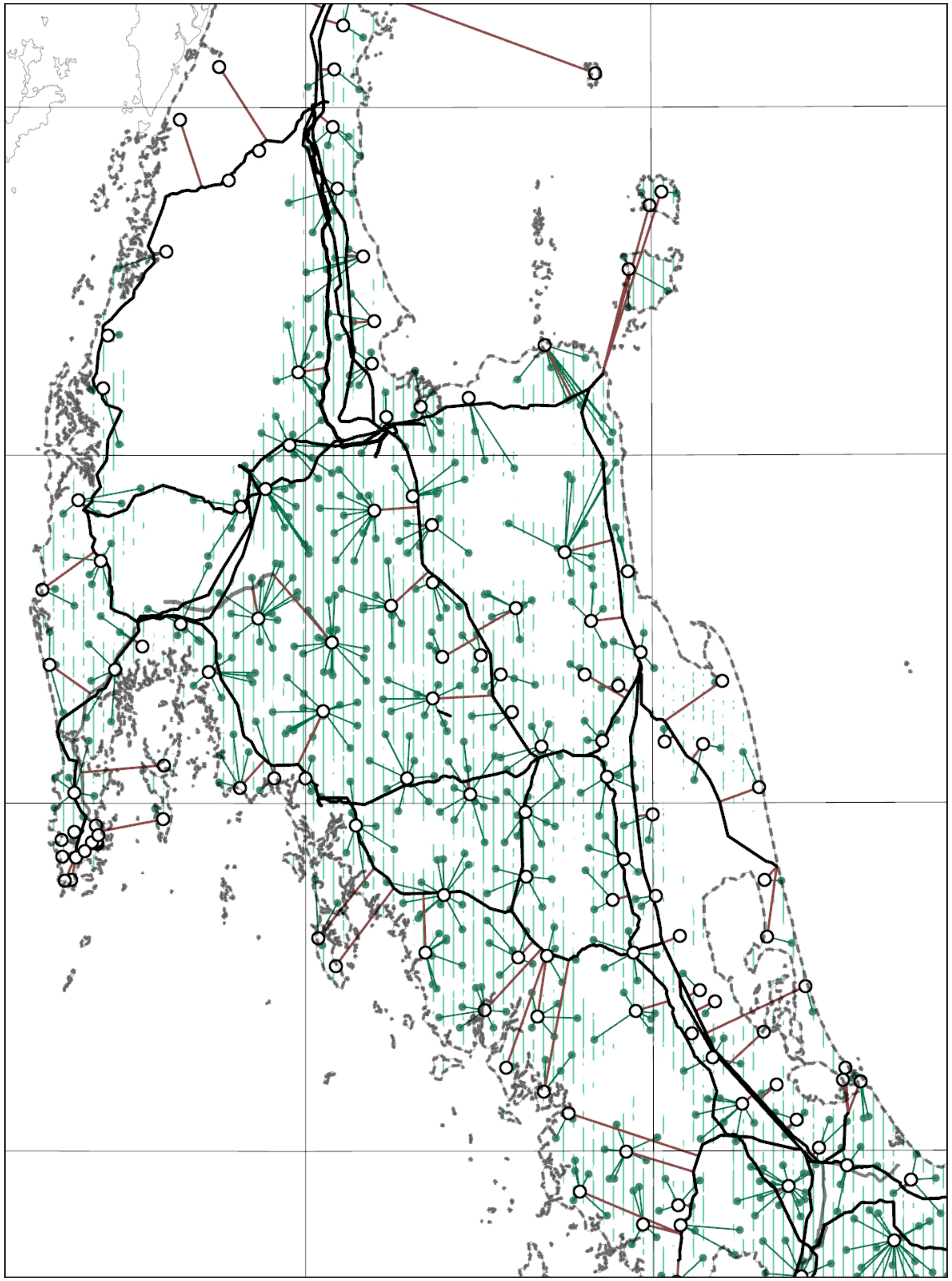




Decentralized Bioenergy Infrastructure
Processing + Bio-powerplant

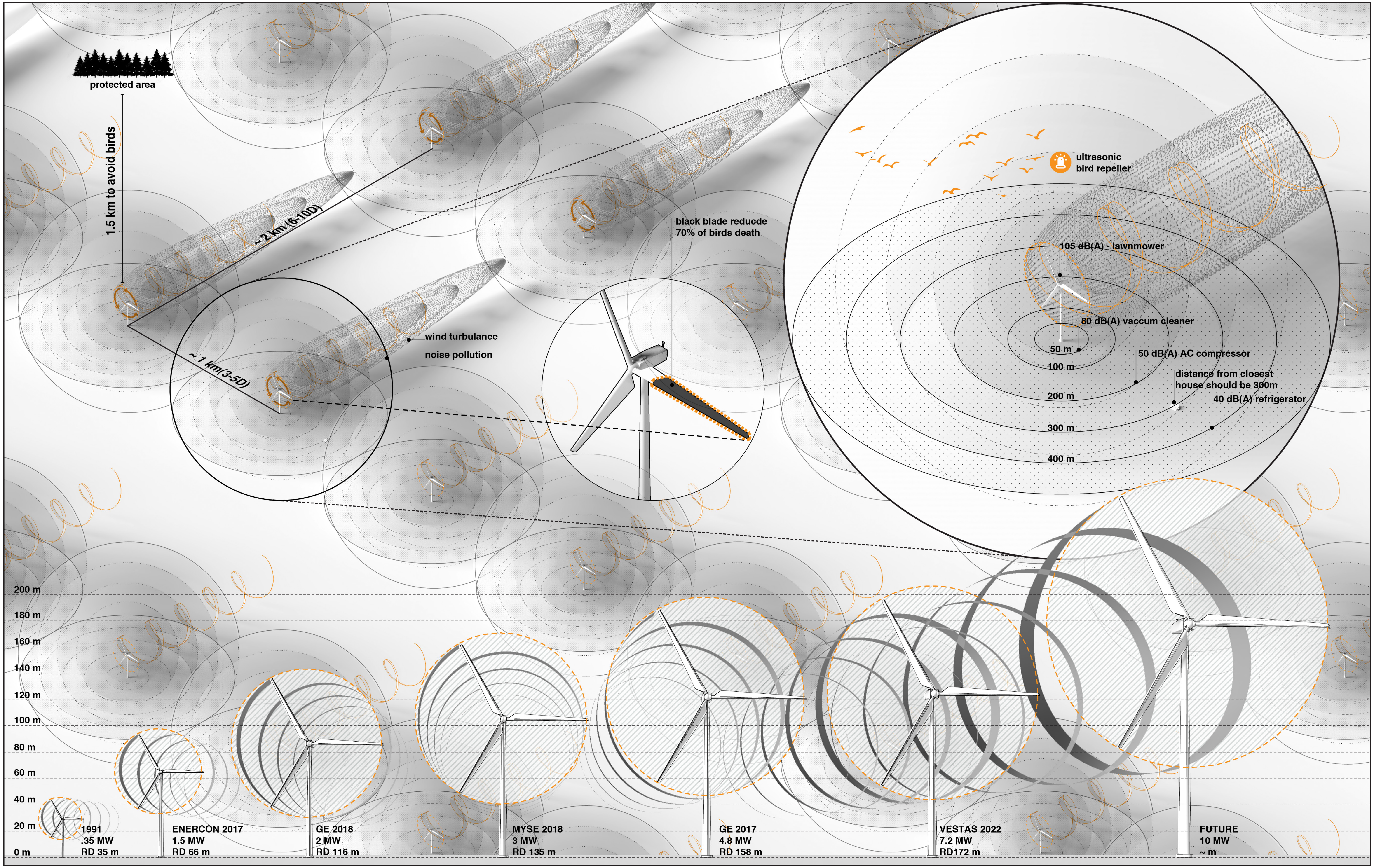
by: Pavin Banternghansa
Advisor: Niall Kirkwood





Connection to The Grid

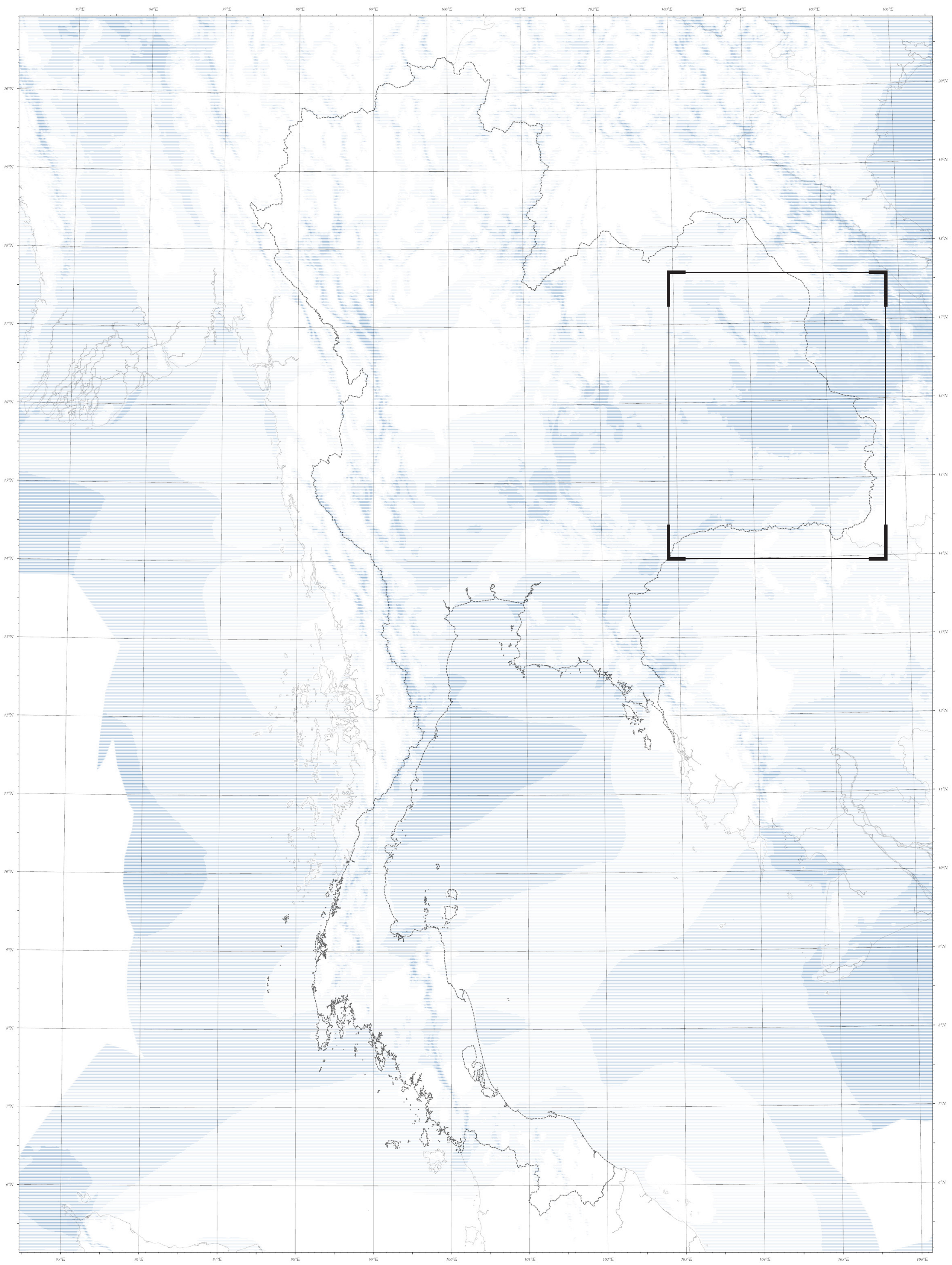
by: Pavin Banternghansa
Advisor: Niall Kirkwood

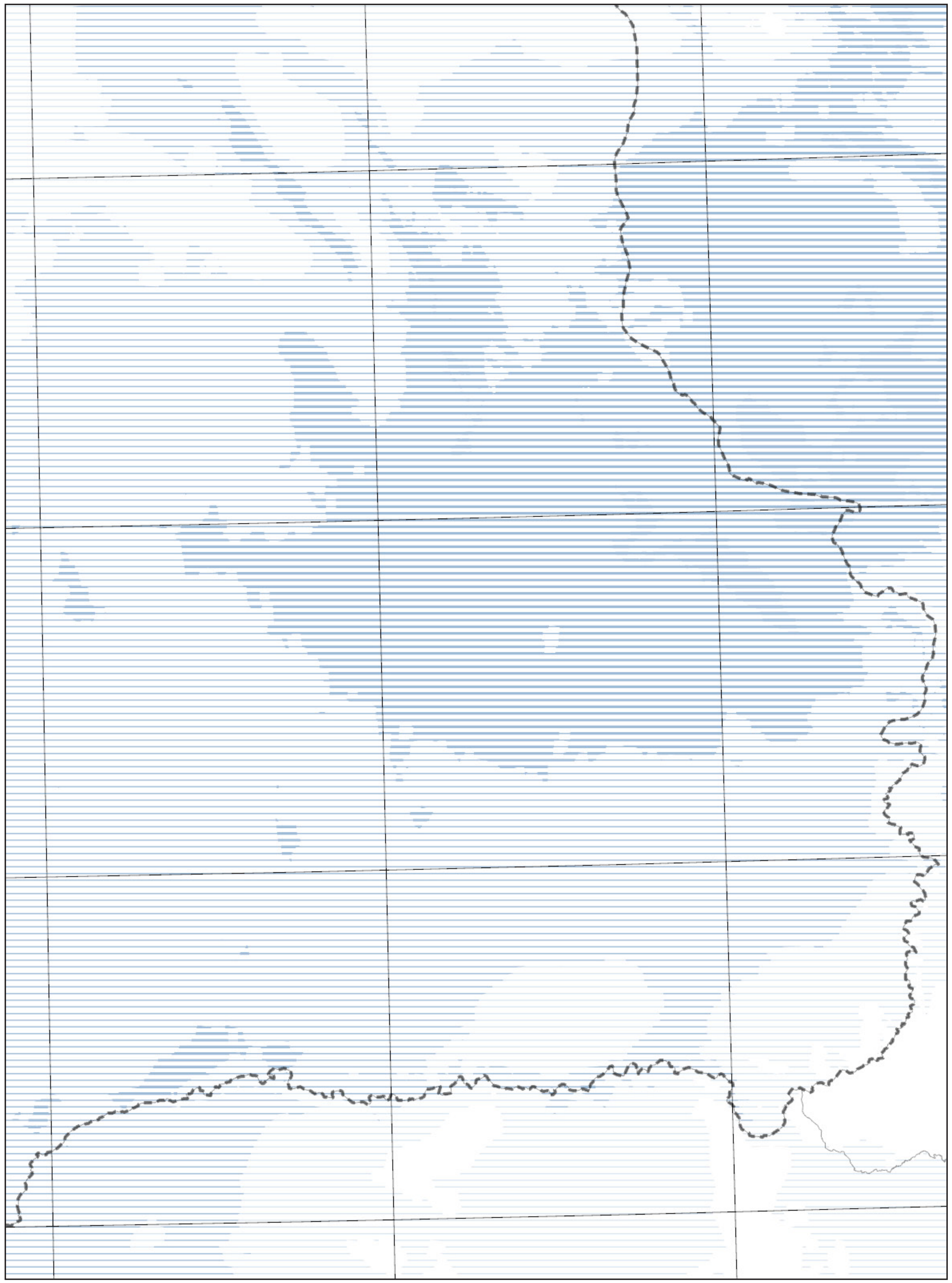


Wind Turbine Spatial Requirement

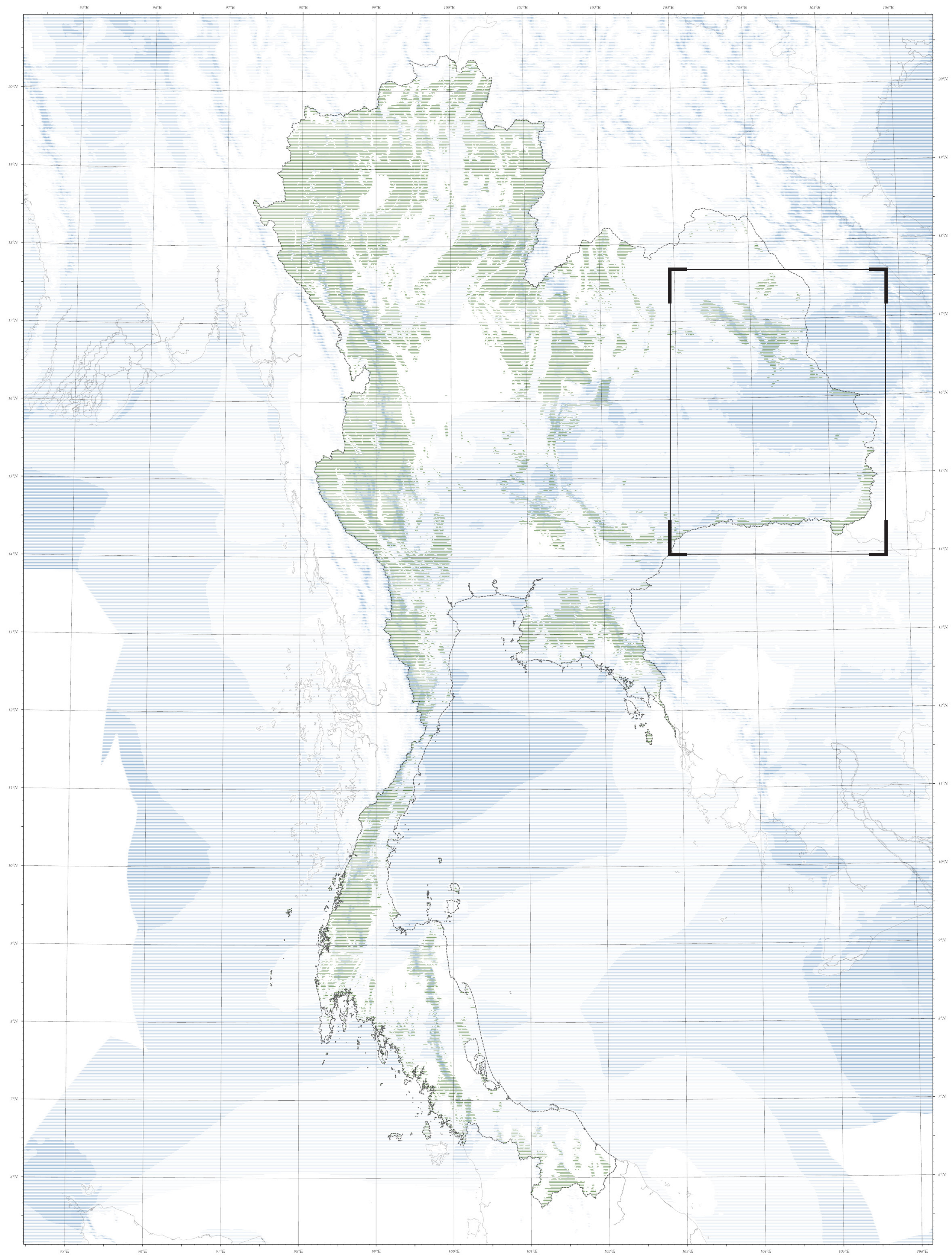
As for wind power, industrial-scale wind turbines need to be 1 mile away from forests with blades painted black to reduce birds' deaths.

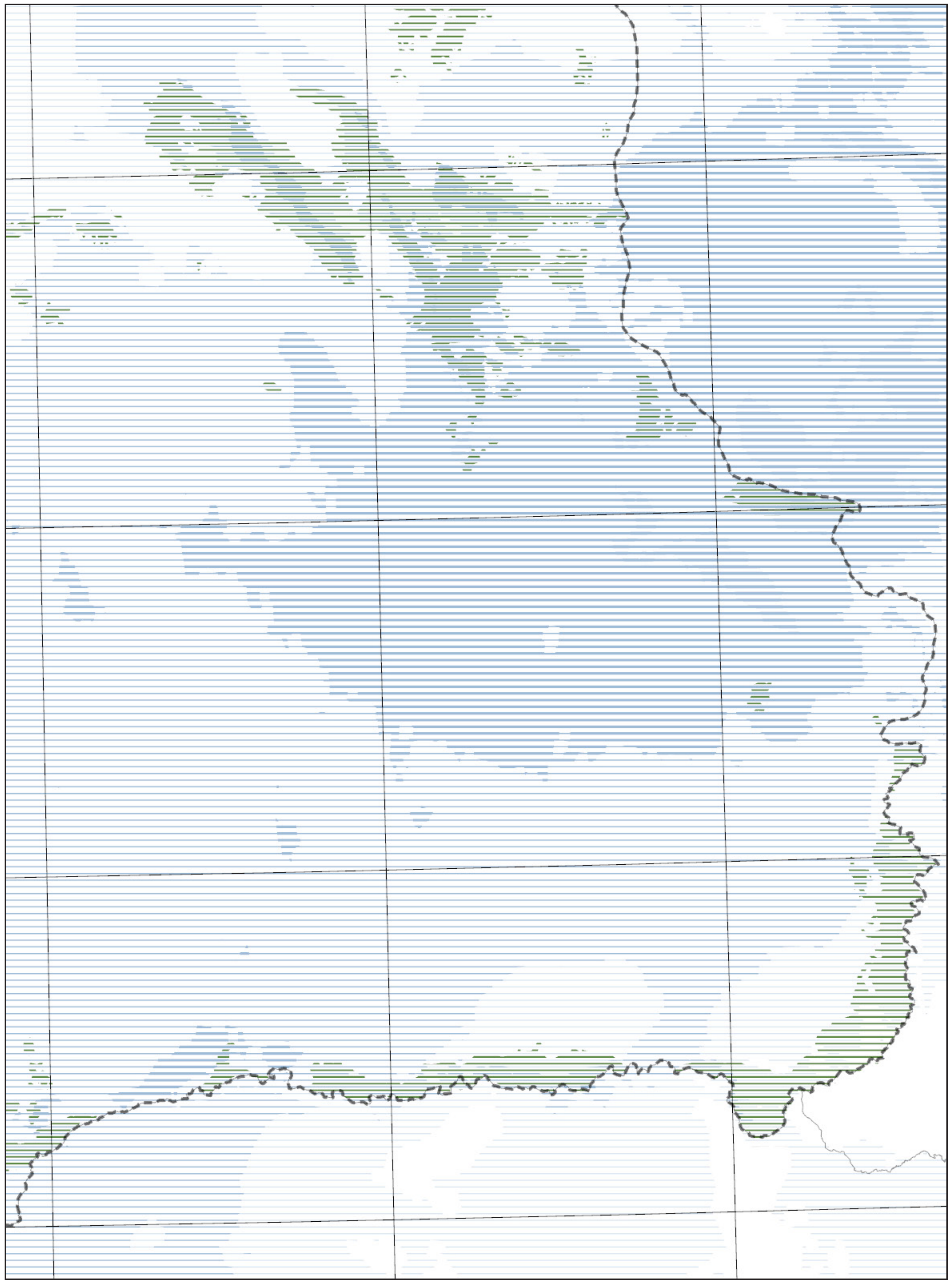
by: Pavin Banternghansa
Advisor: Niall Kirkwood



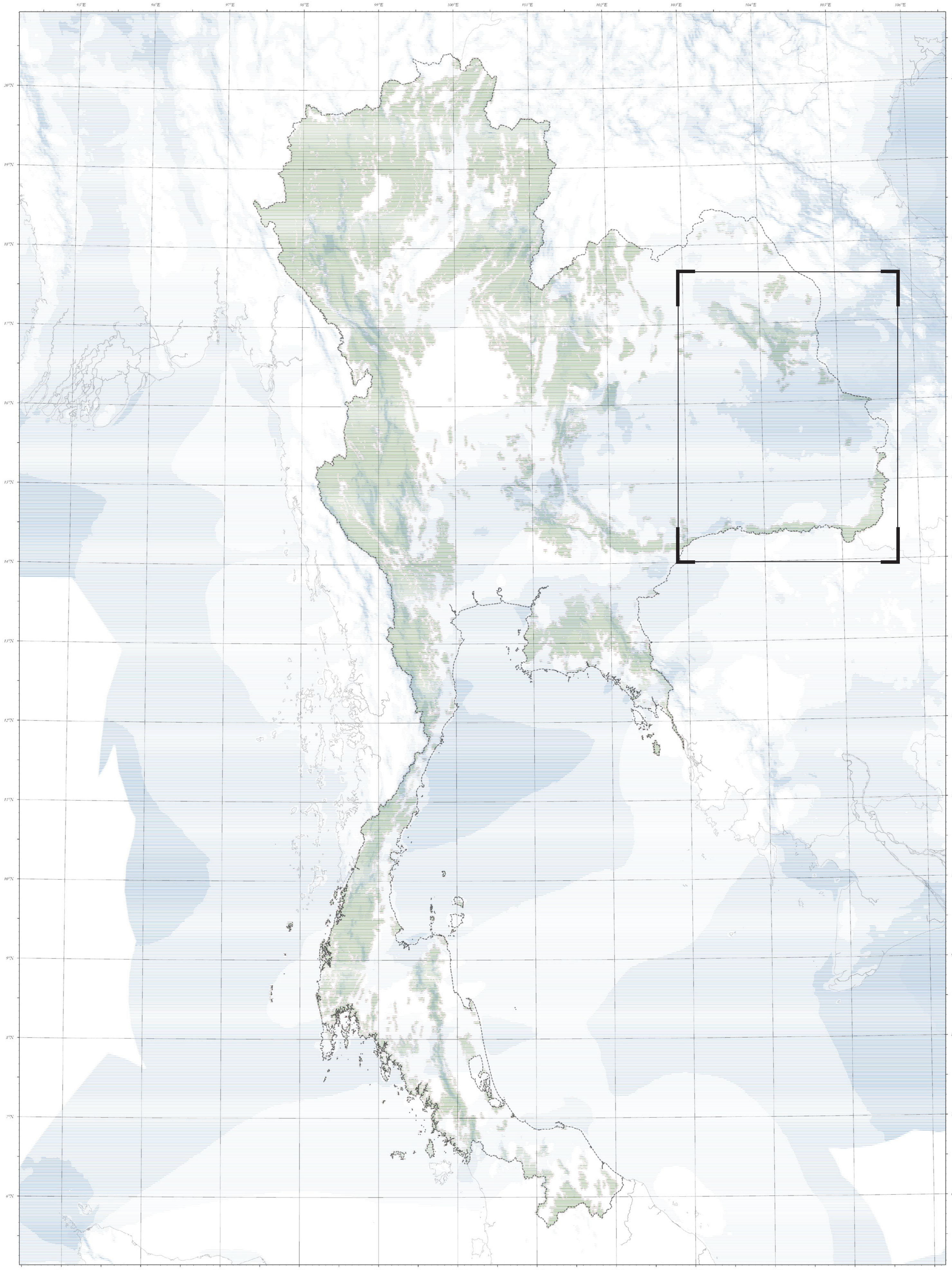


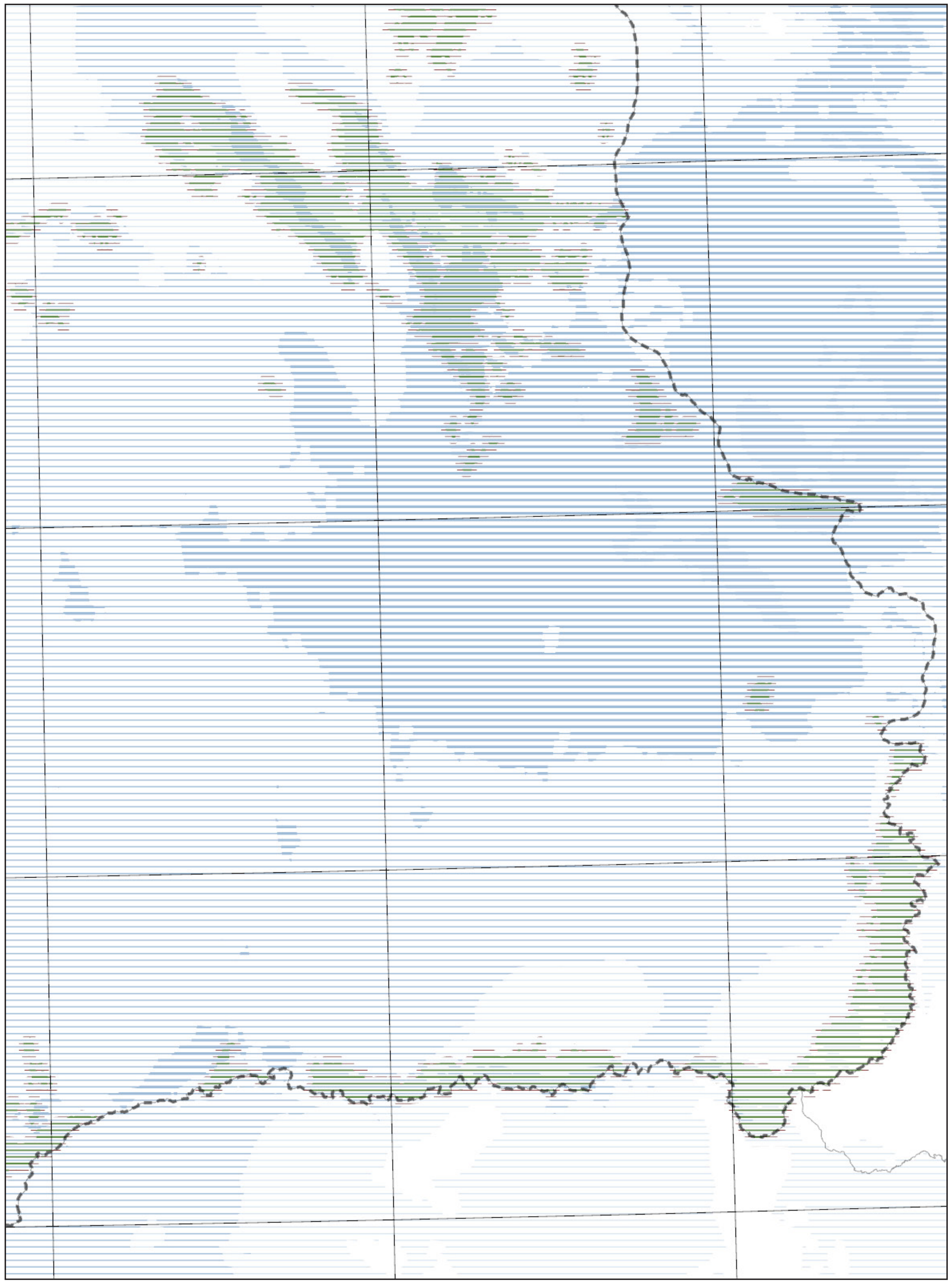
Wind Speed





Forests





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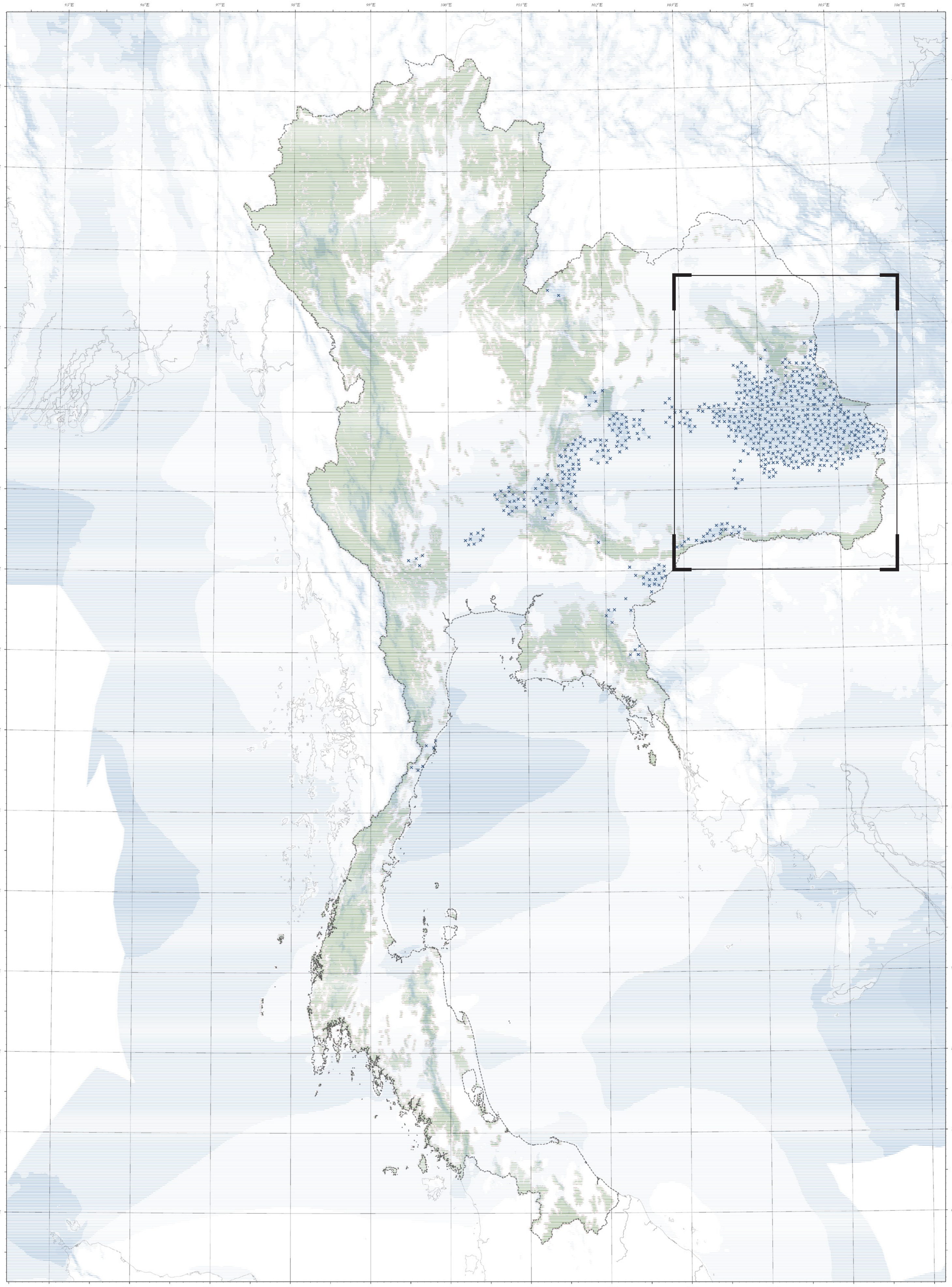
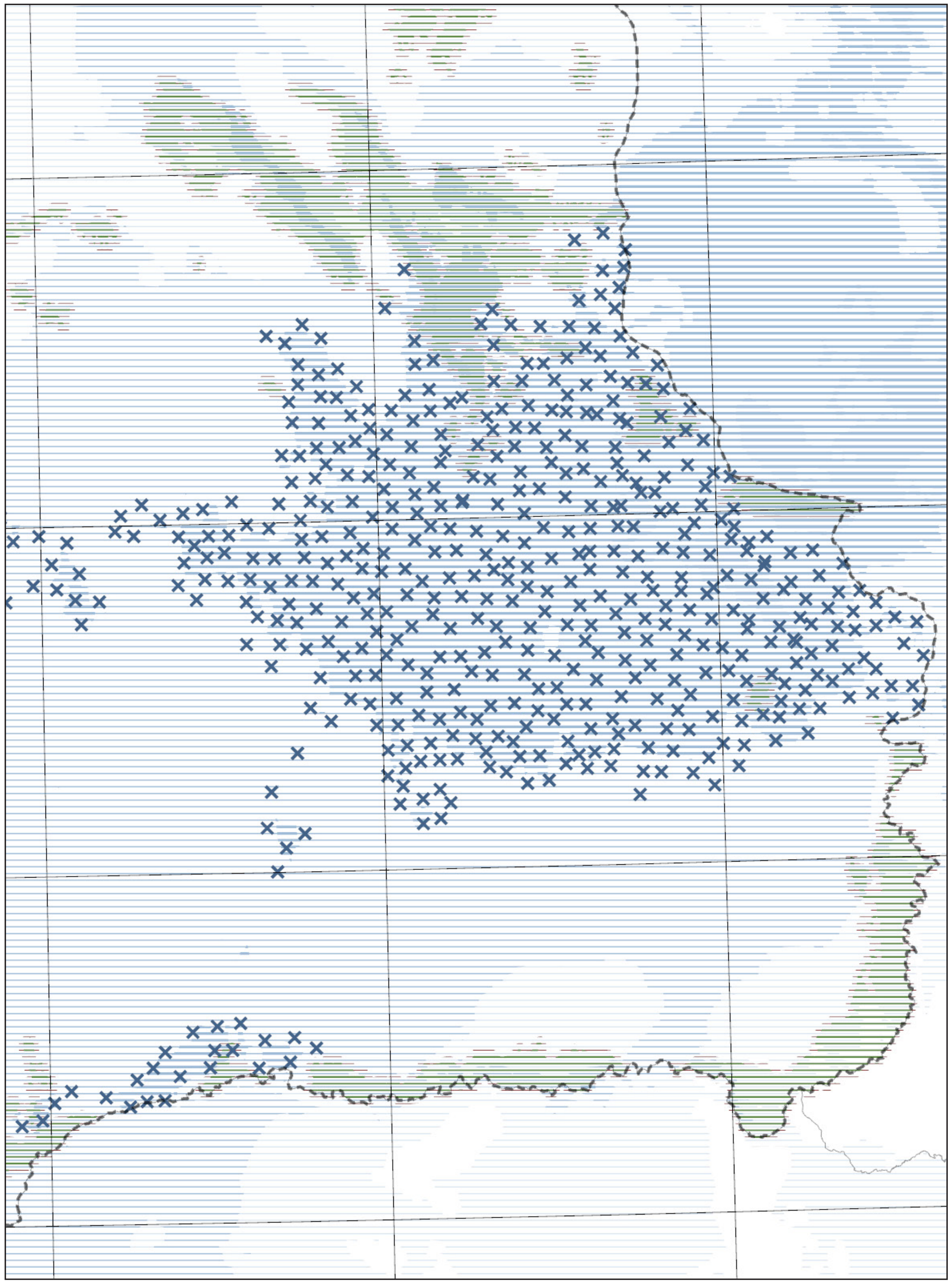
1.5km (1mile) Forest Offset

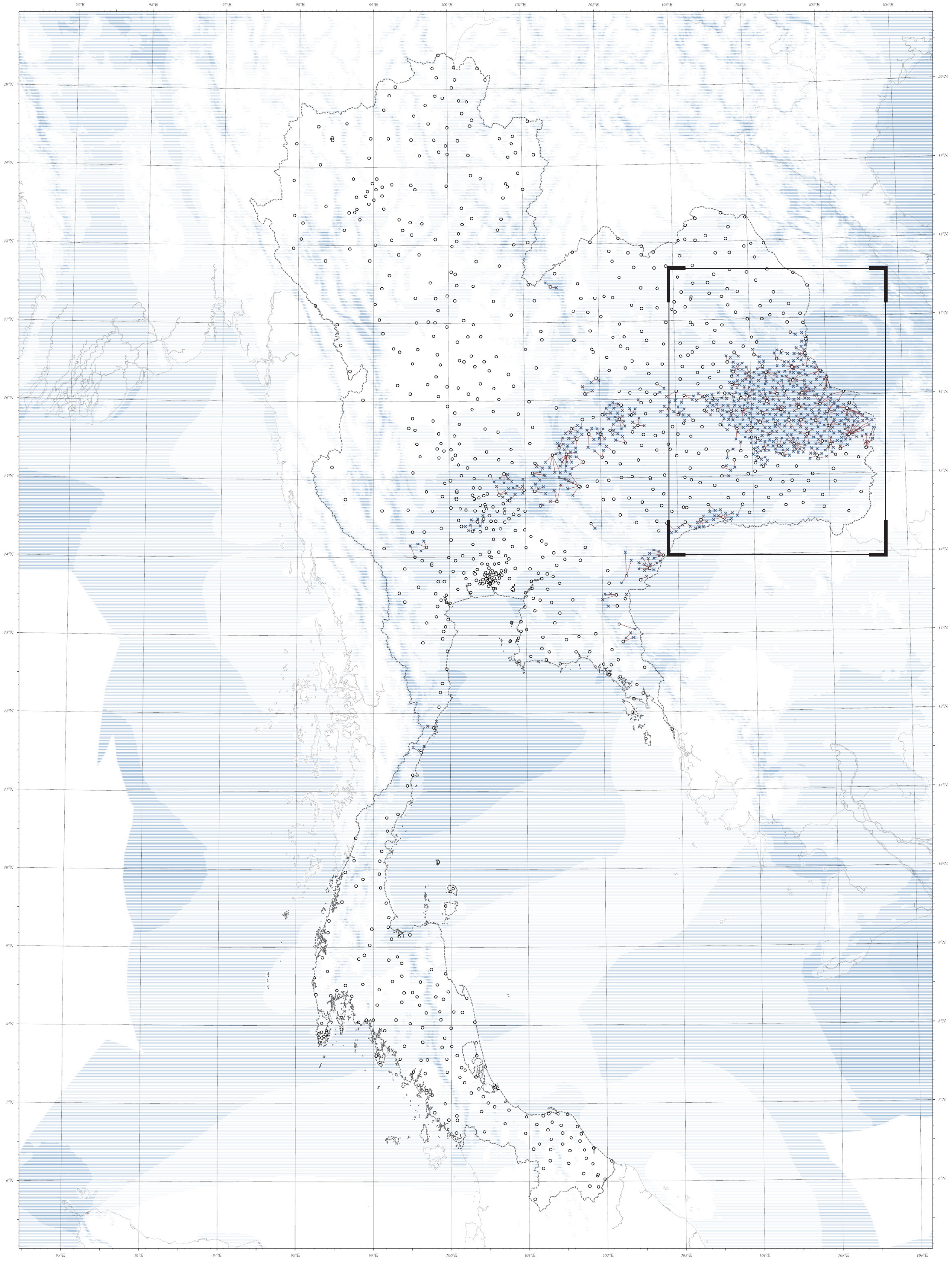
by: Pavin Banternghansa
Advisor: Niall Kirkwood

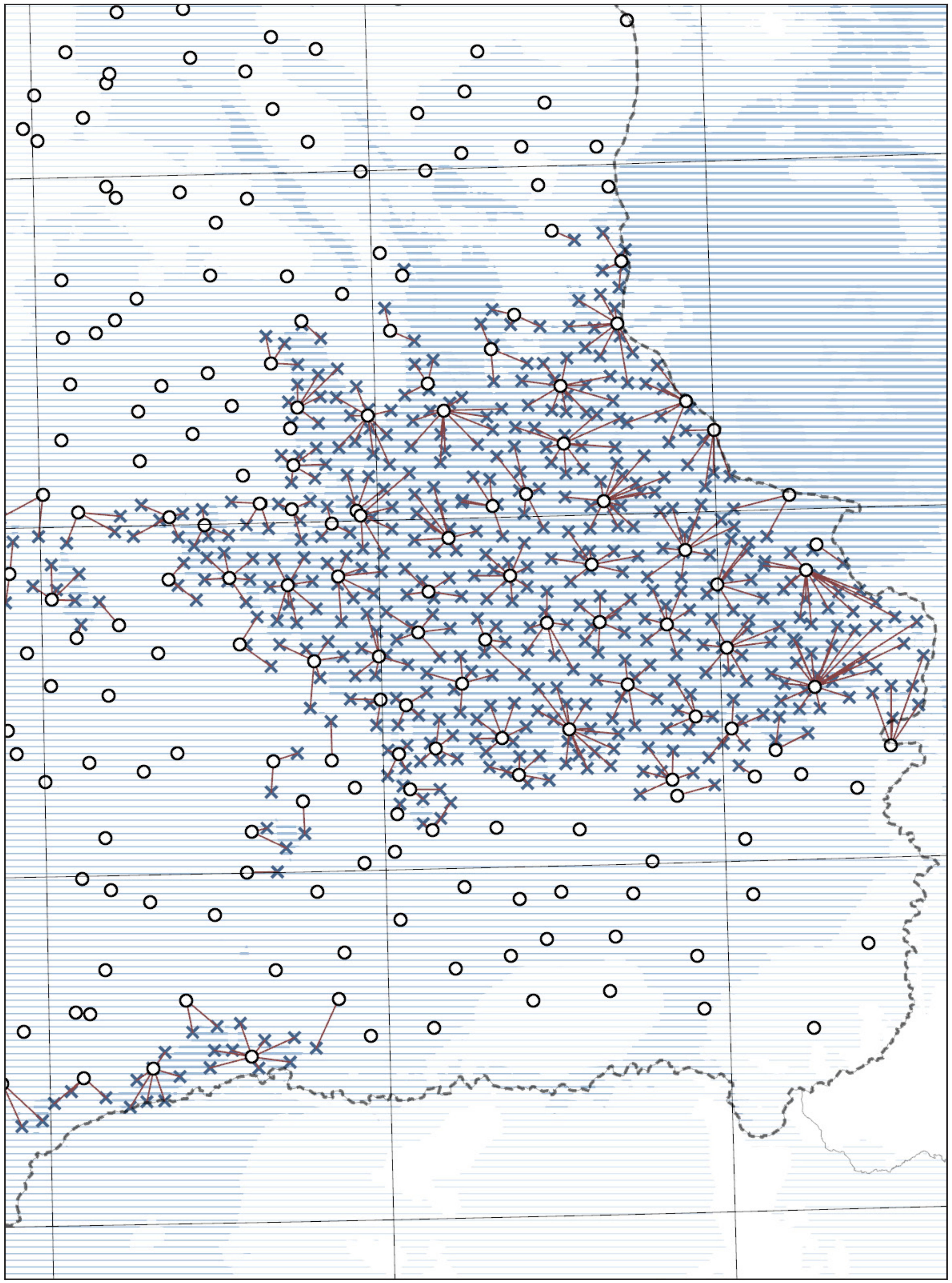




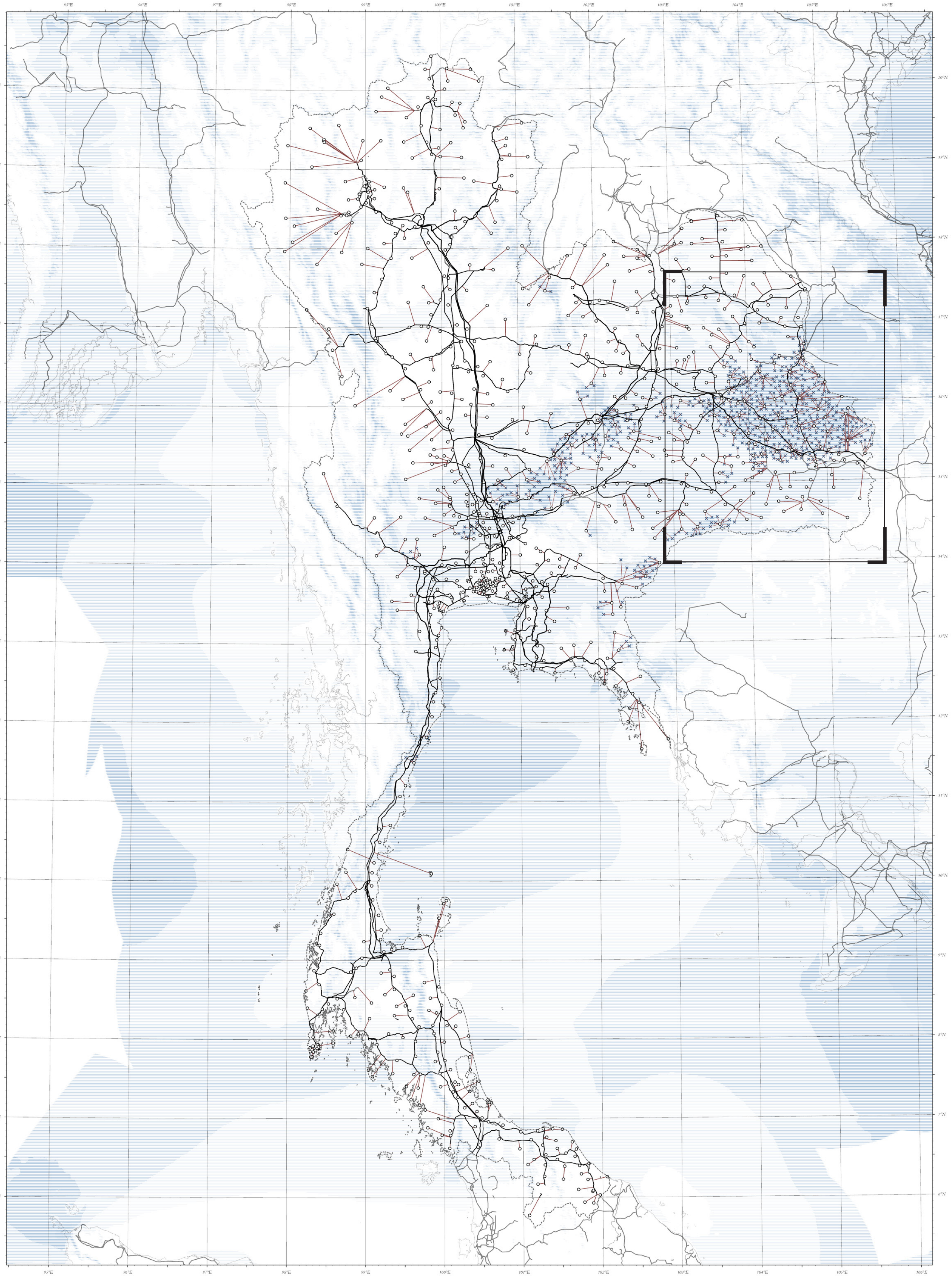
Onshore Utility-scale Turbines

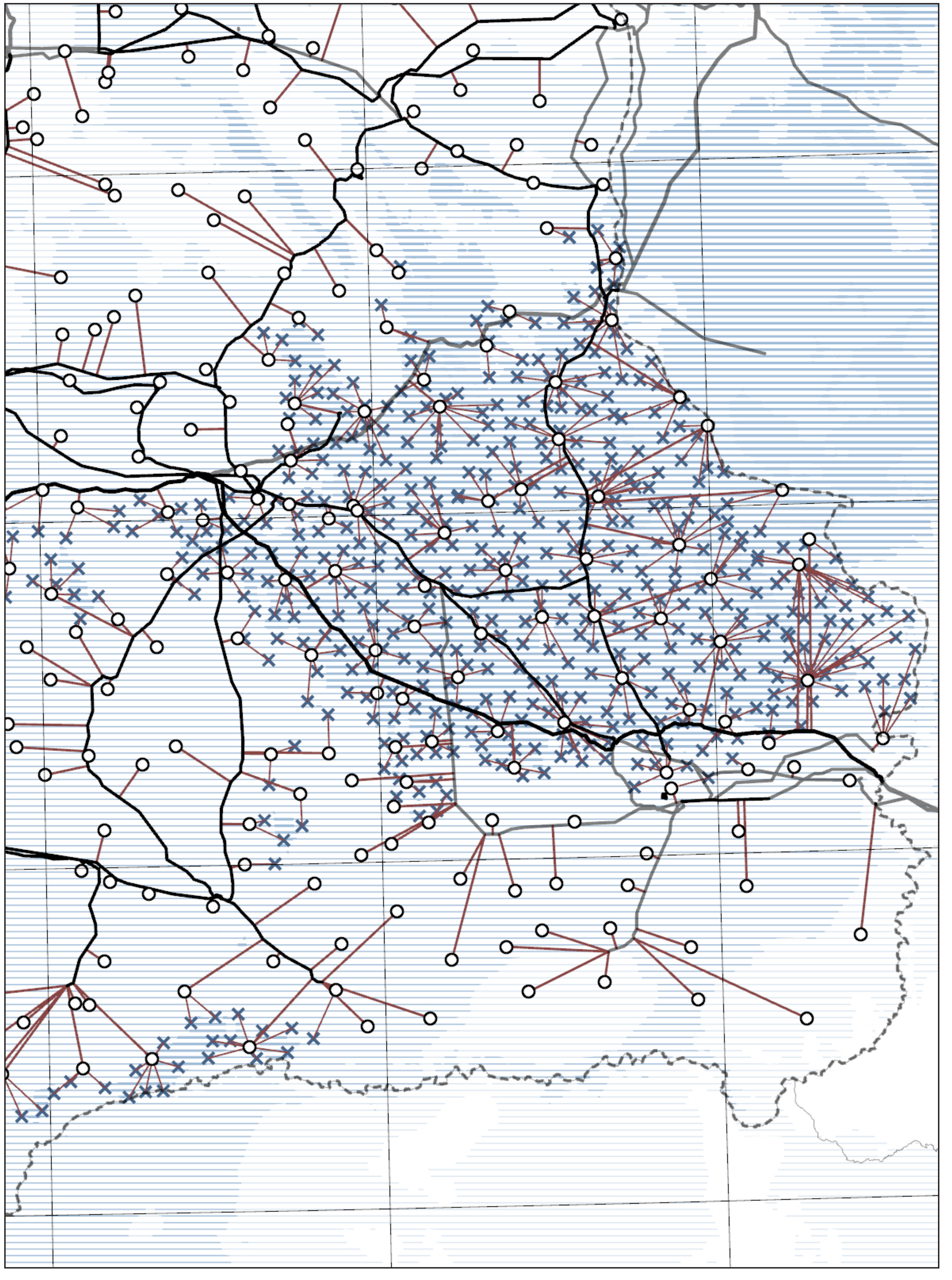
by: Pavin Banternghansa
Advisor: Niall Kirkwood



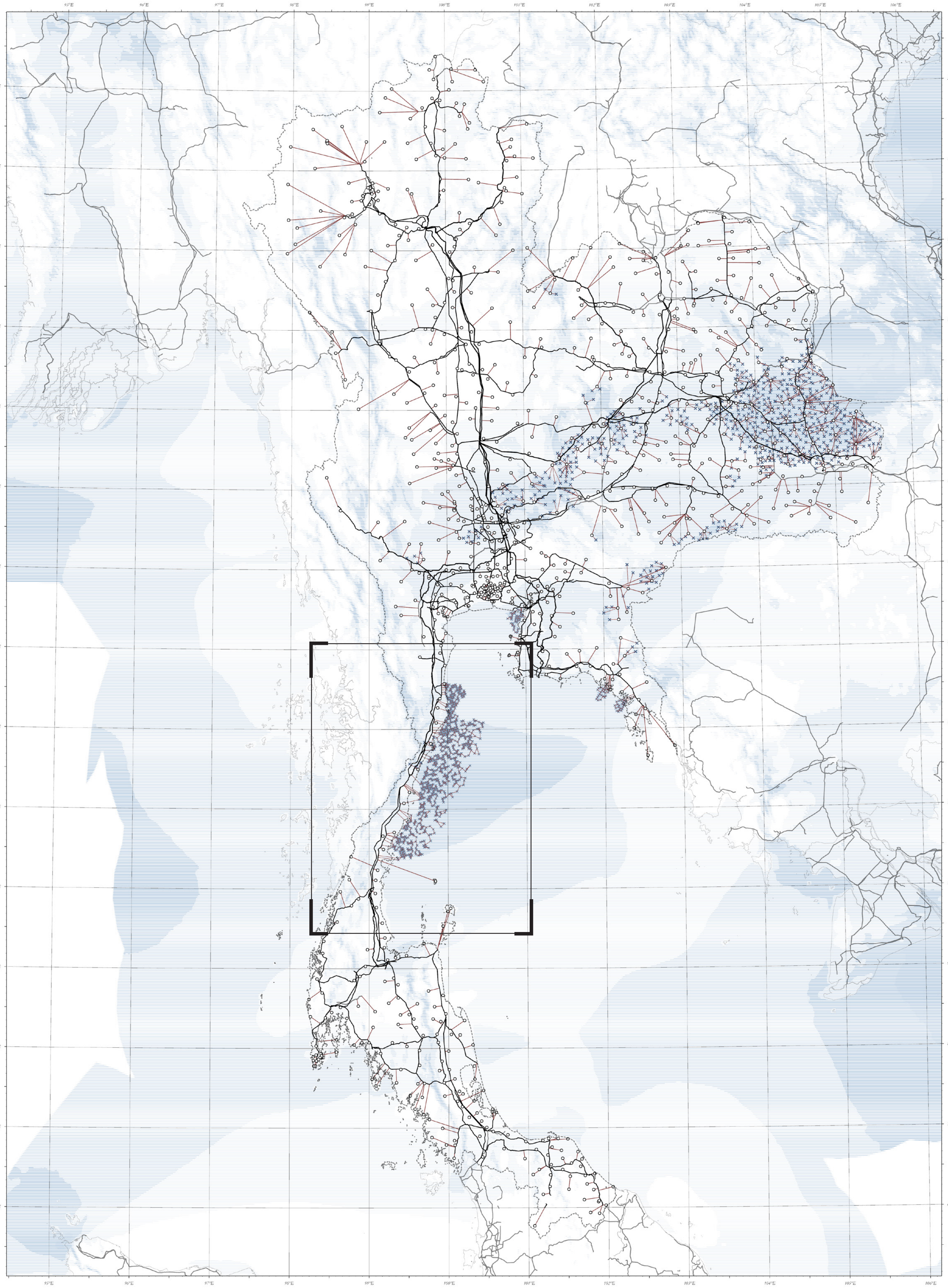


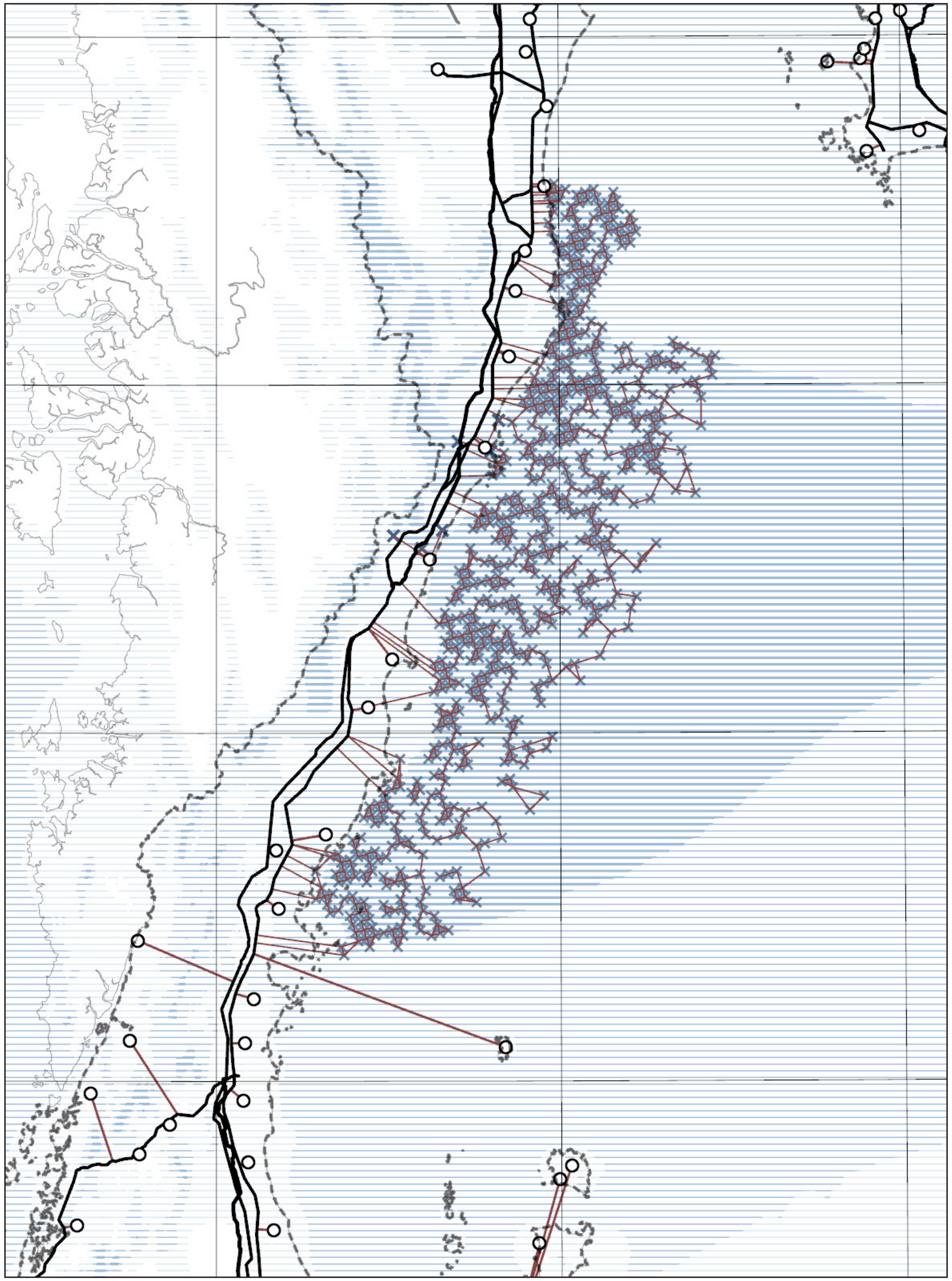
Connection to Nearest Communities





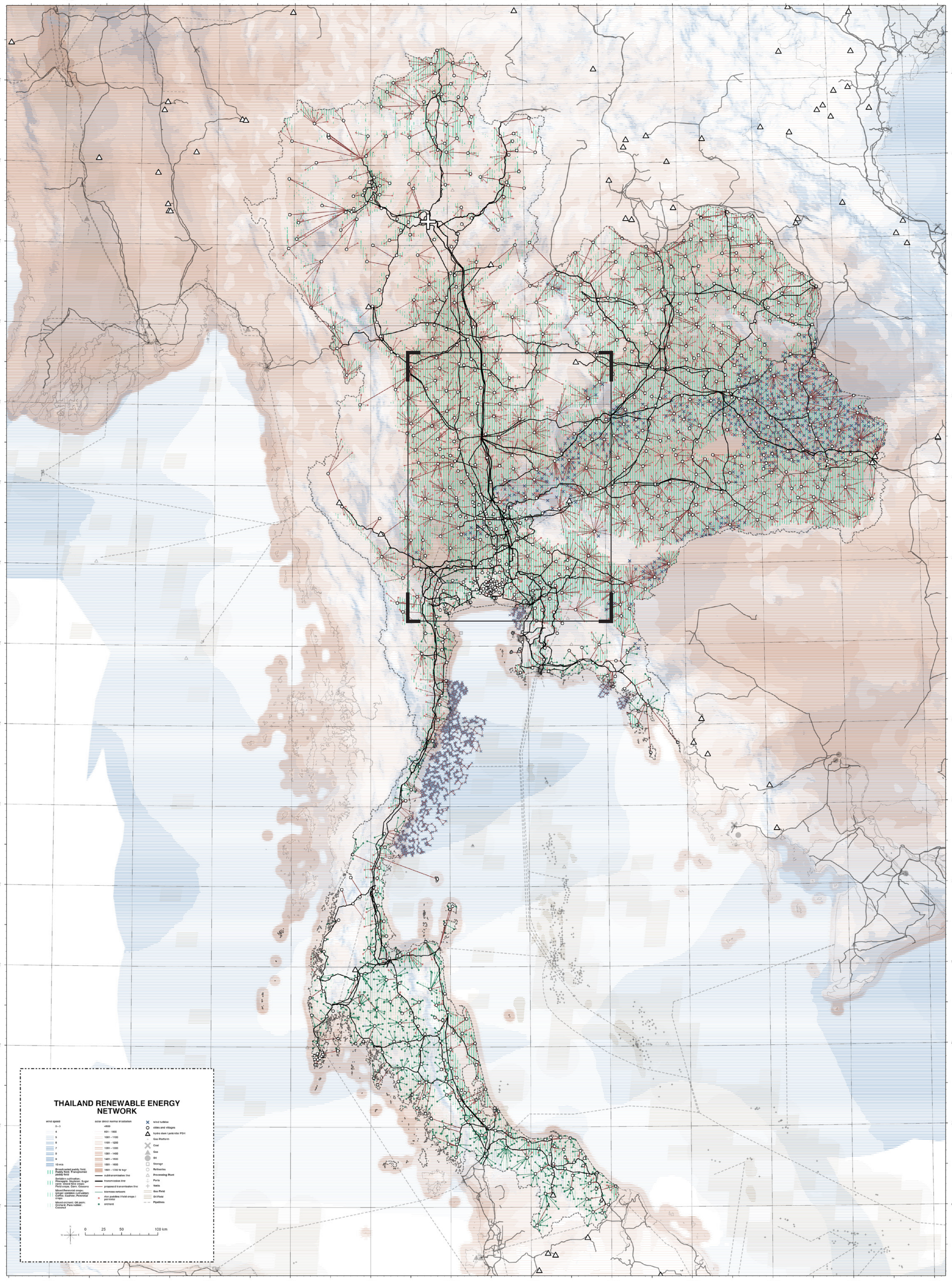
Connection to Transmission Lines

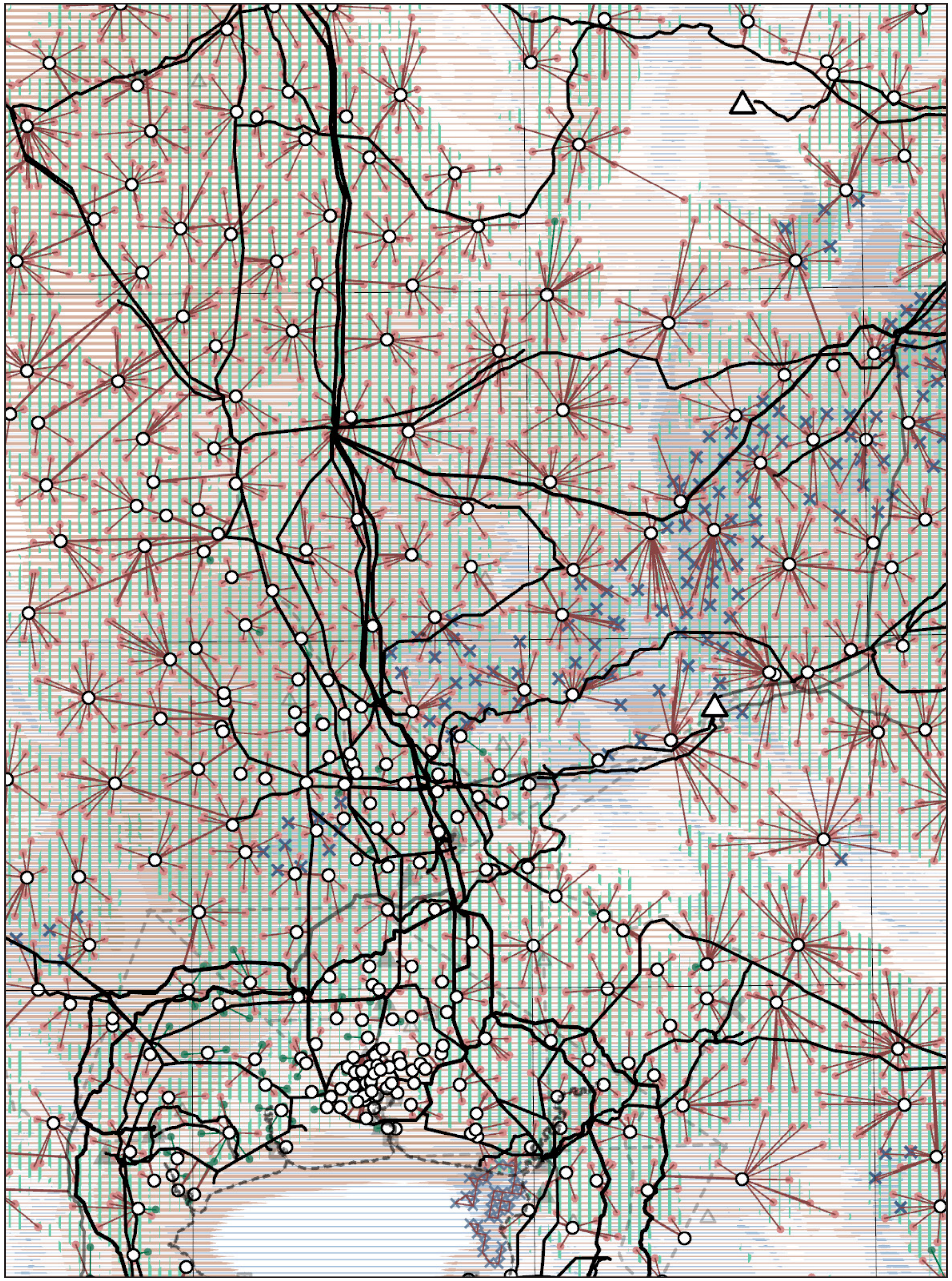




Offshore Turbines

by: Pavin Banternghansa
Advisor: Niall Kirkwood

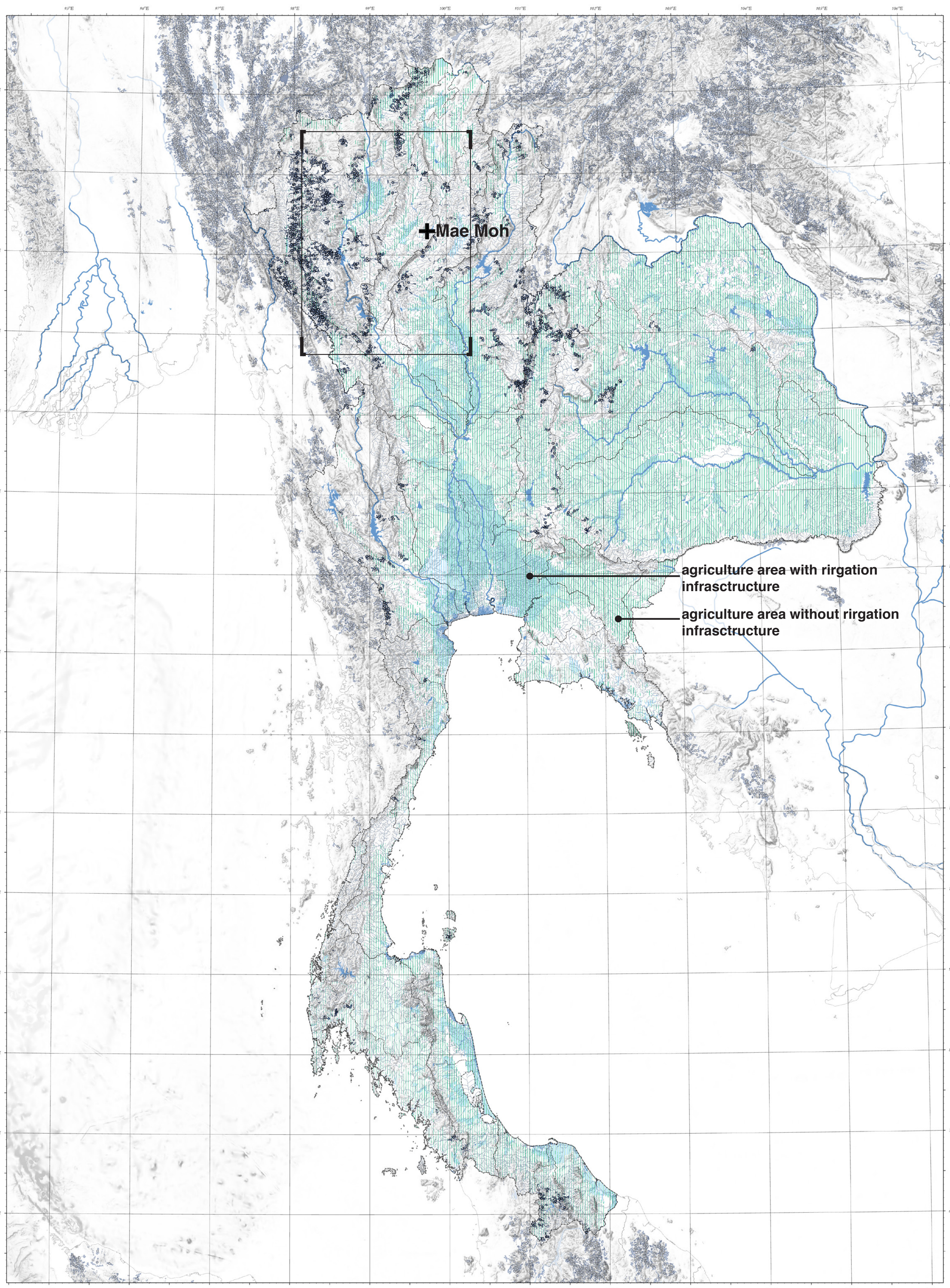


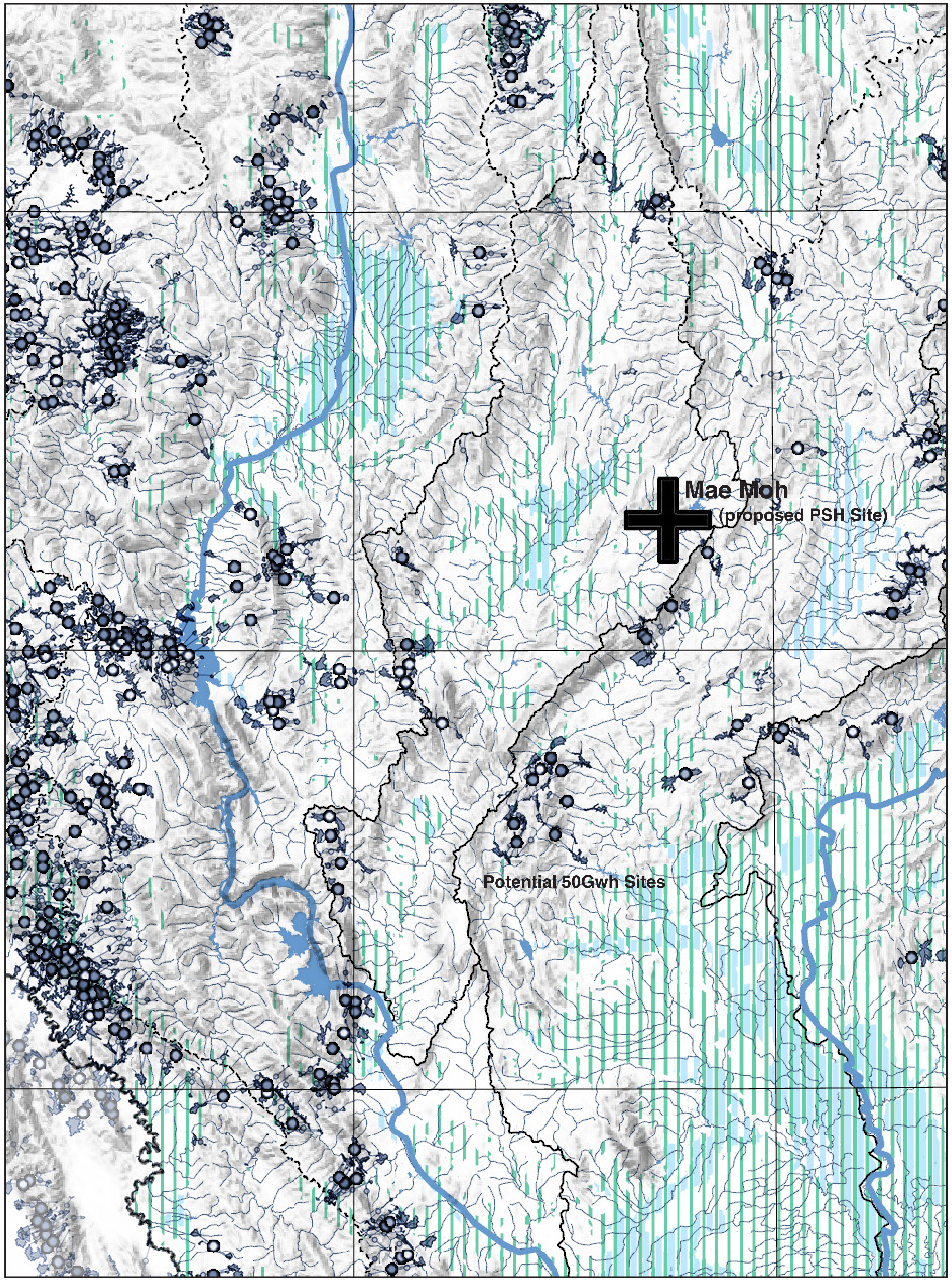


Towards Renewable Energy Network

In combination, this is what the country's renewable production energy network might look like, one that focuses on decentralization and redistribution of sociopolitical and electric power.

by: Pavin Banternghansa
Advisor: Niall Kirkwood





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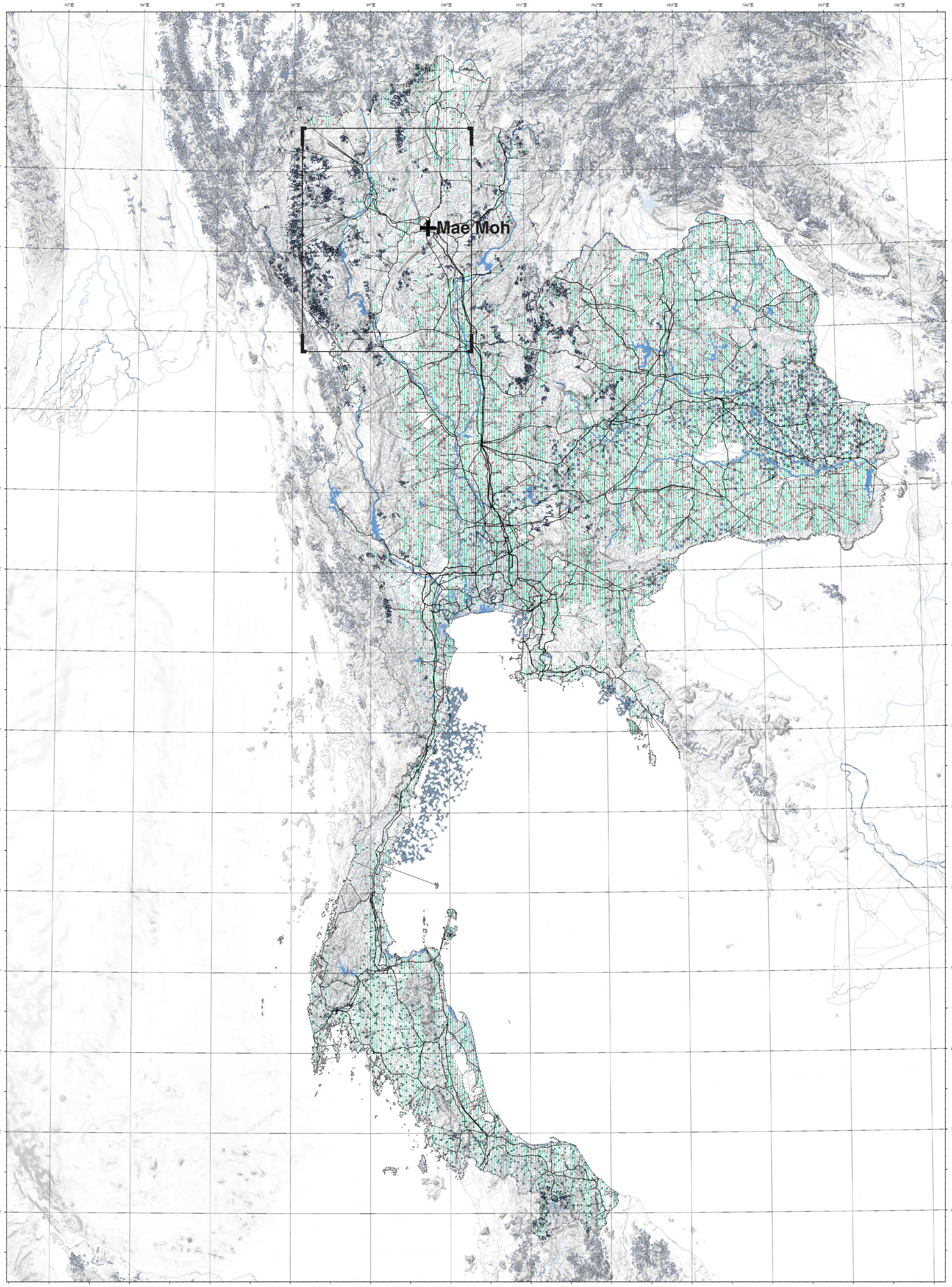
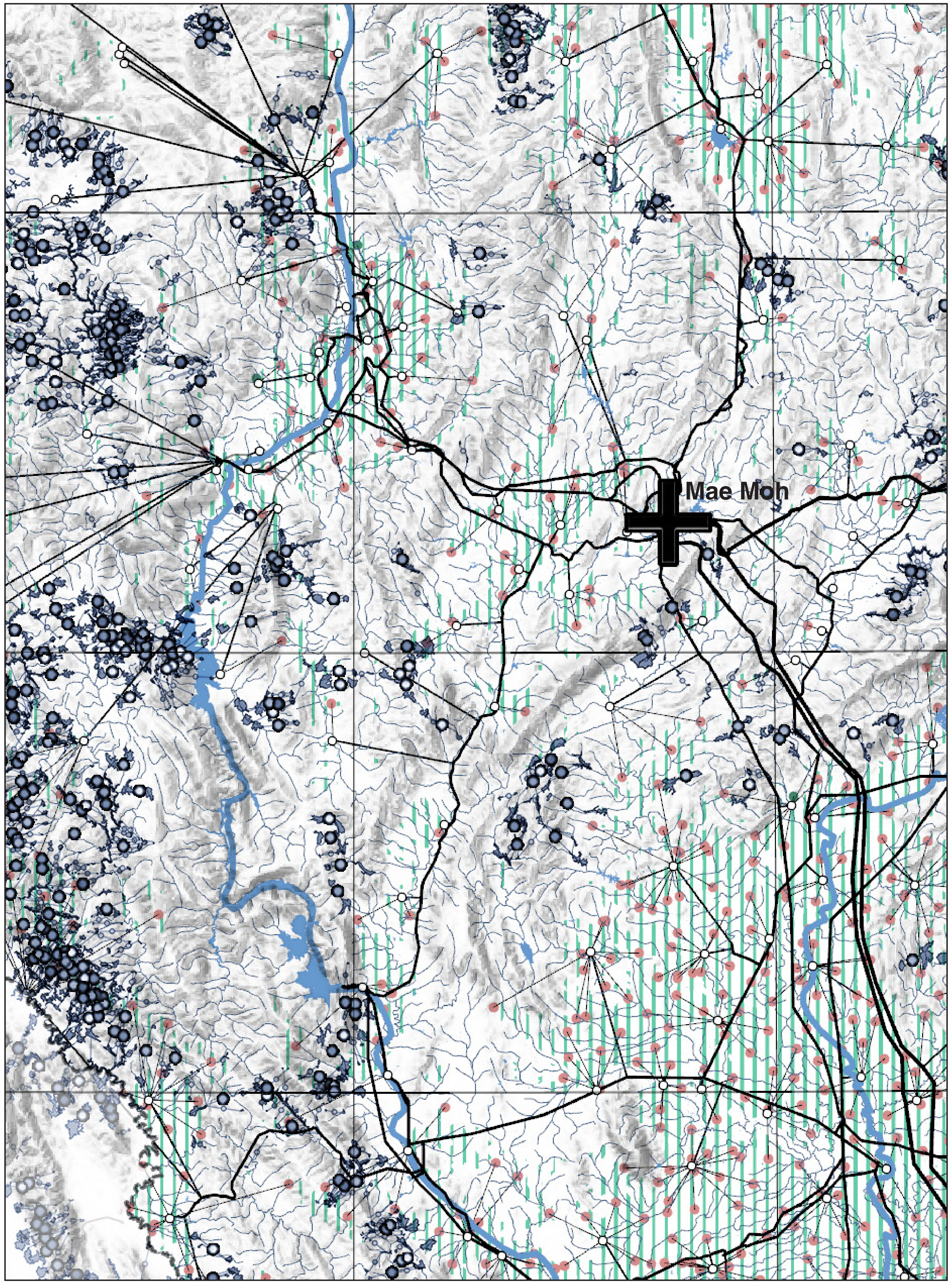
Potential Sites for Pump Storage Hydropower and Agriculture Reservoir

by: Pavin Banternghansa
Advisor: Niall Kirkwood

In this map the blue dots show the potential 50gWh PSH sites base on topography. Each site can store energy for 2.5 million people. The sites are geolocated by Australian National University. Thailand will need about 25 out of several hundred potential sites. At the same time these sites can hold water for agriculture as well. Today only about a quarter of agricultural land has irrigation infrastructures.





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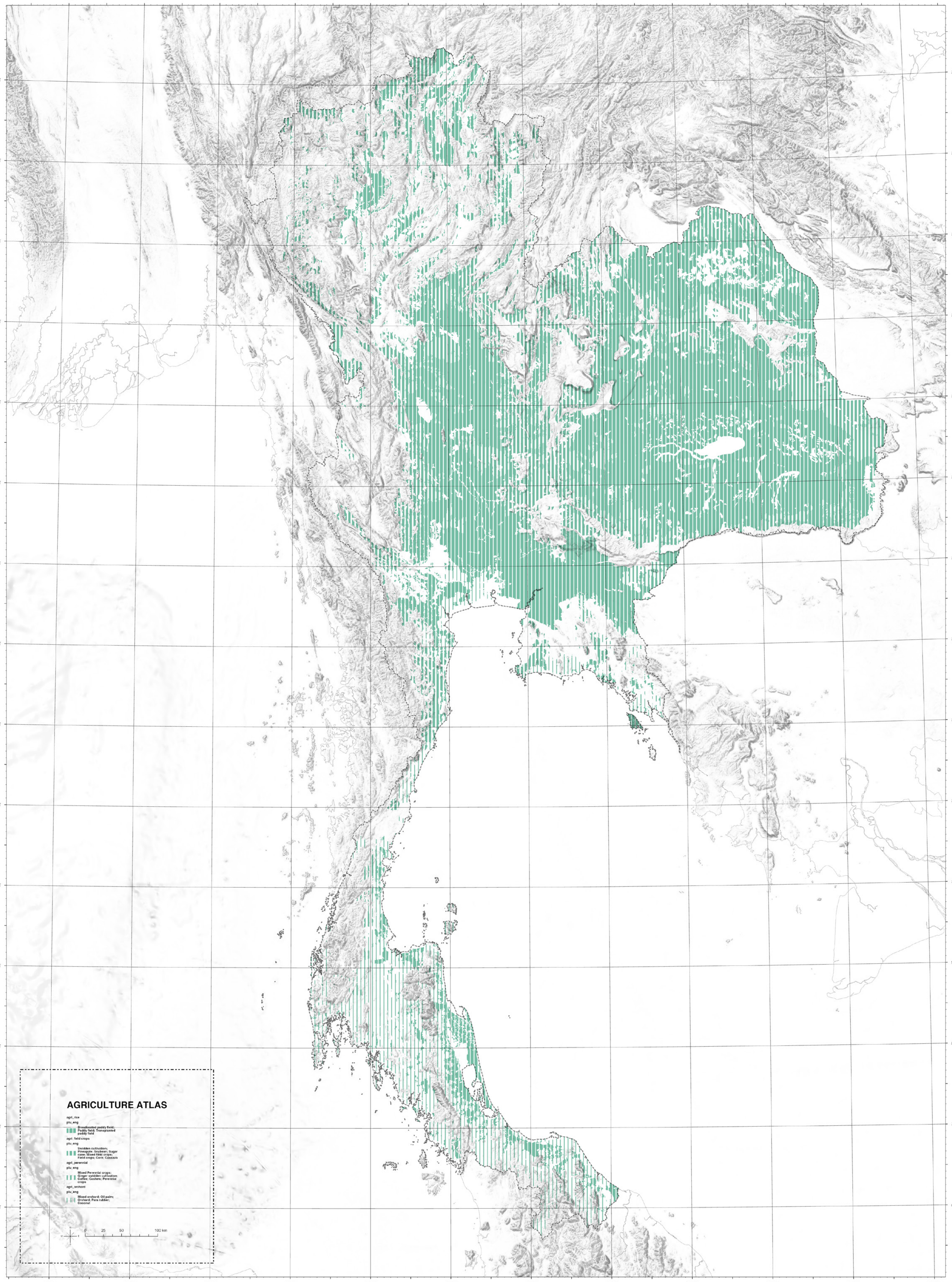
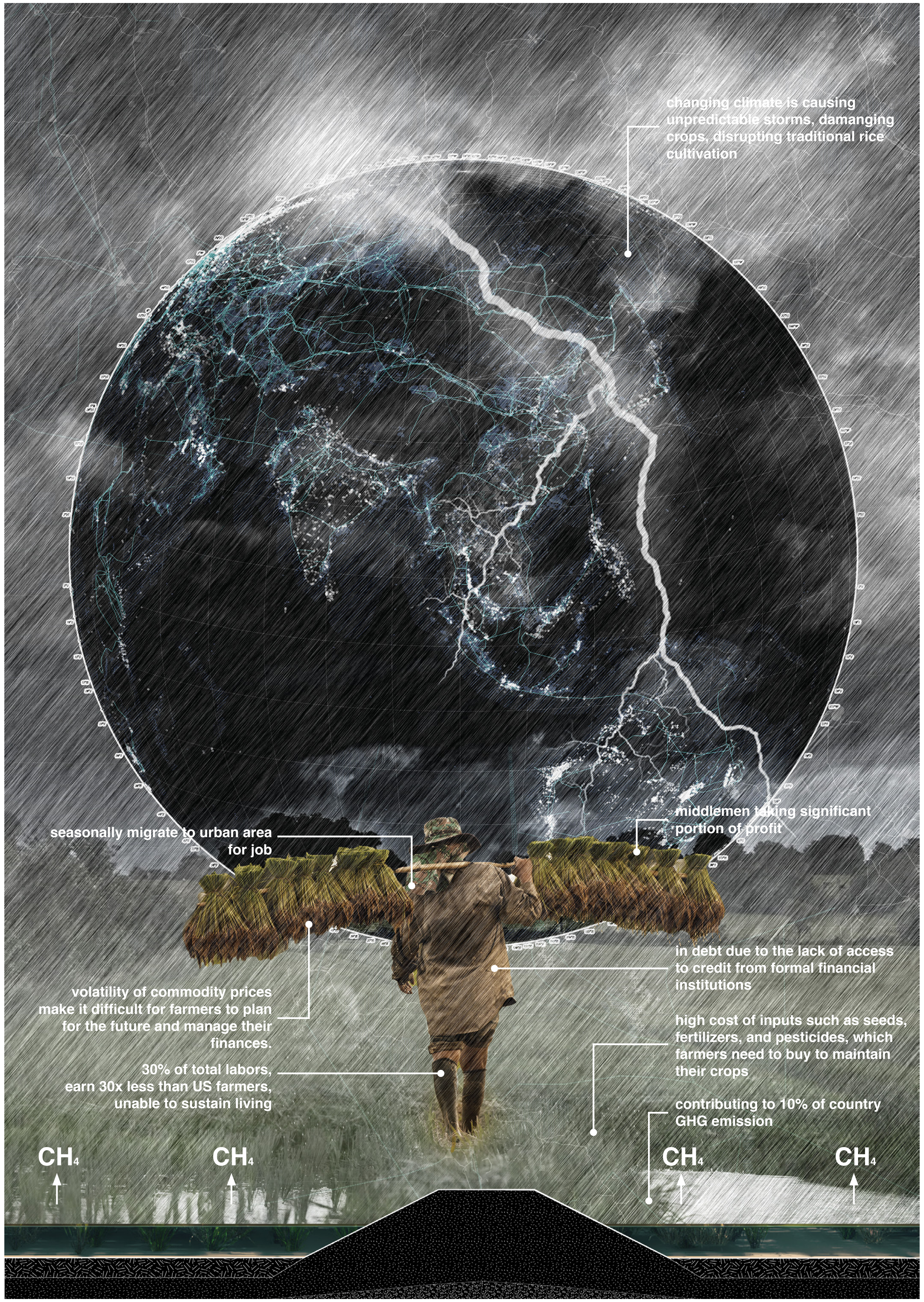
Towards Renewable Energy and Irrigation Network

Together there's a potential synergic relationship in the transition for both storage and distribution.

by: Pavin Banternghansa
Advisor: Niall Kirkwood

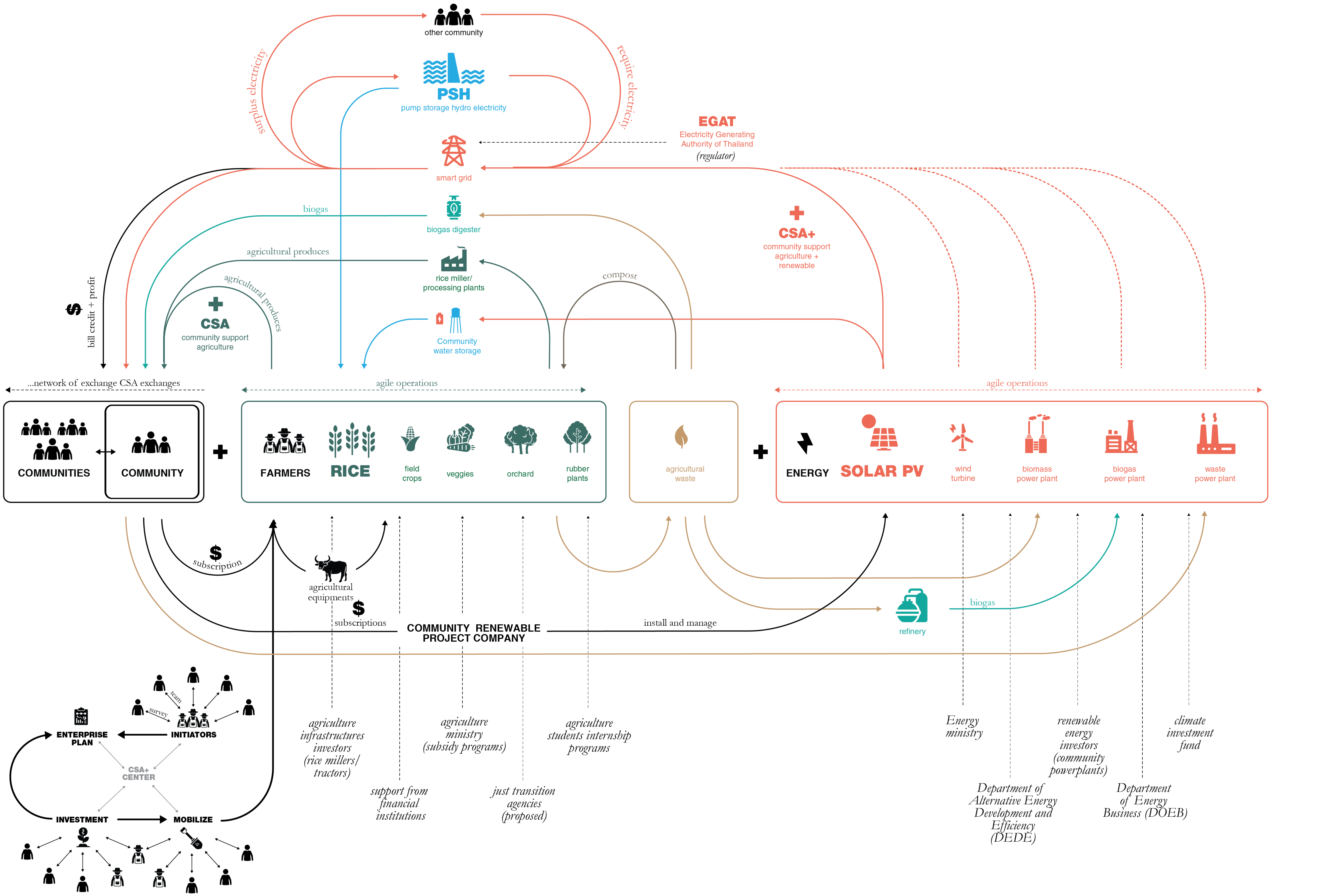




Vulnerable Communities

Rice is the primary crop of Thailand, but rice farmers are one of the nation's most vulnerable groups due to the current commercial structure. Rice cultivation includes high input costs and lacking credit from formal financial institutions, its operation is highly volatile to fluctuations in price, drastically changing climates and an exchange in which middlemen gain a significant portion of profit.

by: Pavin Banternghansa
Advisor: Niall Kirkwood

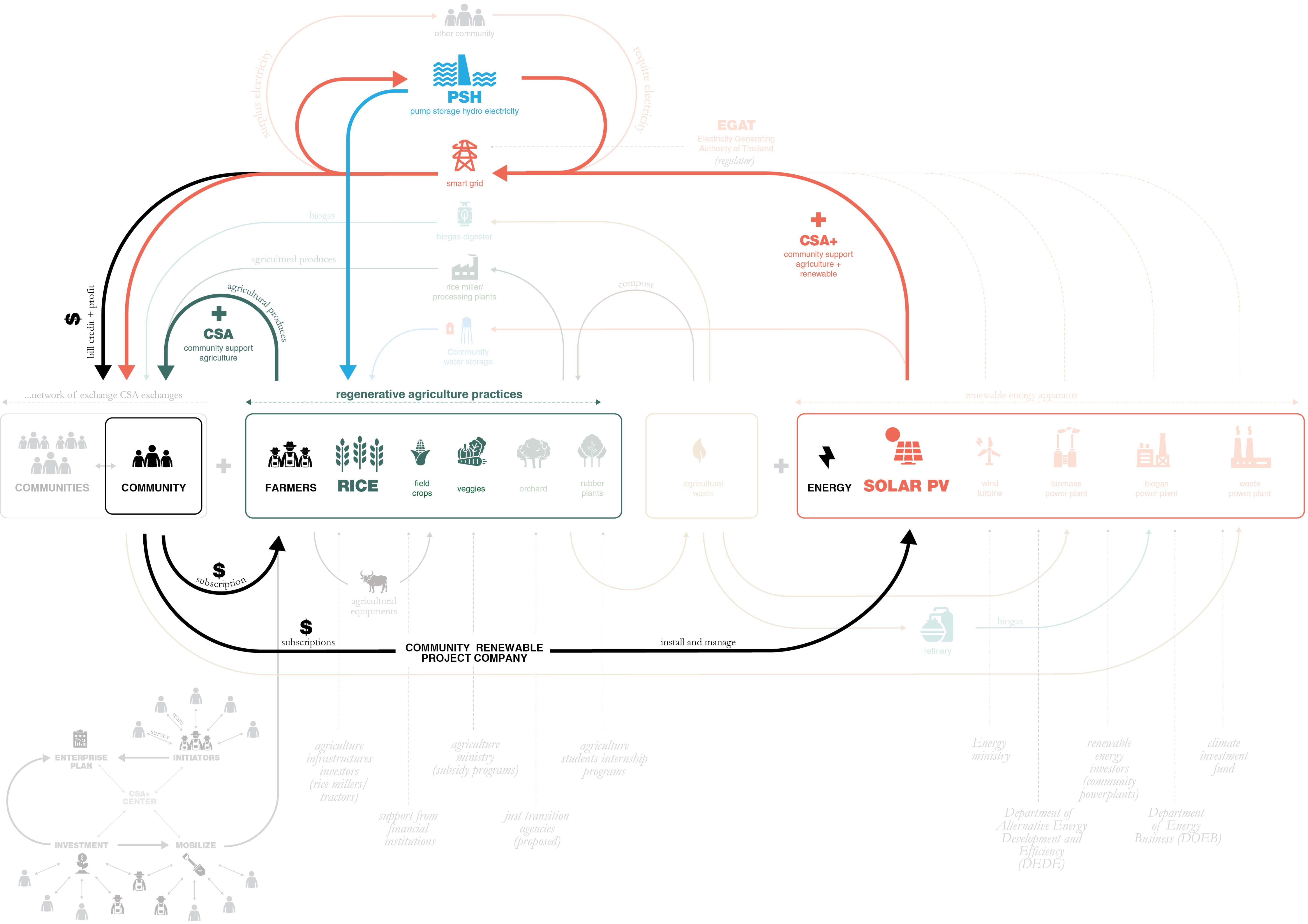


source: Pavin Banternghansa

Bottom-up Transition Strategy
Community Support Agrivoltaic

Here I propose an Agrivoltaic Community Support model in order to bypass middlemen, encourage investment, and funding from the agriculture and energy ministry. The community can simultaneously subscribe to farmers for agriculture produce and pv panels managed by a local solar company.

by: Pavin Banternghansa
Advisor: Niall Kirkwood



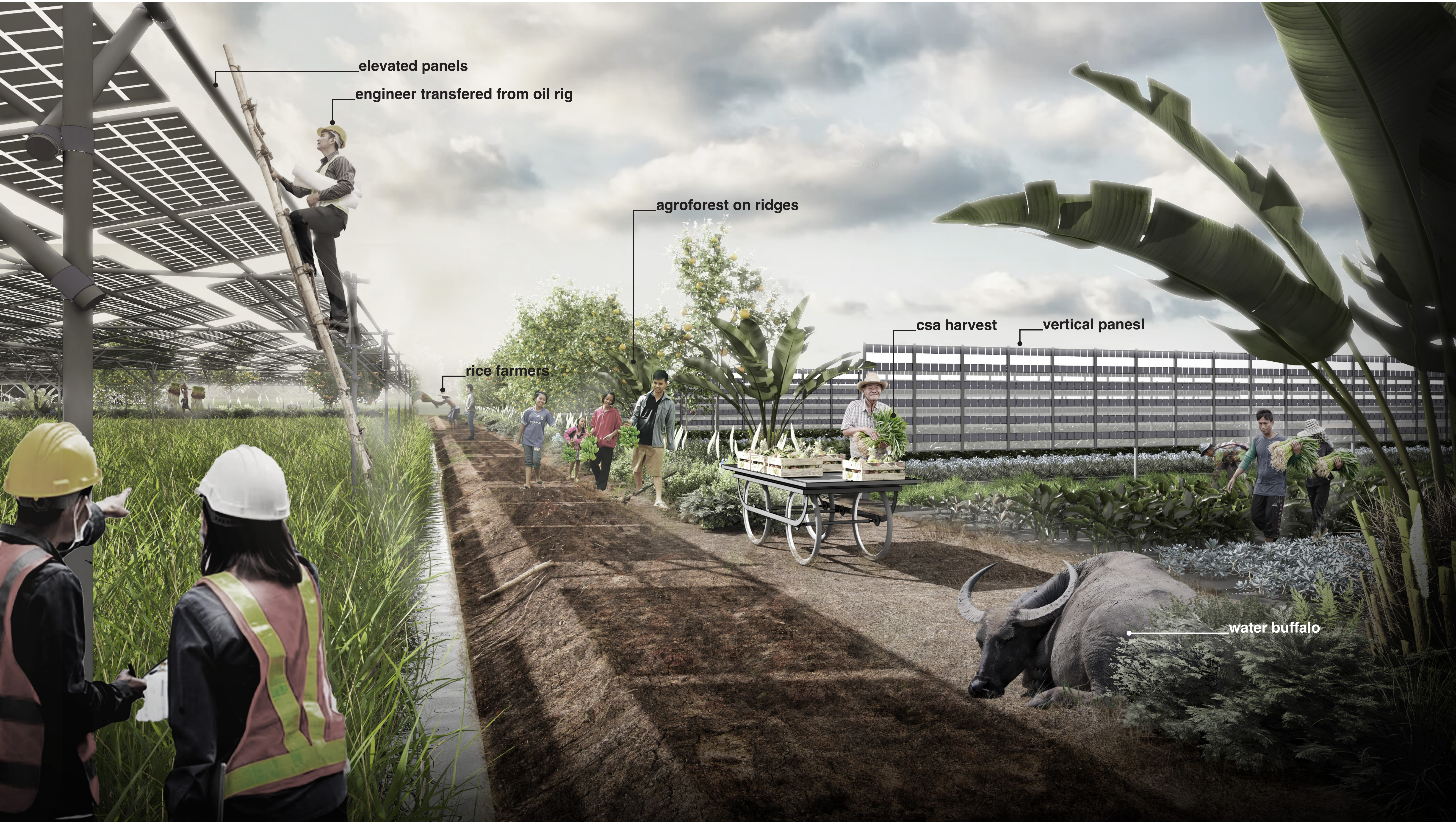
Community Solar + CSA

Electricity produced from panels will offset subscribers' electricity bills. The subscribers will save costs, solar company gets investment funding, and the farmers, the rental fee from leasing land to solar panels.

by: Pavin Banternghansa
Advisor: Niall Kirkwood

Synergic Agrivoltaic System

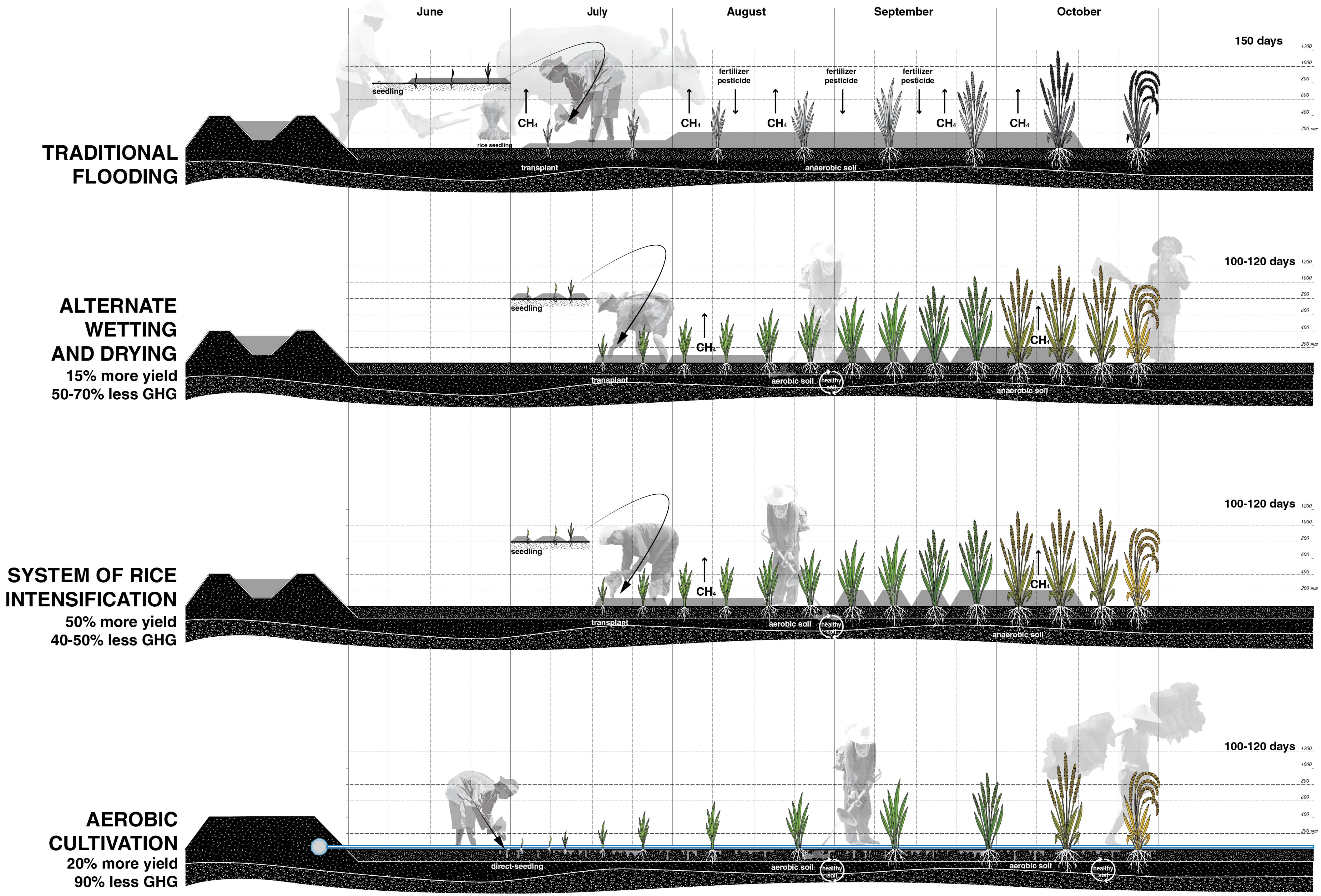
The plants transpiration create microclimate that cool the panels for optimum efficiency. While the panels protect the rice from severe weather events, reduce heat stress, and reduce water consumptions. While research of the panels on rice concluded about 80% yield of both solar and rice productions, together they produce 160% of the yield. We will need to equip about 1 in 7 paddy fields in this fashion. This Win-win approach is the catalyst for the decentralized renewable energy network that will redistribute socioeconomic power in the energy transition.



Agrivoltaic Community

Solar PV has a symbiotic relationship with the agricultural land.

by: Pavin Banternghansa
Advisor: Niall Kirkwood



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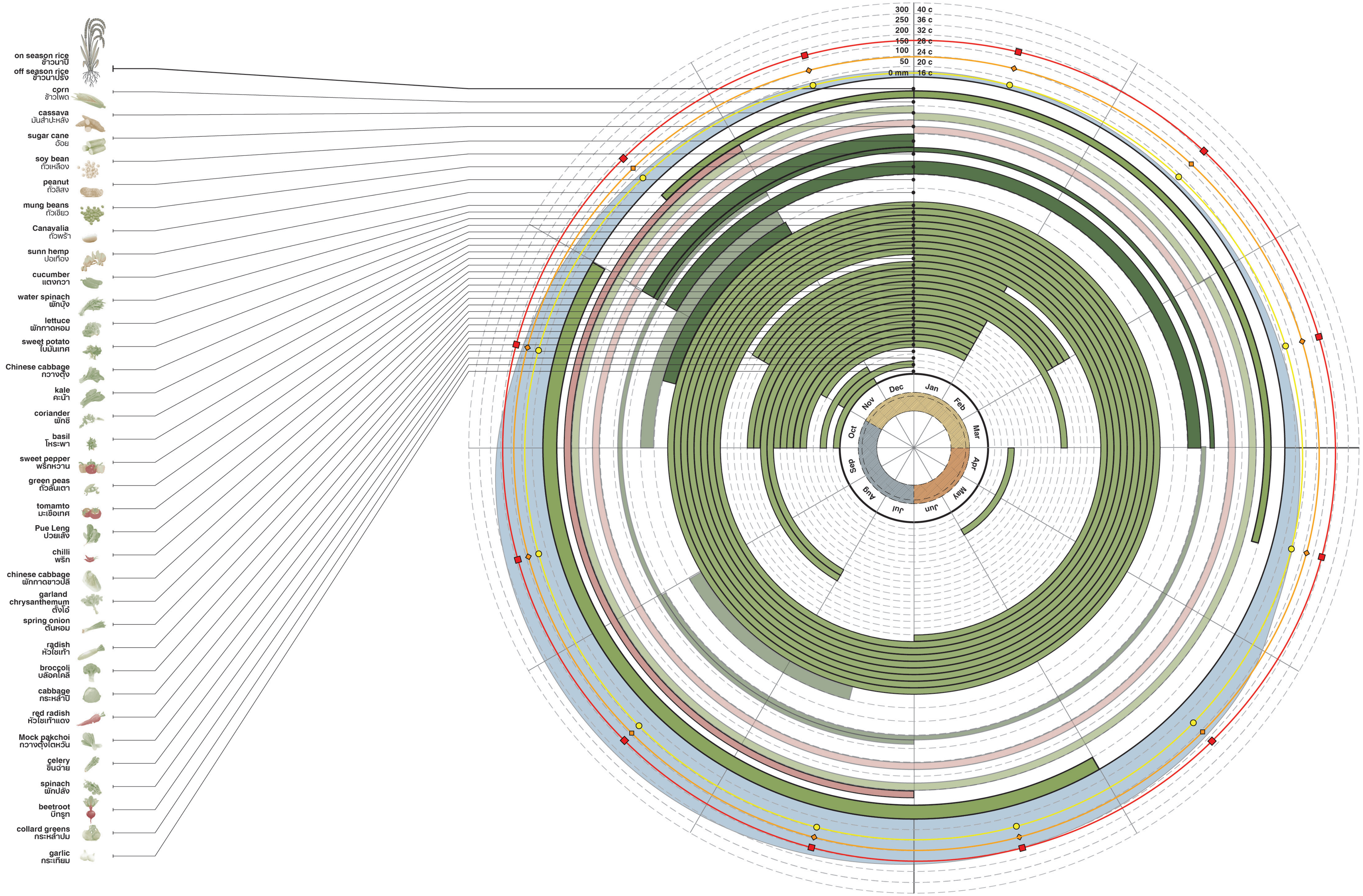
Alternative Rice Cultivation

Today traditional flooding method is water intensive, generates a lot of methane, time-consuming yet produces less yield. Alternate Wetting and Drying, a System of Rice Intensification, and Aerobic cultivation show promise for climate adaptation.

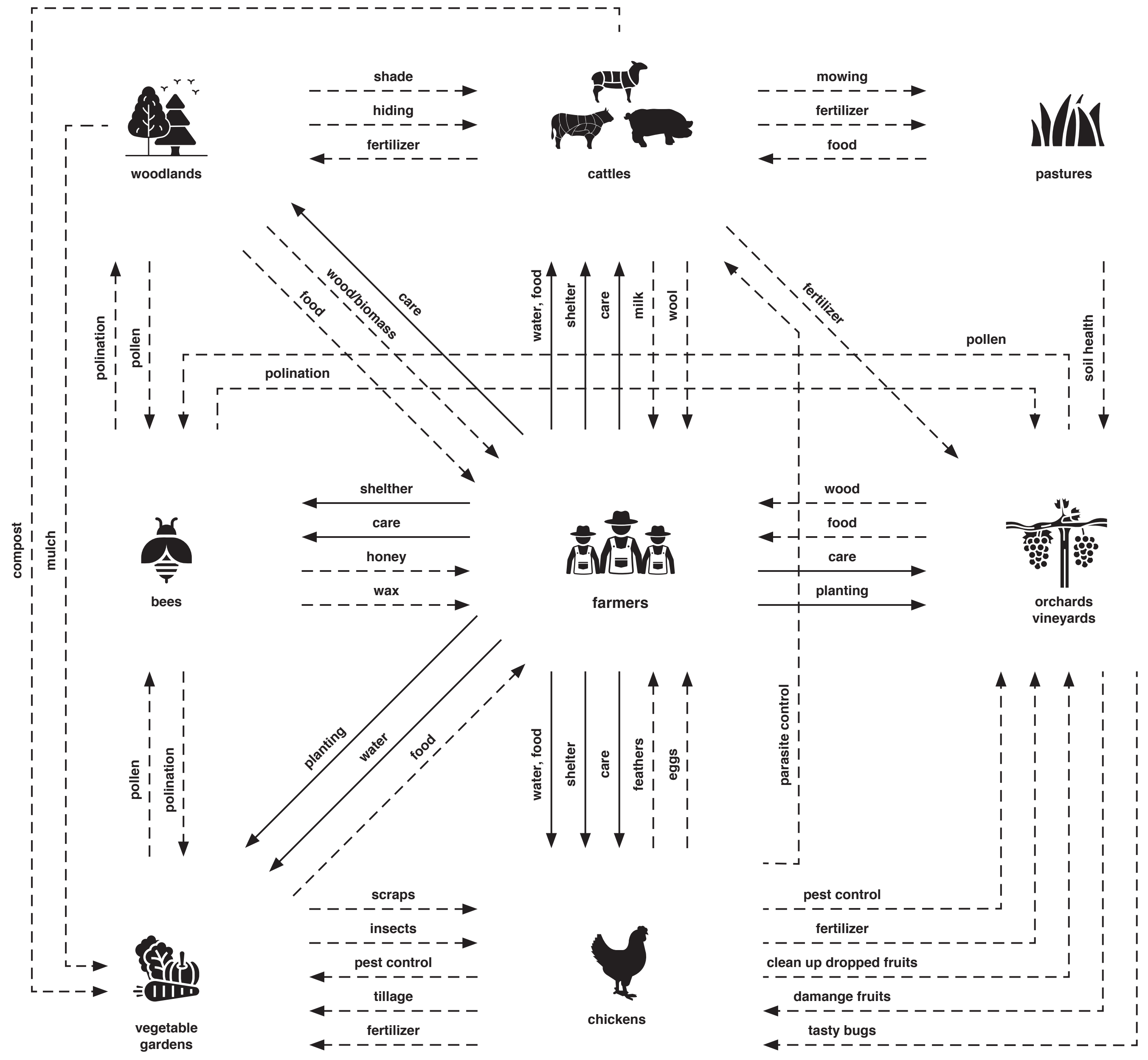
by: Pavin Banternghansa
Advisor: Niall Kirkwood

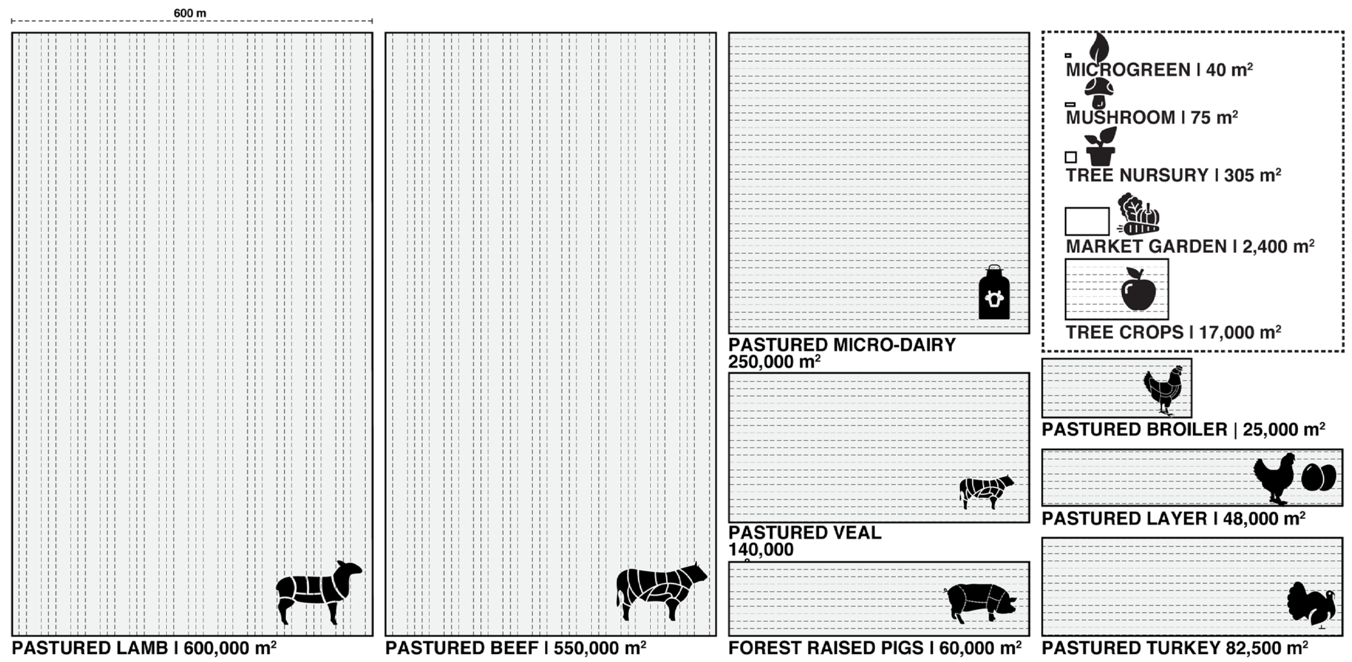


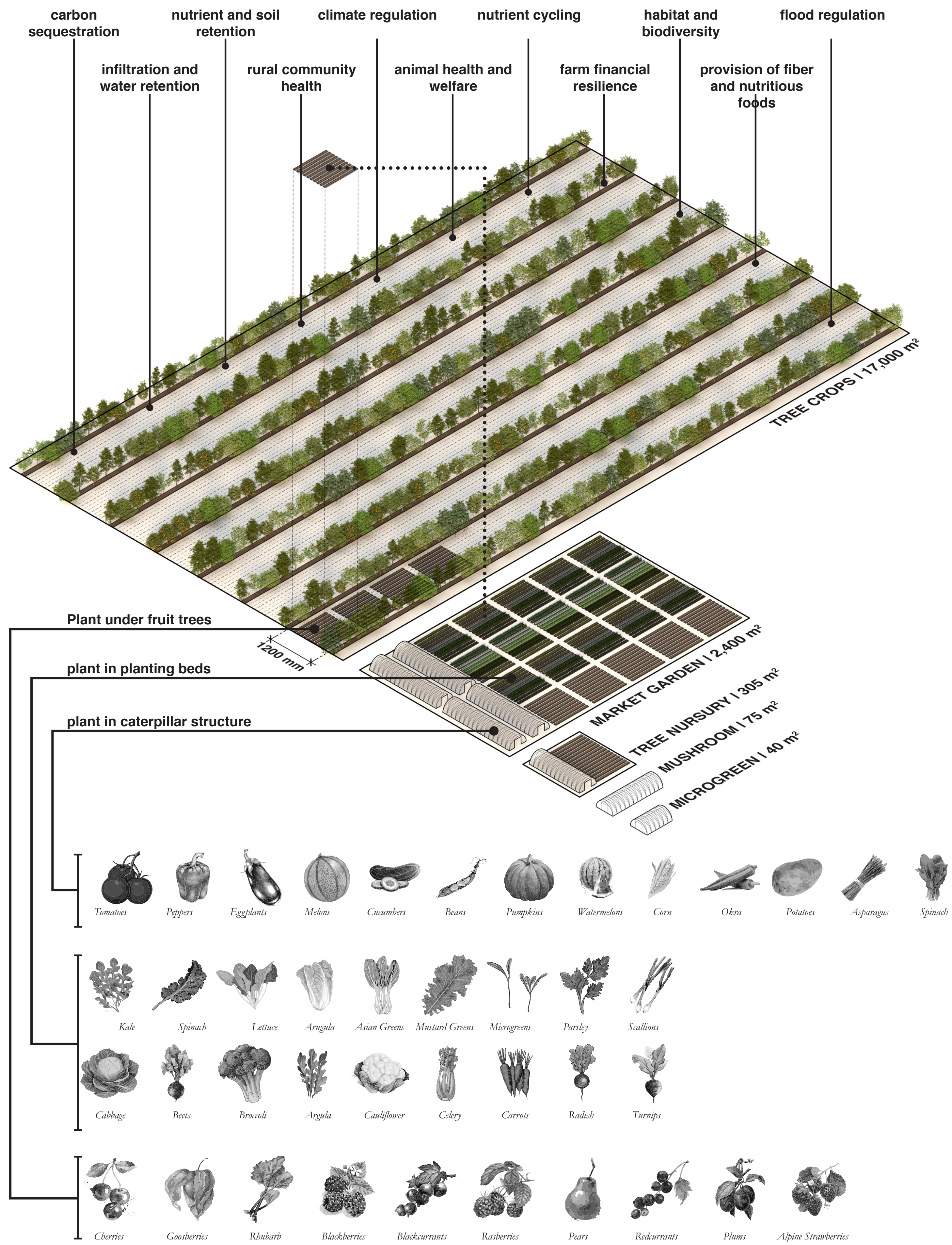
Crop Rotation

Adopting crop rotations promote carbon sequestration, nutrient and water retention, and financial resiliency giving the farmer year round income while nourishing the land.

by: Pavin Banternghansa
Advisor: Niall Kirkwood

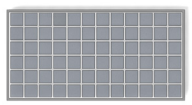




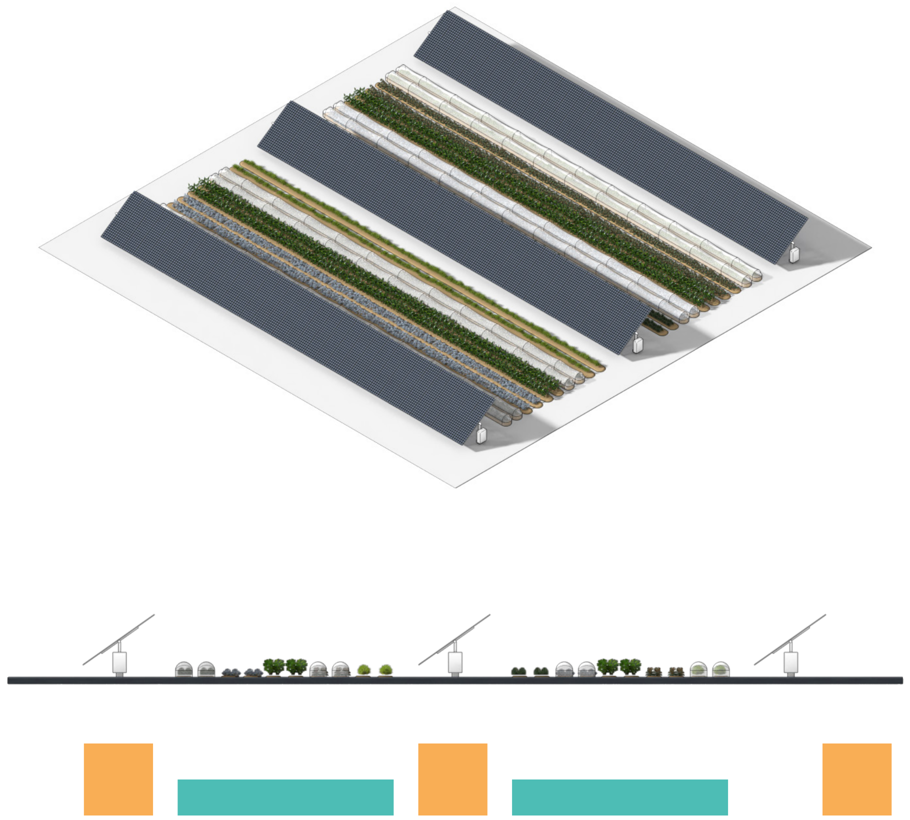


Regenerative Agriculture Practices

by: Pavin Banternghansa
Advisor: Niall Kirkwood



typical panel

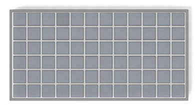


conventional agrivoltaic

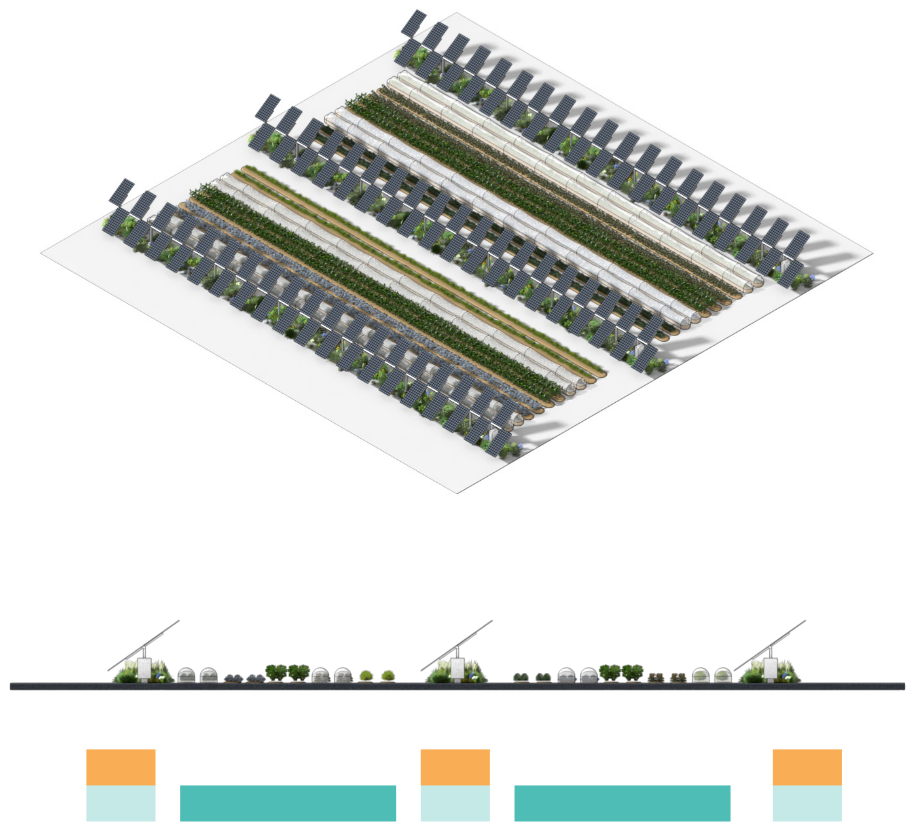
total area: 1,600 m^2

agricultural area: 700 m^2
perenial area: 0 m^2
circulation: 140 m^2

photovoltaic area: 420 m^2
photovoltaic panels: 210 panels
electricity: 72,450 kWh/yr
7.2 average homes



typical panel

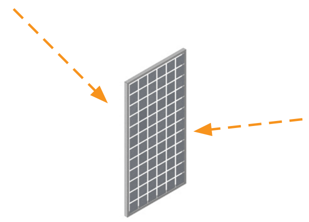


alternated conventional agrivoltaic

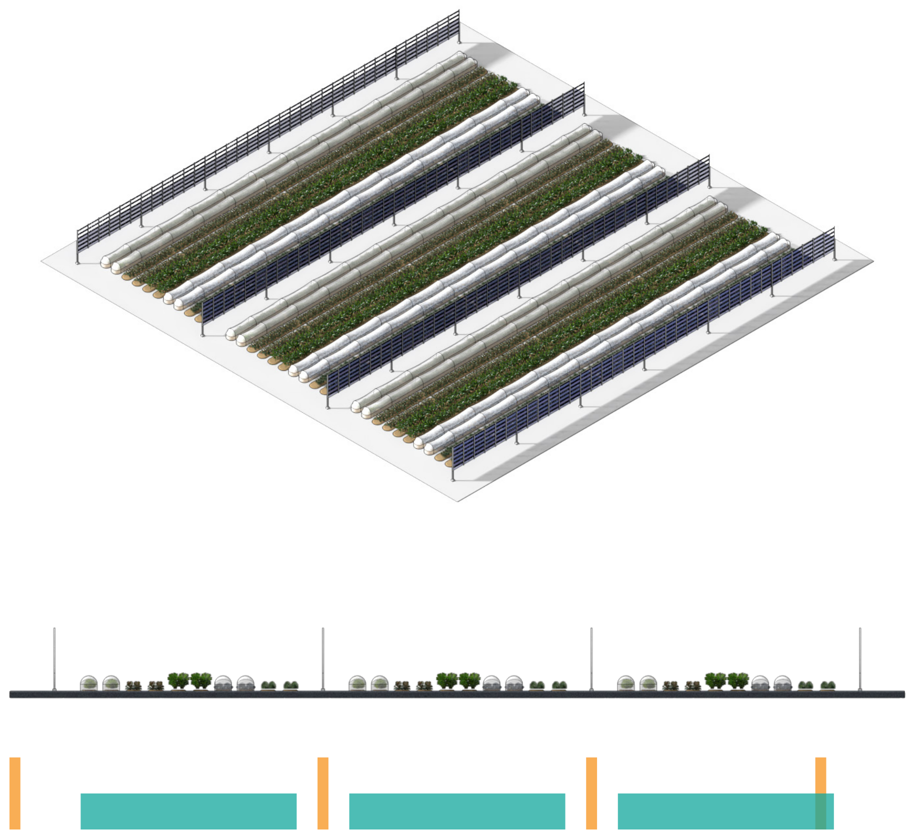
total area: 1,600 m^2

agricultural area: 700 m^2
perenial area: 360 m^2
circulation: 140 m^2

photovoltaic area: 210 m^2
photovoltaic panels: 105 panels
electricity: 36,225 kWh/yr
3.6 average homes



double sided panel



vertical mount agrivoltaic

total area: 1,600 m^2

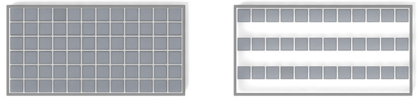
agricultural area: 1,050 m^2
perenial area: 0 m^2
circulation: 210 m^2

photovoltaic area: 576 m^2
photovoltaic panels: 144 double sided panels
electricity: N/A kWh/yr
N/A average homes

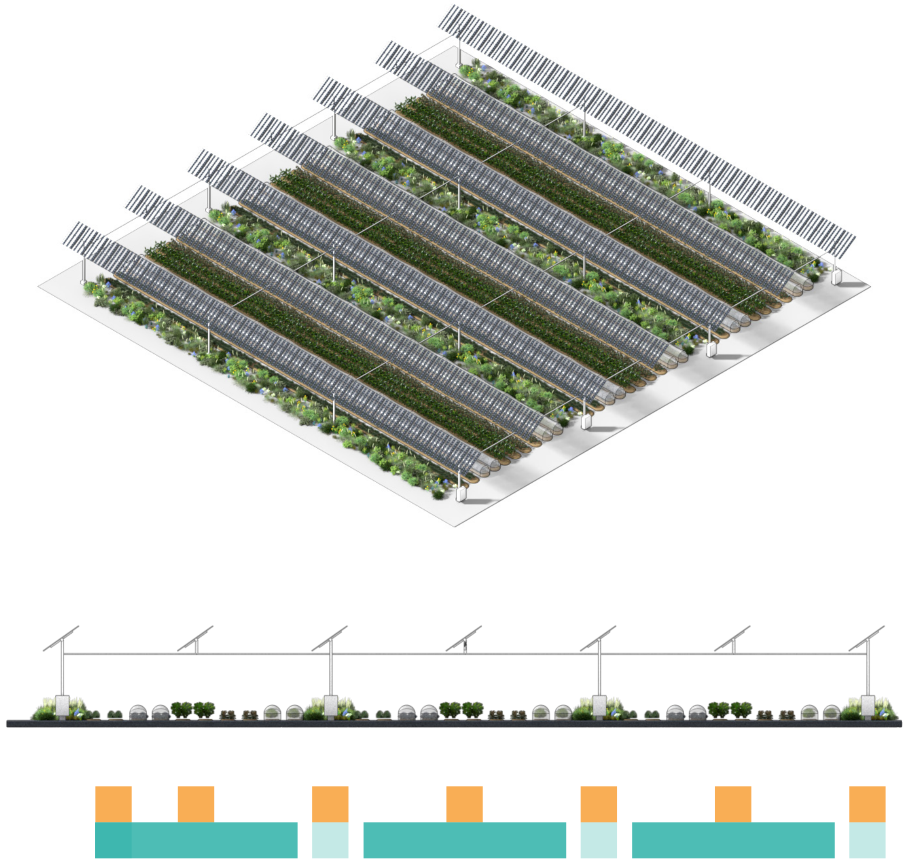
Sun Crops Configurations

Ctalog of renewable infrastructure on agricultural land

by: Pavin Banternghansa
Advisor: Niall Kirkwood



typical panel semi-transparent panels

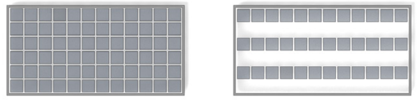


long-span elevated panels

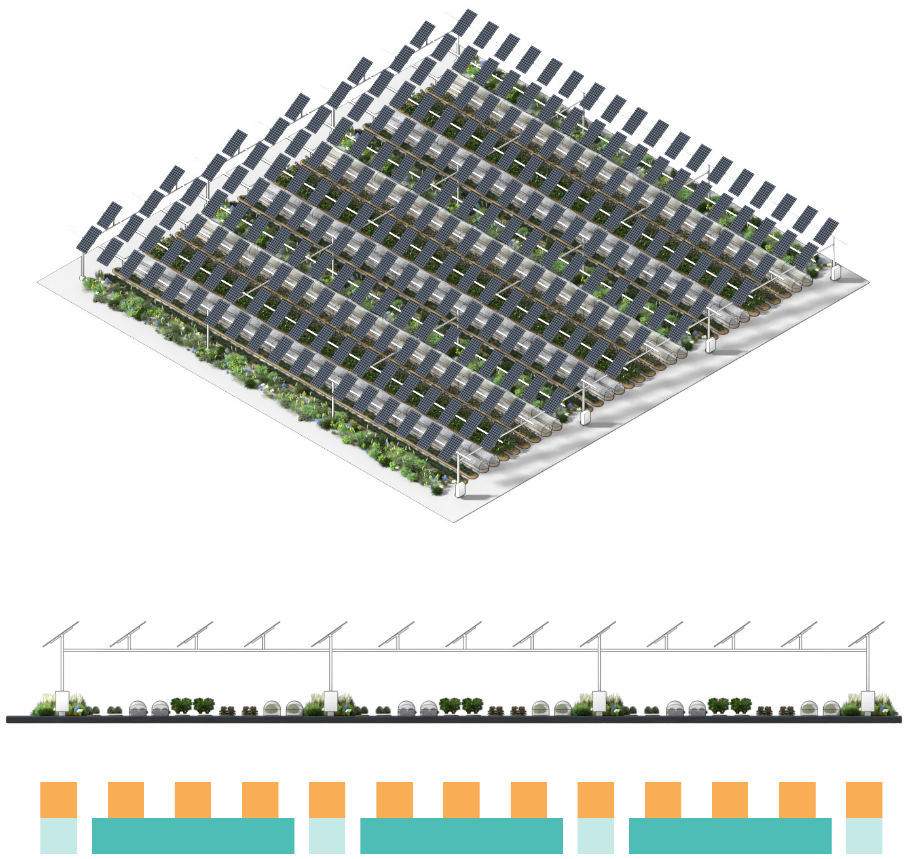
total area: 1,600 m^2

agricultural area: 1,050 m^2
perenial area: 144 m^2
circulation: 216 m^2

photovoltaic area: 420 m^2
photovoltaic panels: 266 panels
electricity: 91,770 kWh/yr
9.2 average homes



typical panel semi-transparent panels

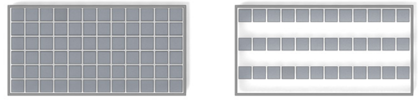


alternated long-span elevated panels

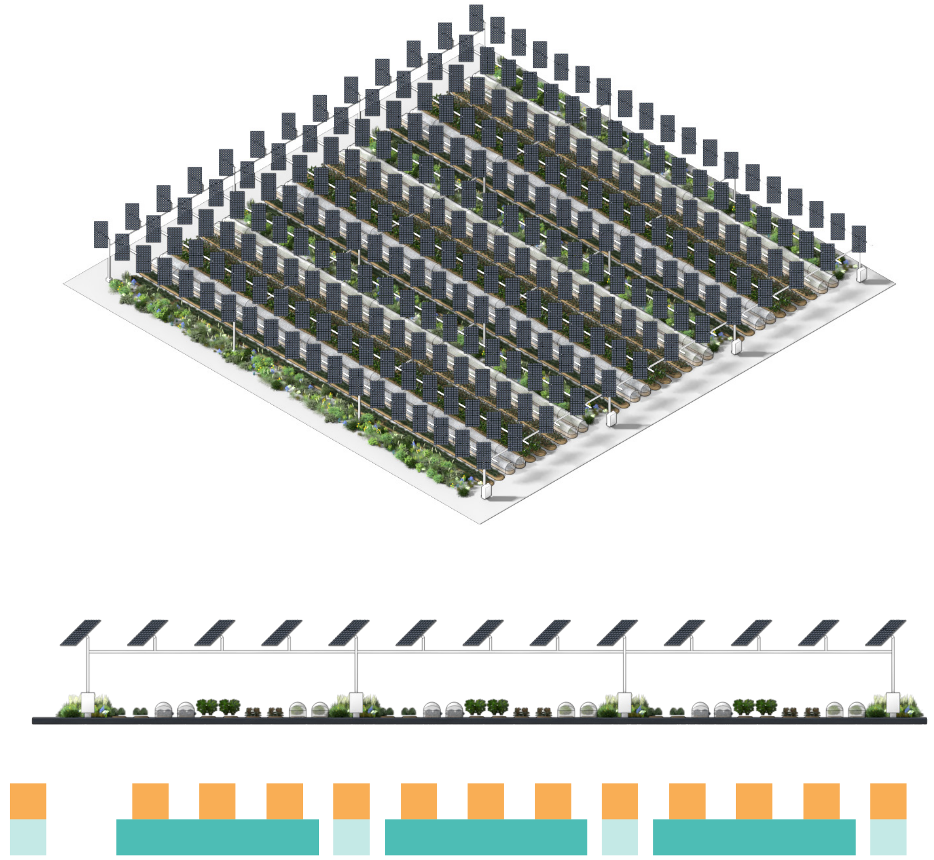
total area: 1,600 m^2

agricultural area: 1,050 m^2
perenial area: 144 m^2
circulation: 216 m^2

photovoltaic area: 496 m^2
photovoltaic panels: 248 panels
electricity: 85,560 kWh/yr
8.5 average homes



typical panel semi-transparent panels



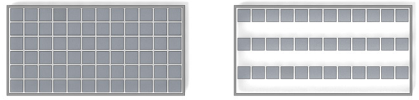
angled long-span elevated panels

total area: 1,600 m^2

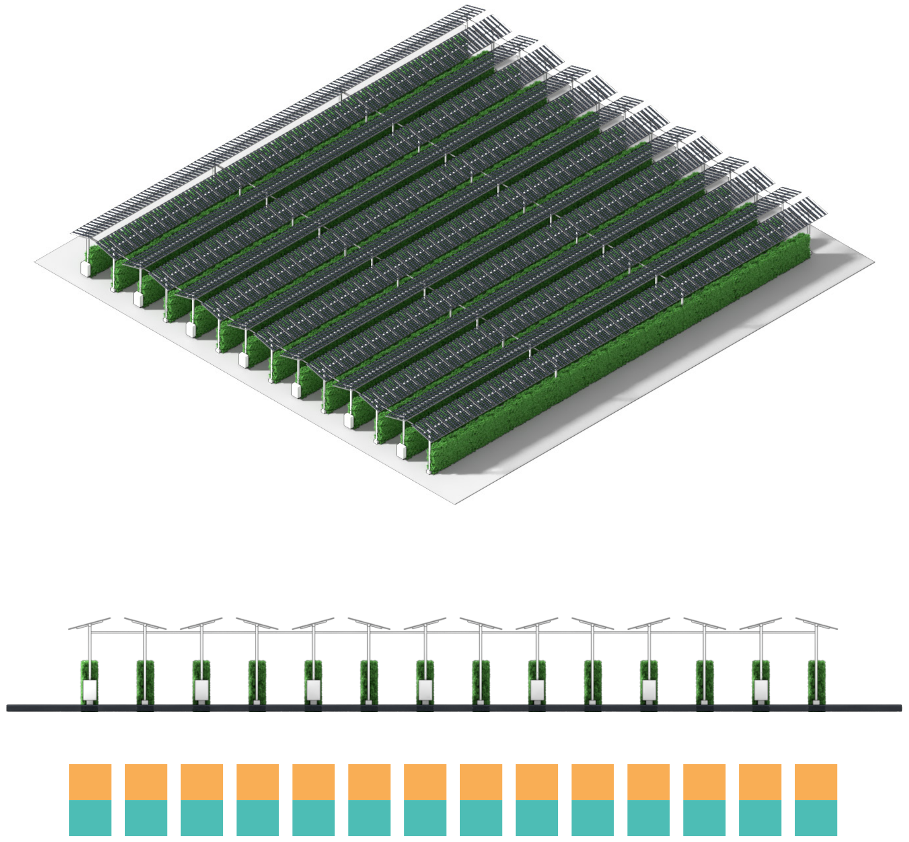
agricultural area: 1,050 m^2
perenial area: 144 m^2
circulation: 216 m^2

photovoltaic area: 494 m^2
photovoltaic panels: 247 panels
electricity: 85,215 kWh/yr
8.5 average homes

Partial-Shade Crops Configurations



typical panel **semi-transparent panels**

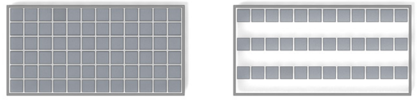


short-span elevated panels

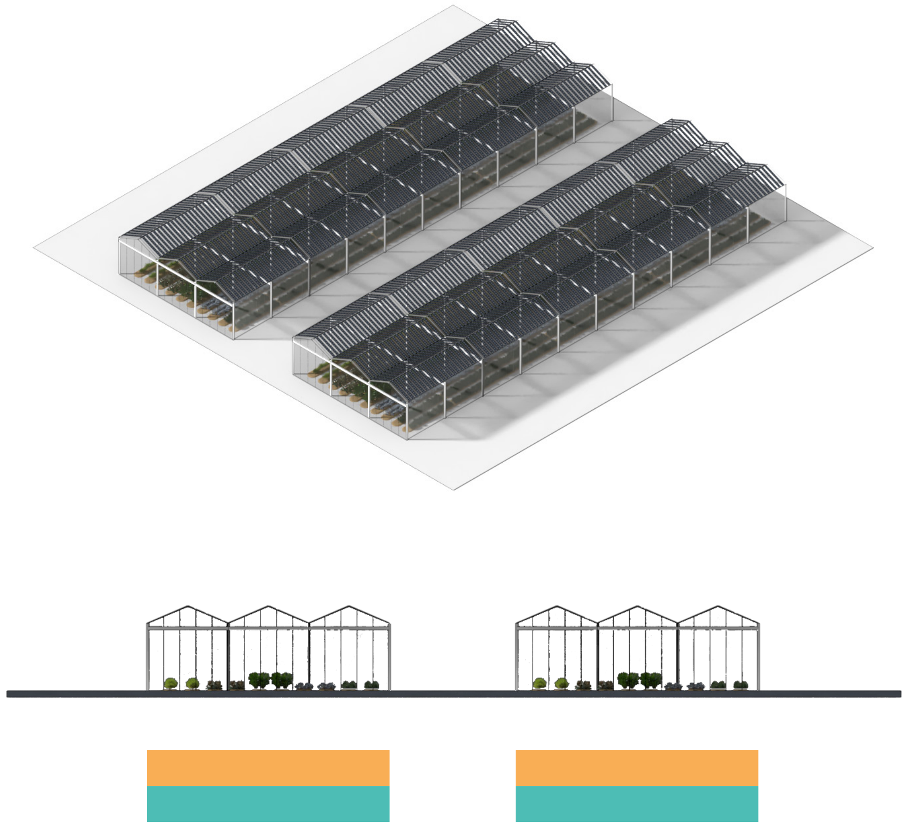
total area: 1,600 m^2

agricultural area: 518 m^2
perenial area: 0 m^2
circulation: 518 m^2

photovoltaic area: 1,036 m^2
photovoltaic panels: 518 panels
electricity: 89,355 kWh/yr
8.9 average homes



typical panel **semi-transparent panels**

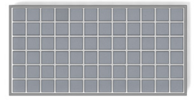


crop protection structure

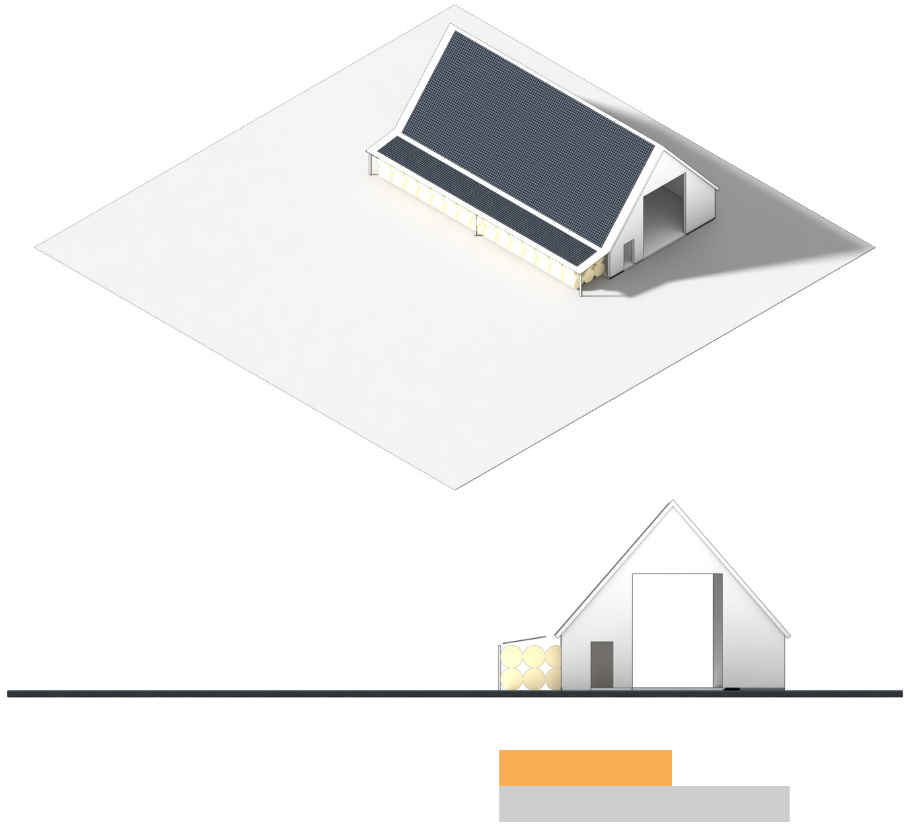
total area: 360 m^2

agricultural area: 300 m^2
perenial area: 0 m^2
circulation: 216 m^2

photovoltaic area: 360 m^2
photovoltaic panels: 180 panels
electricity: 32,850 kWh/yr
3.3 average homes



typical panel



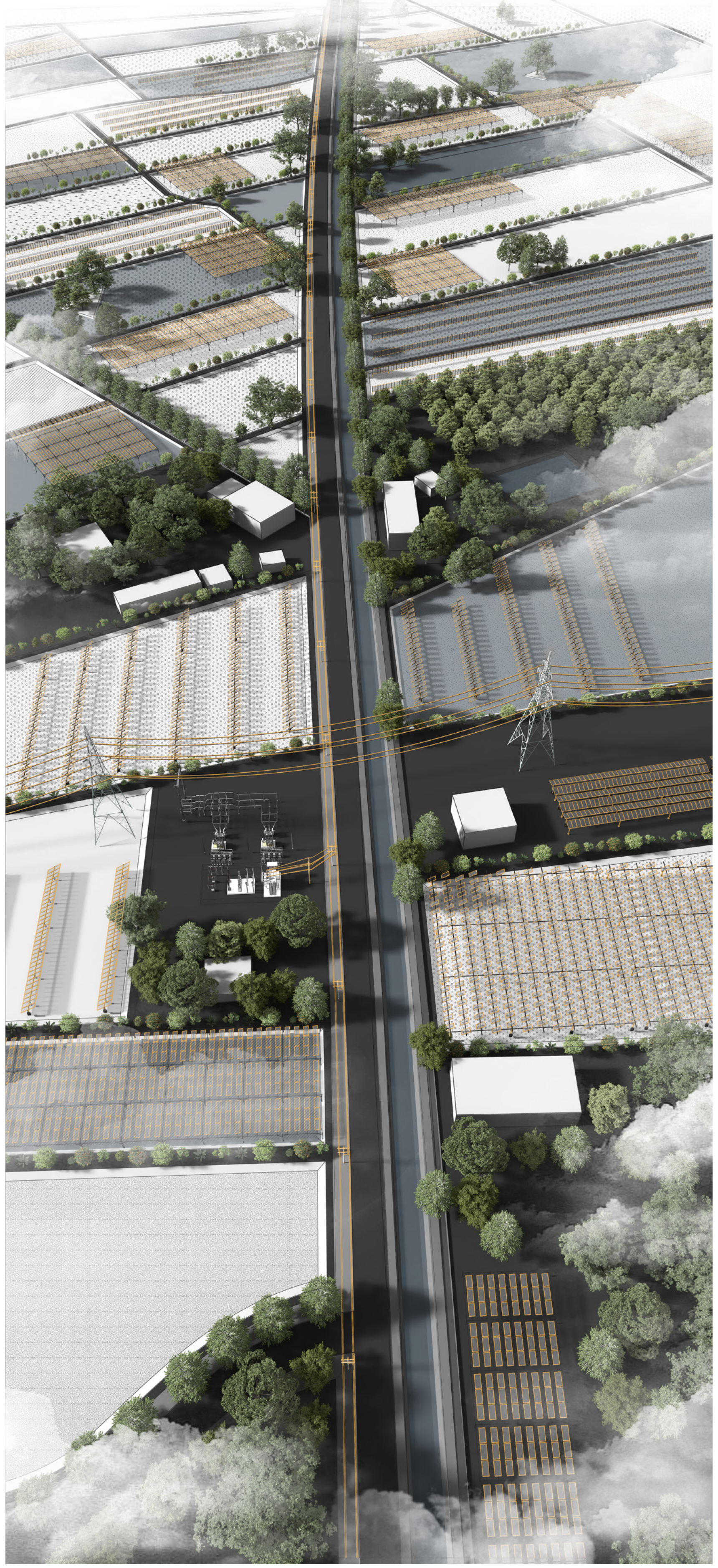
barn

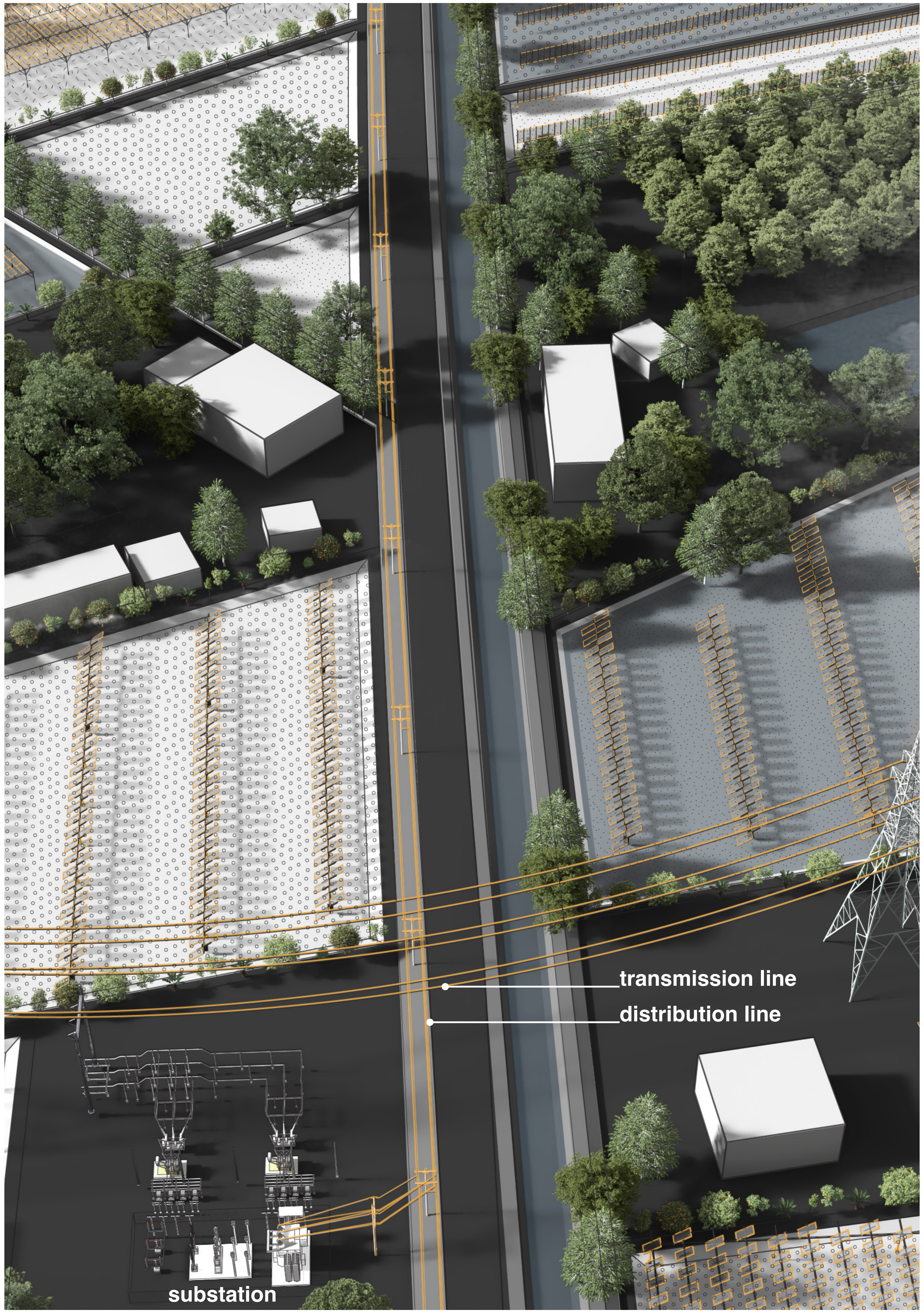
total area: 360 m^2

agricultural area: N/A m^2
perenial area: N/A m^2
circulation: N/A m^2

photovoltaic area: 190 m^2
photovoltaic panels: 95 panels
electricity: 32,775 kWh/yr
3.3 average homes

Constructed Configurations





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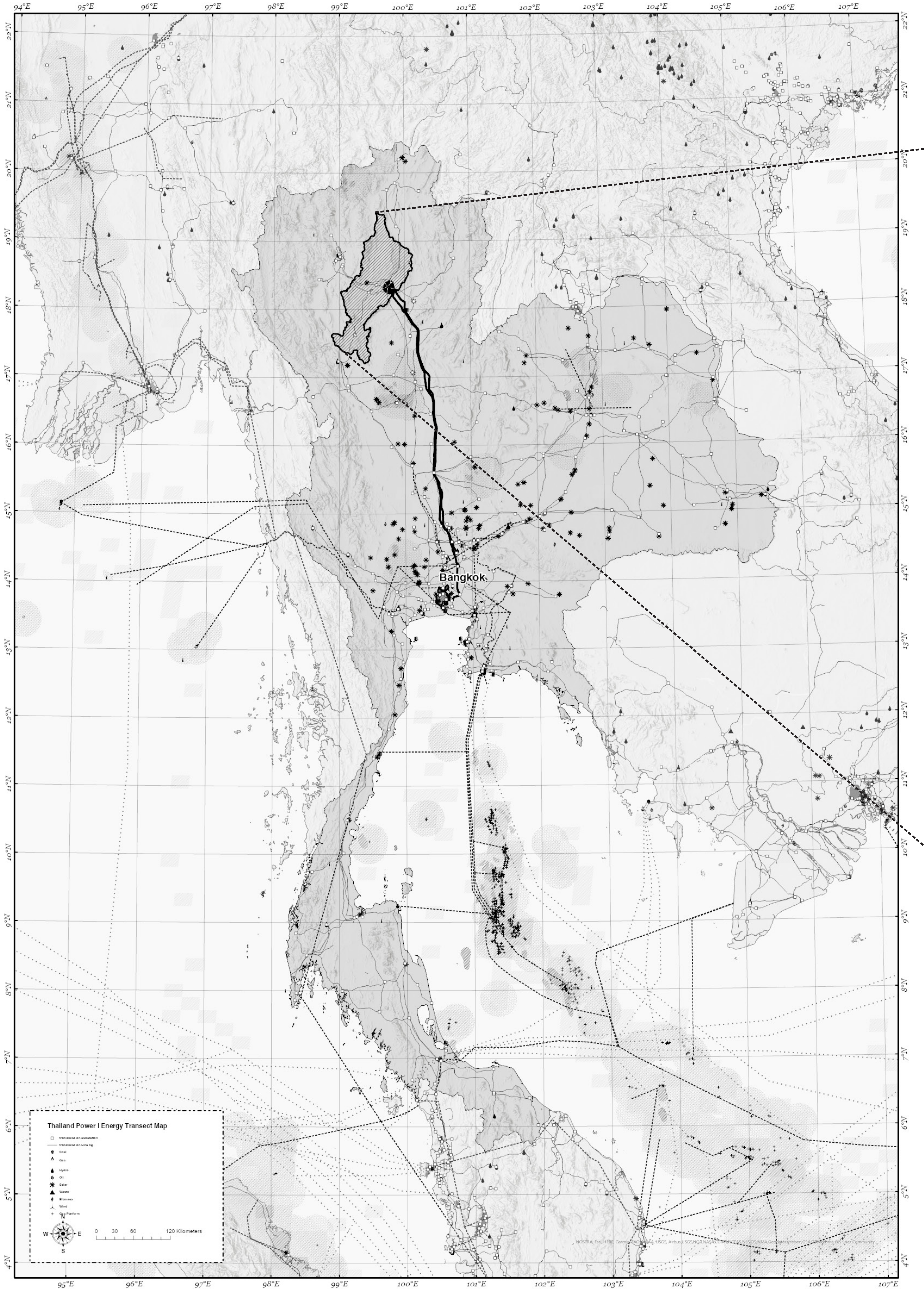
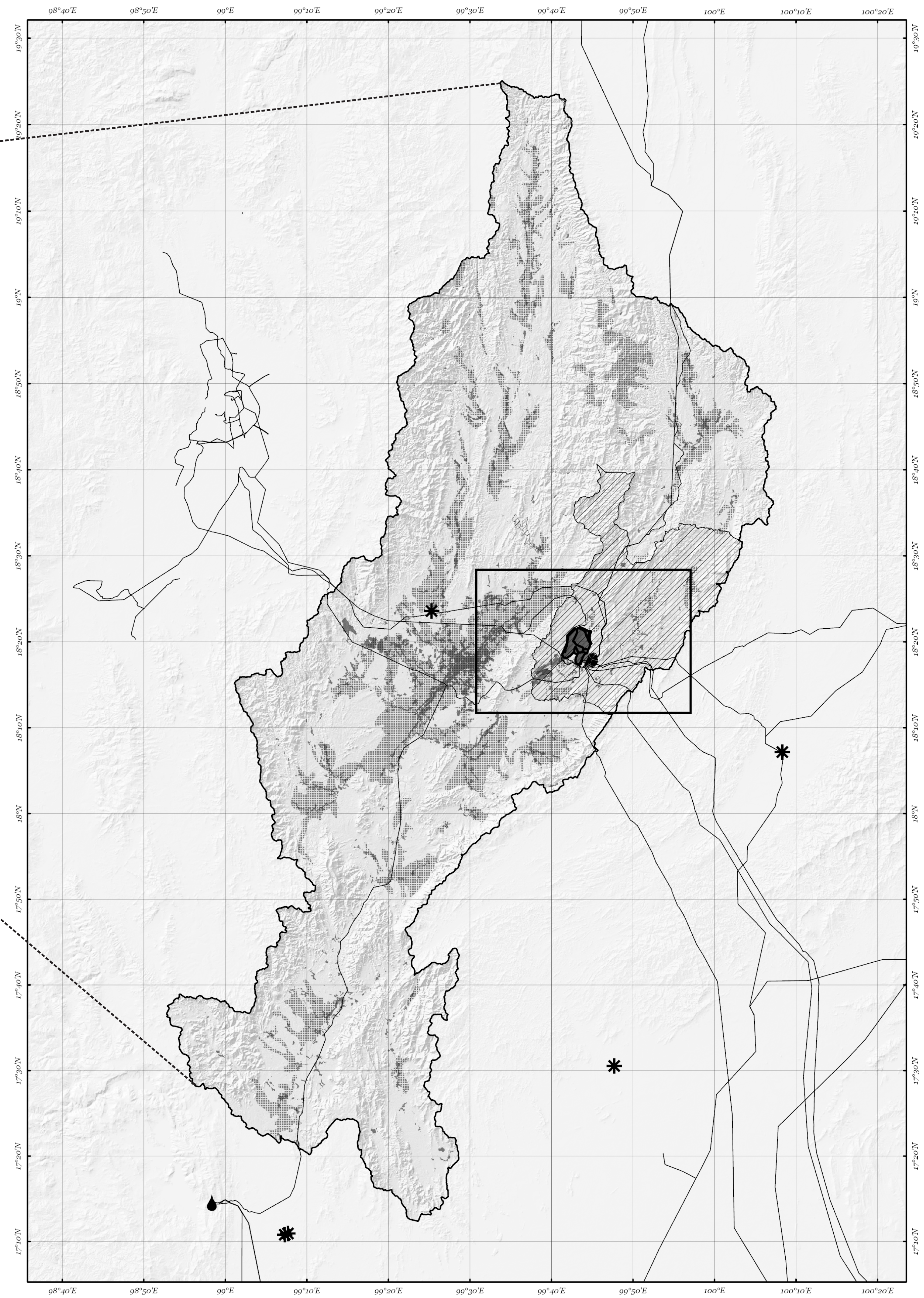
Pairing Renewable Energy with Regenerative Agriculture

by: Pavin Banternghansa
Advisor: Niall Kirkwood

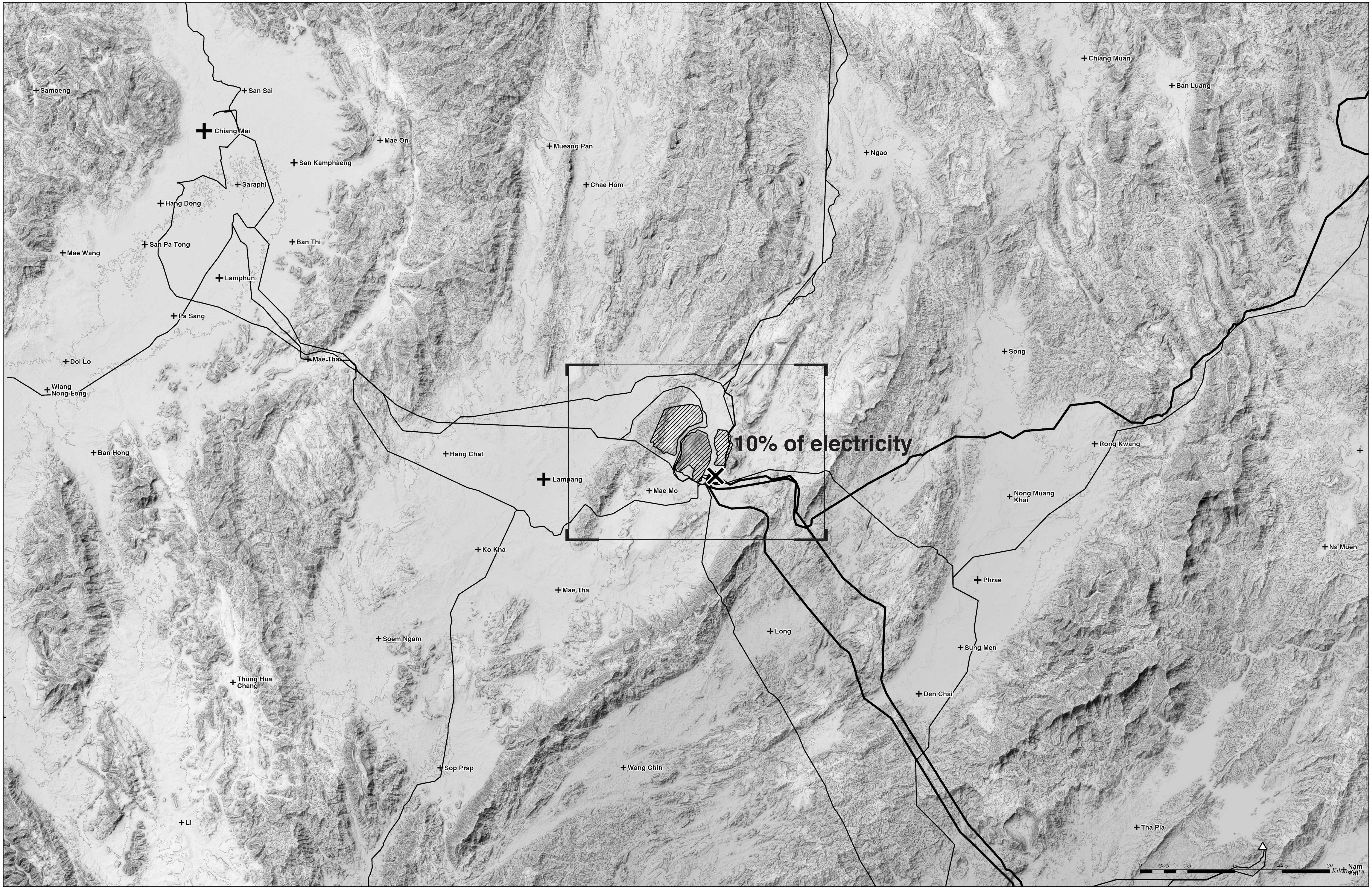
Here we can see the panels being deployed on the rice paddies, to the distribution line, substation, and transmission line. In this way, energy production will be unraveled in our landscape, no longer concealed. Thereby, it becomes necessary to incorporate water storage and distributing systems towards revising cultivation methods which are increasingly affected by severe climatic conditions.





Mae Moh, Lampang, Thailand

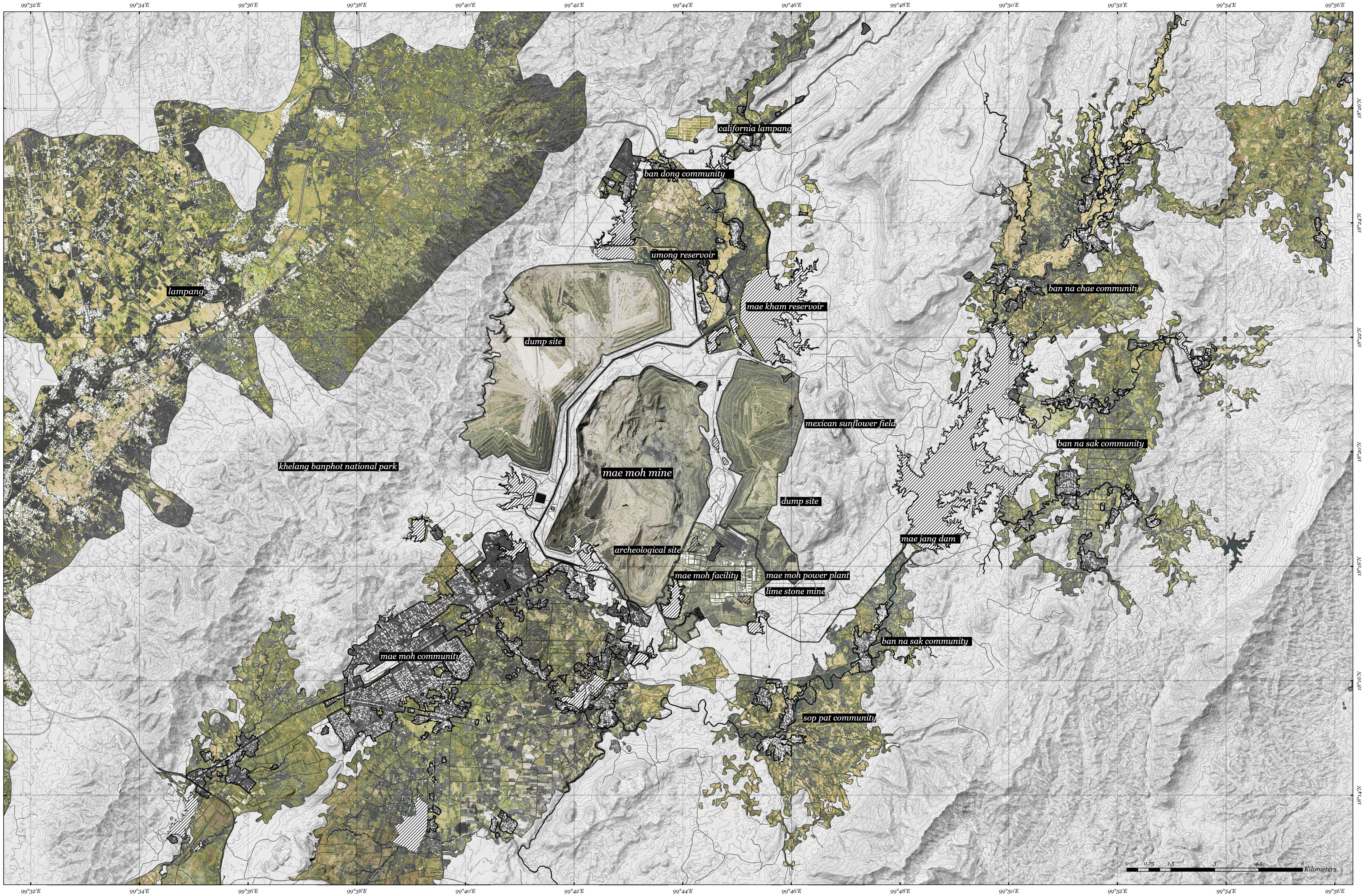
As a potential site and catalyst for such transition, I focus on how the Mae Moh Lignite Mine in Lampang could terraform to PSH through extraction.



Mae Moh Lignite Powerplant

Currently, the Mae Moh lignite power plant produces 10% of electricity for the nation, the largest lignite mine in SEA.

by: Pavin Banternghansa
Advisor: Niall Kirkwood



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Mae Moh Community

The mine is situated between 6 agricultural communities, with a total population of 40,000, mostly low-income laborers and farmers growing rice, perennials, and fruits.

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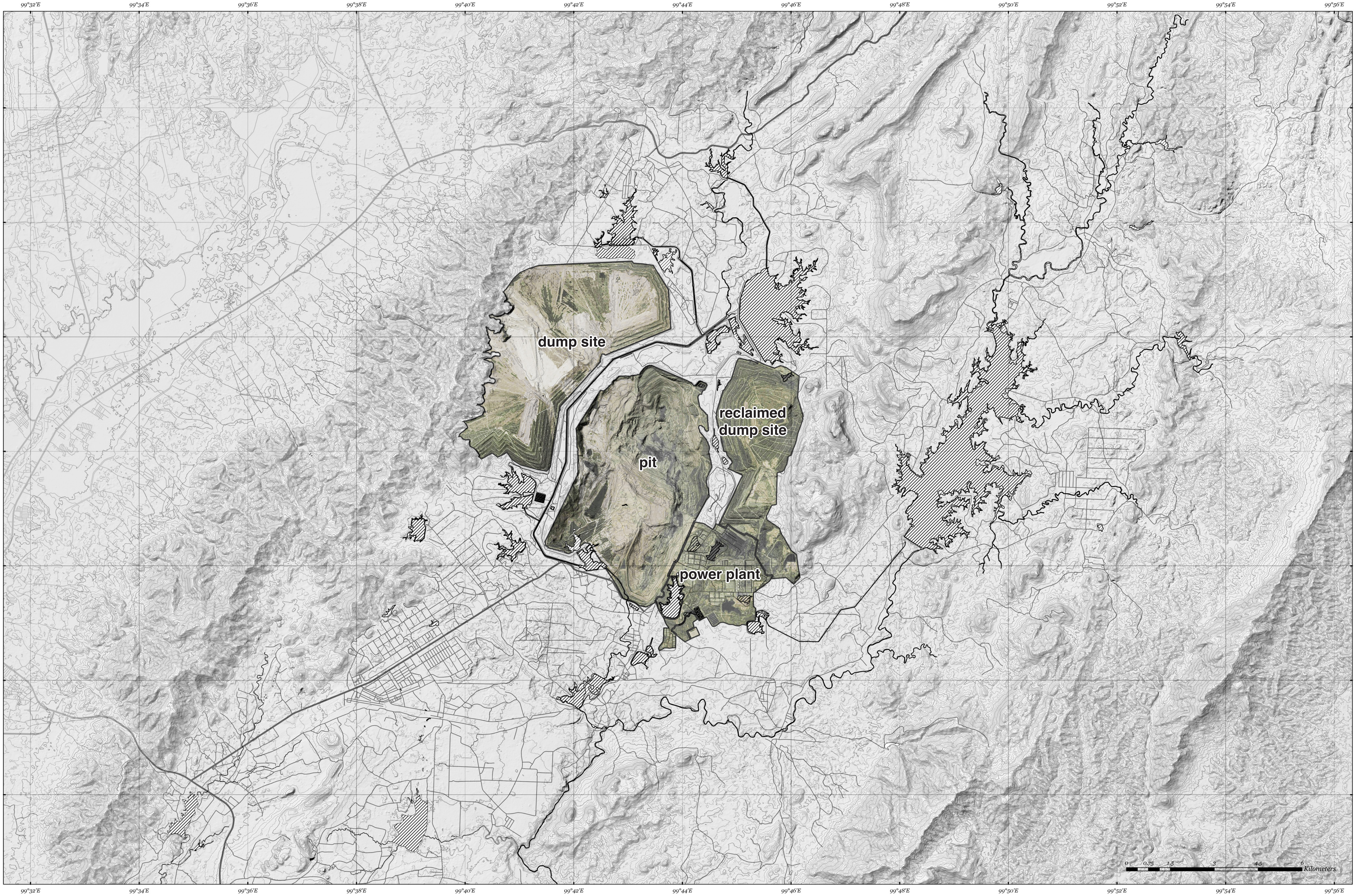
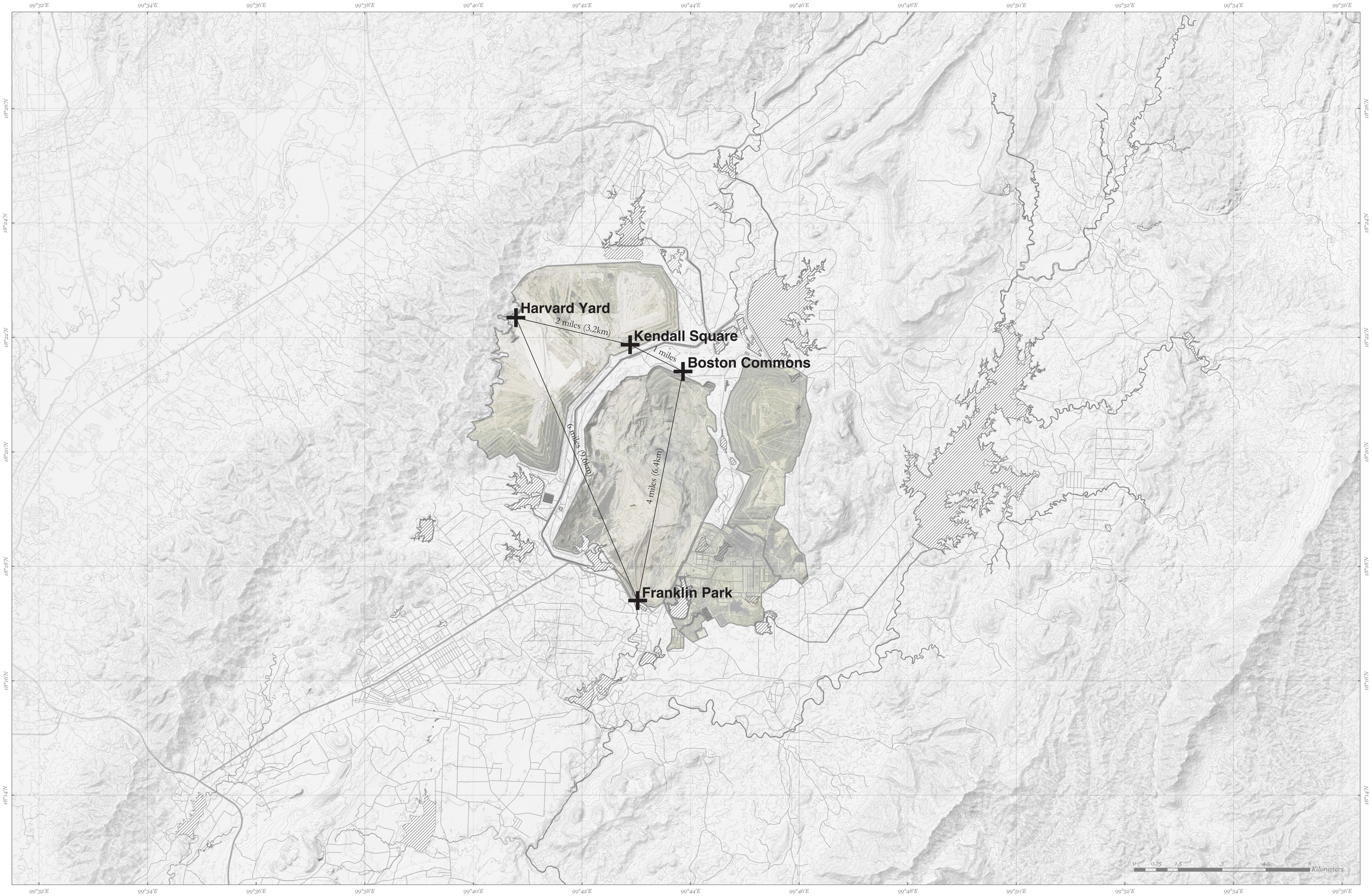
Advisor: Niall Kirkwood



Mae Moh Lignite Mine

Mae Moh consists of four main program areas- pit, dump site, reclaimed dump site, and powerplant facility.



Scale Reference

The expanse of the mine is comparable to the distance from harvard yard to franklin park.

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Advisor: Niall Kirkwood

Mae Moh Lignite Power Plant 1969
source: https://maemohmine.egat.co.th/about.html

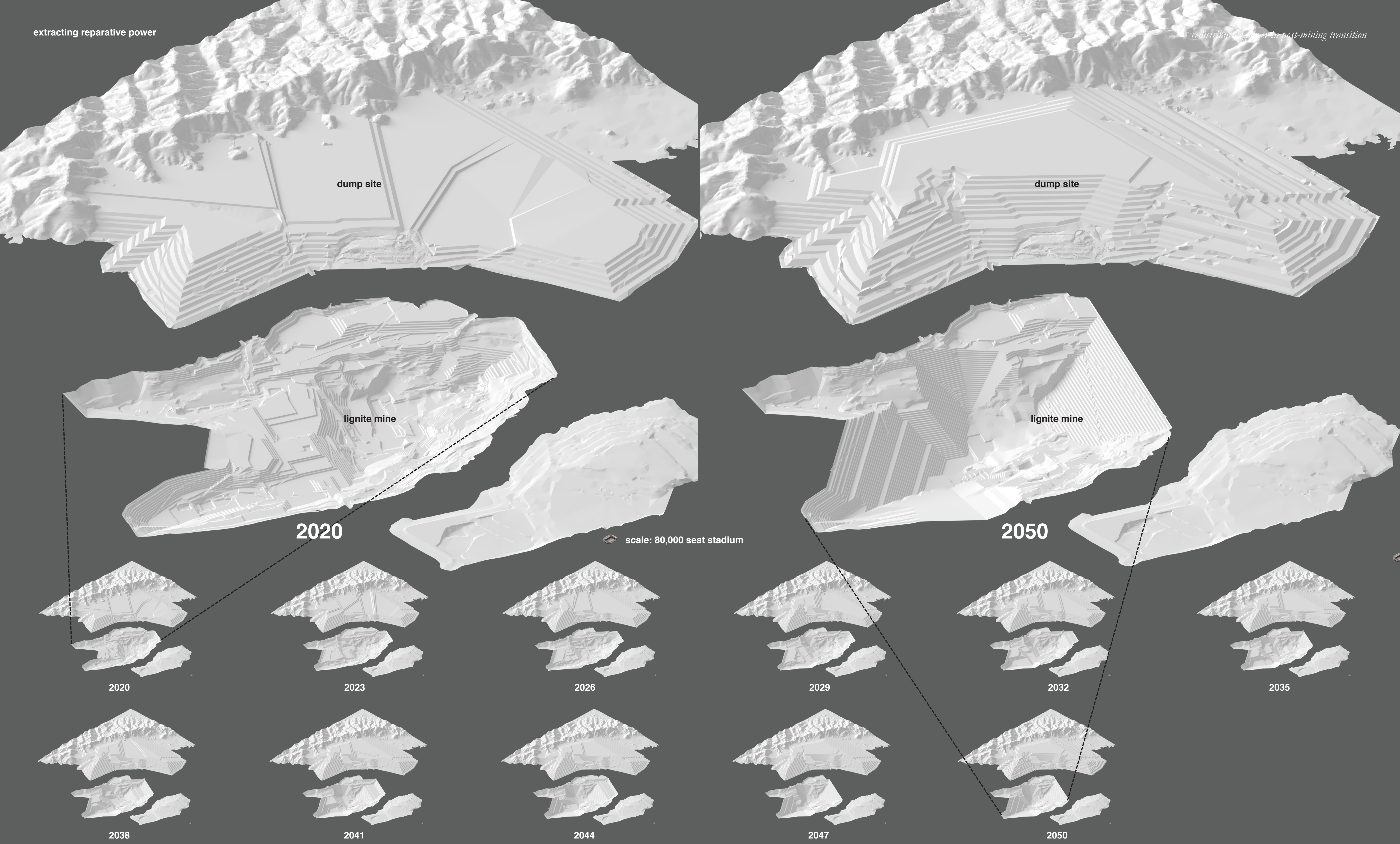
Mae Moh Lignite Power Plant 2022
source: https://www.egat.co.th/home/en/20220128e/

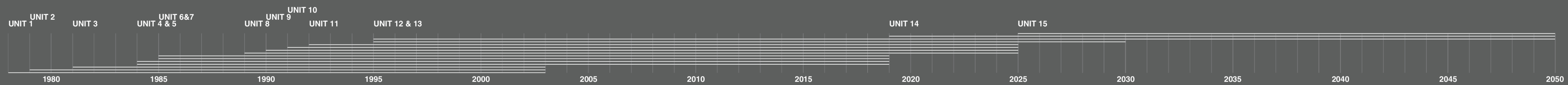
Electricity Generating Authority of Thailand (EGAT)

EGAT, a state enterprise and the national grid operator, has managed the facility since 1969, while the mine will be depleted of lignite and close in 2050.

extracting reparative power

redistributing power in post-mining transition





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Current Excavation Plan

I am proposing to shift the current excavation plan from simply extracting and dumping from today to 2050.

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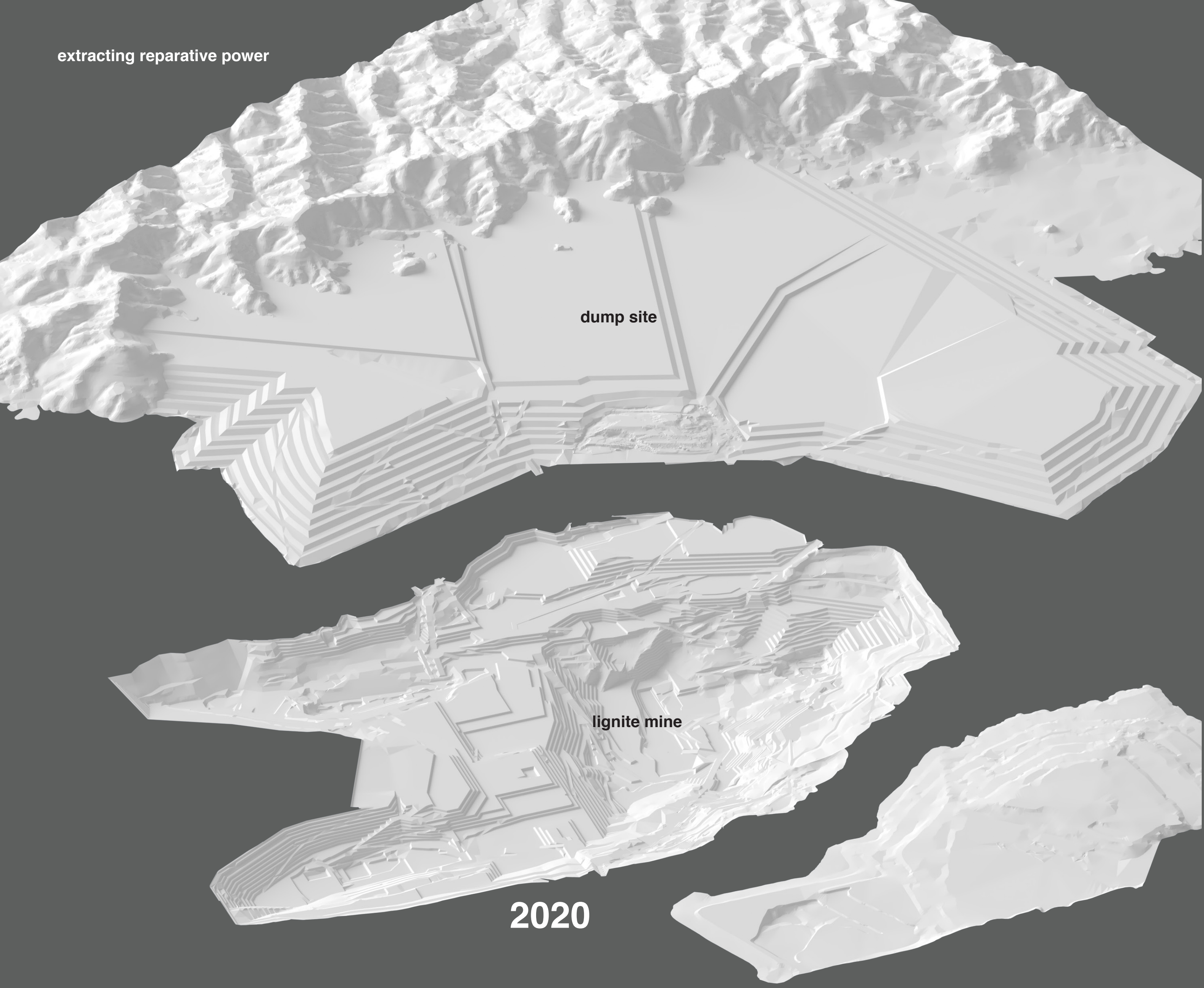
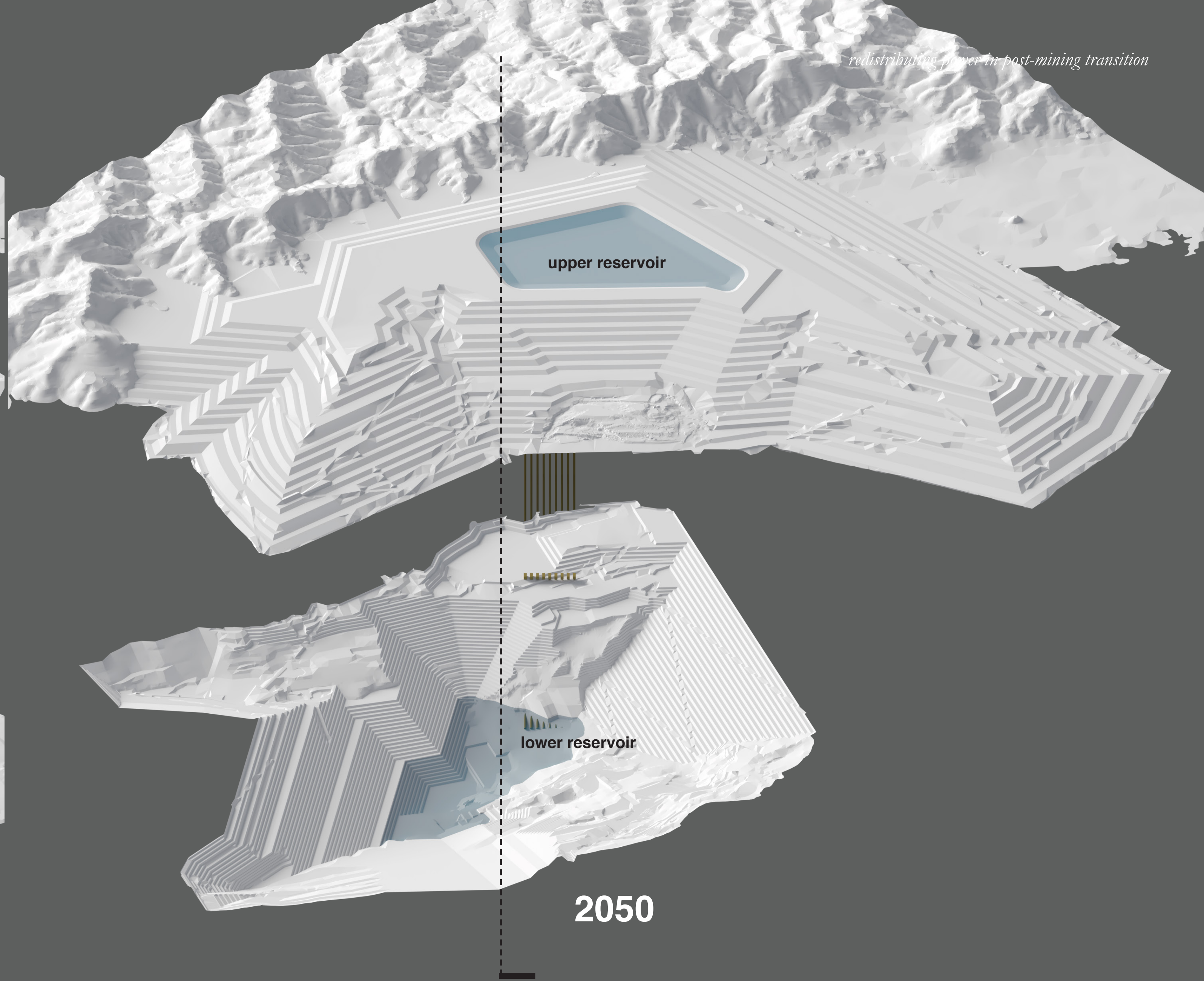
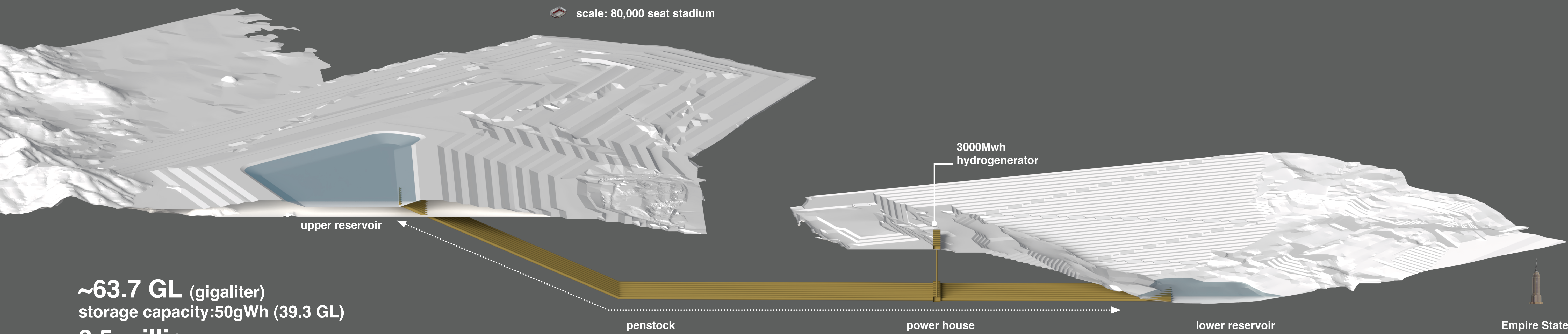
Advisor: Niall Kirkwood

extracting reparative power

redistributing power in post-mining transition







~63.7 GL (gigaliter)
storage capacity:50gWh (39.3 GL)
2.5 million for 18 hours
(24.4GL for irrigation)

Pump Storage Hydropower Potential

My proposal utilize the extractive lignite mine into a lower reservoir, and reshape the dump site of the extracted land into an upper reservoir. This allows the site to function as a pump storage hydropower facility. The upper reservoir has a capacity for 60 gigalitres of water of which 40 could be charged and discharged, providing electricity for 2.5 million people.

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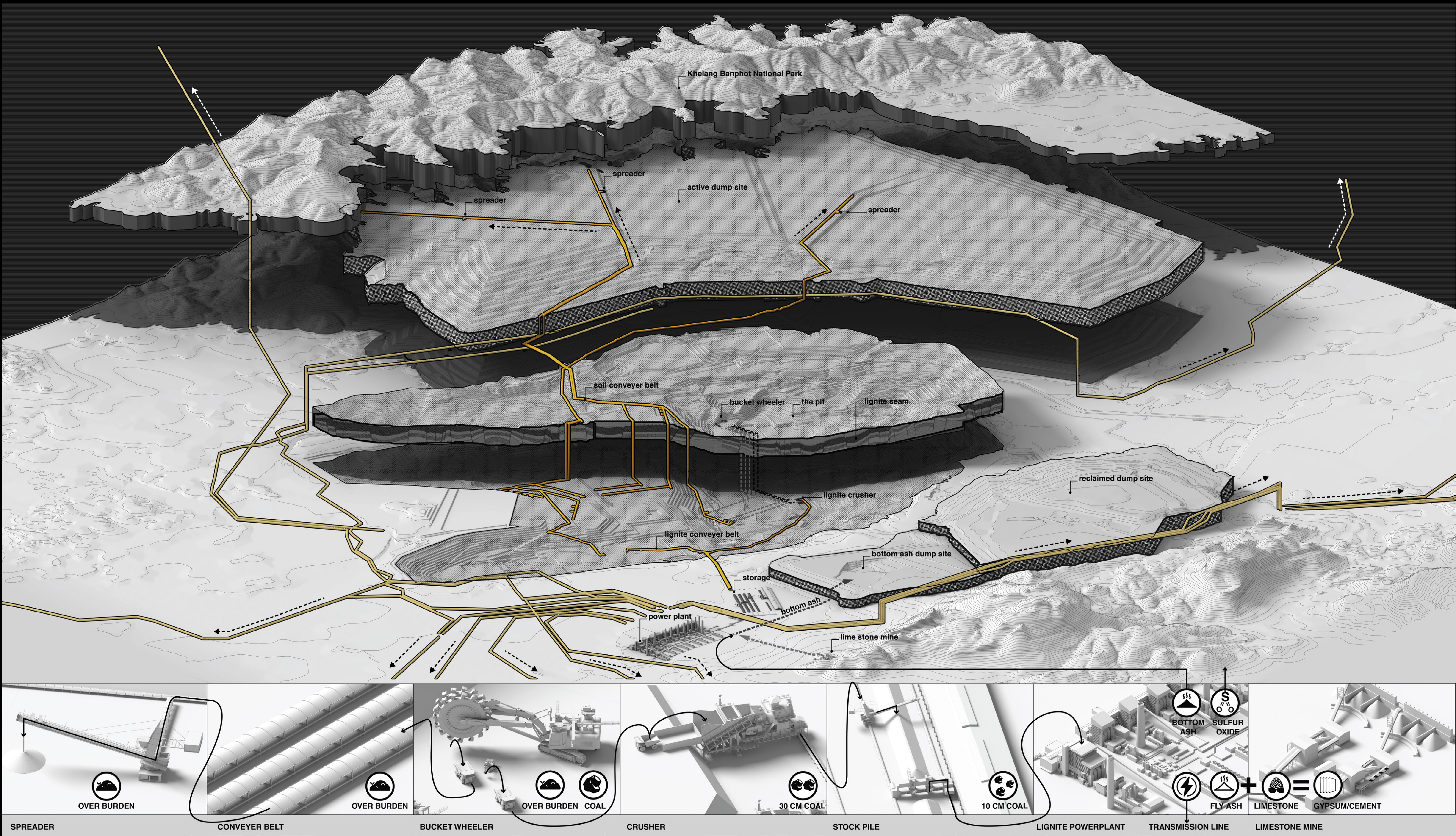
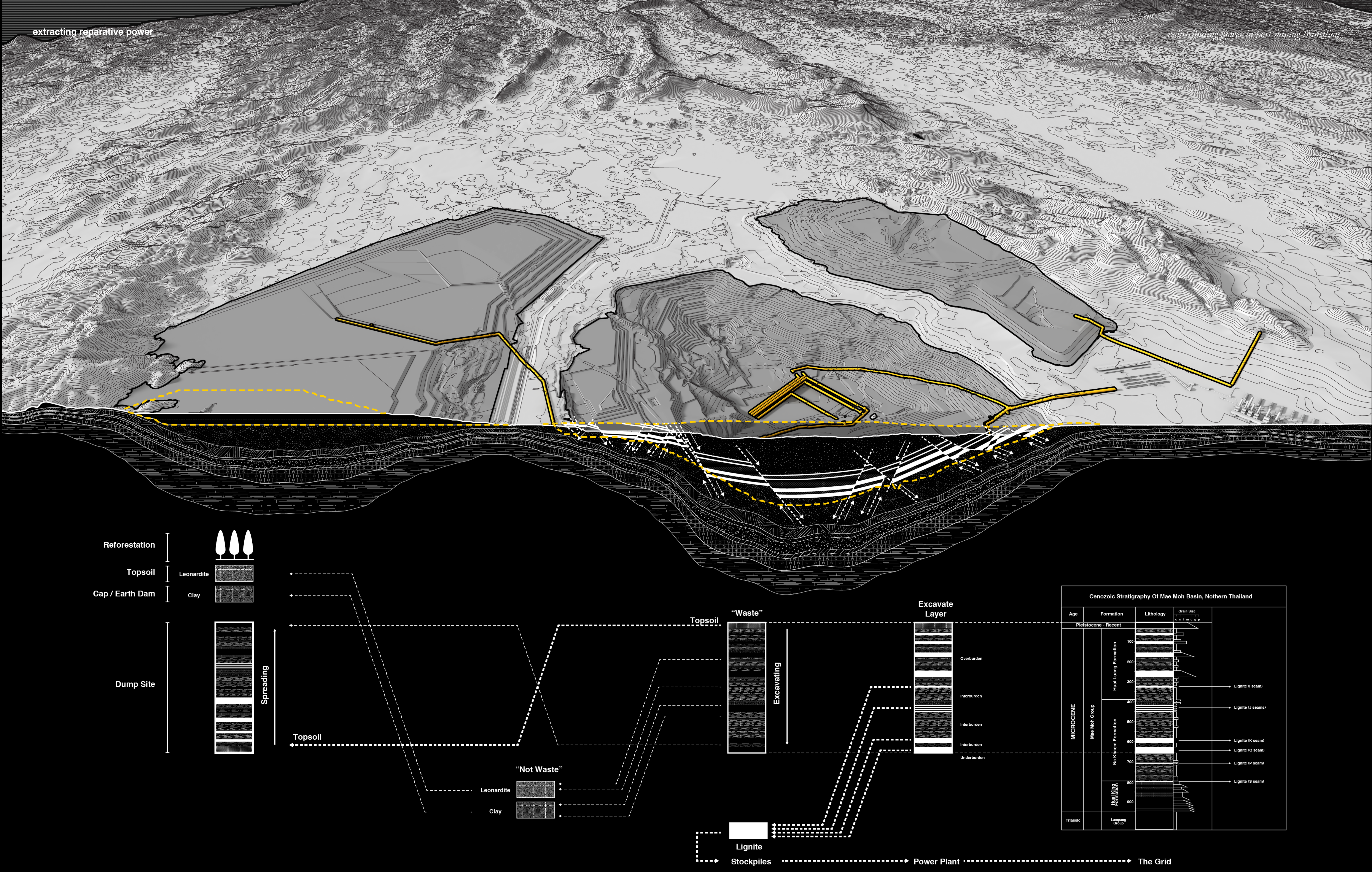
by: Pavin Banternghansa
Advisor: Niall Kirkwood



Existing Lignite Extraction

The processing of extracting and dumping land in the lignite mining operation itself then becomes key to the design as the overburden piled up onto the dump site to form the upper reservoir.

by: Pavin Banternghansa
Advisor: Niall Kirkwood



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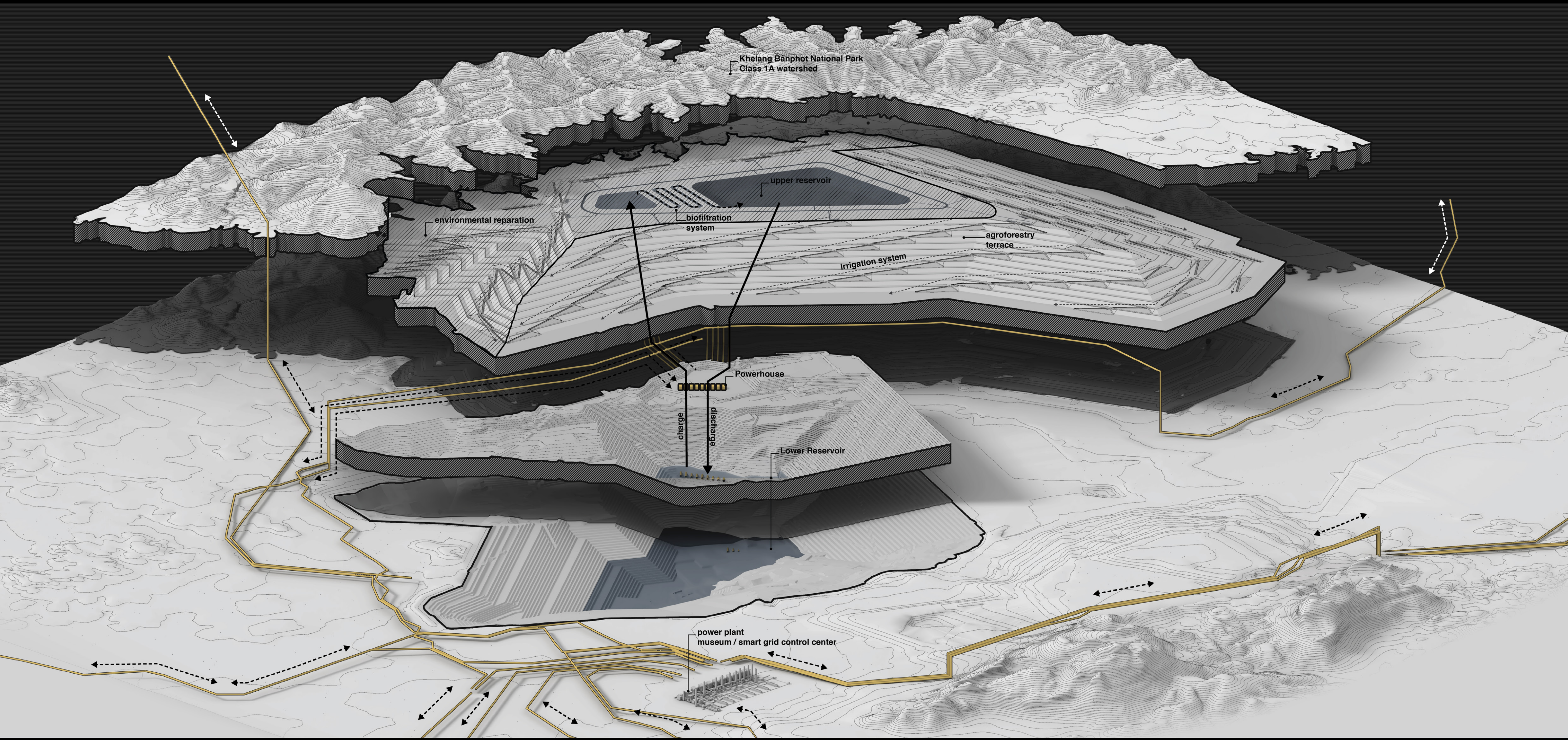
Reclaiming Overburden

Currently, anything other than lignite is labeled "waste". The excavated soil is layered on to the dumped site in reverse order. The topsoil that used to cover the pit is now buried at the bottom. As this process continues, clay needs to be separated as capping material and homogeneous earth dam while leodarnite separated as topsoil for reforestation.

by: Pavin Banternghansa
Advisor: Niall Kirkwood



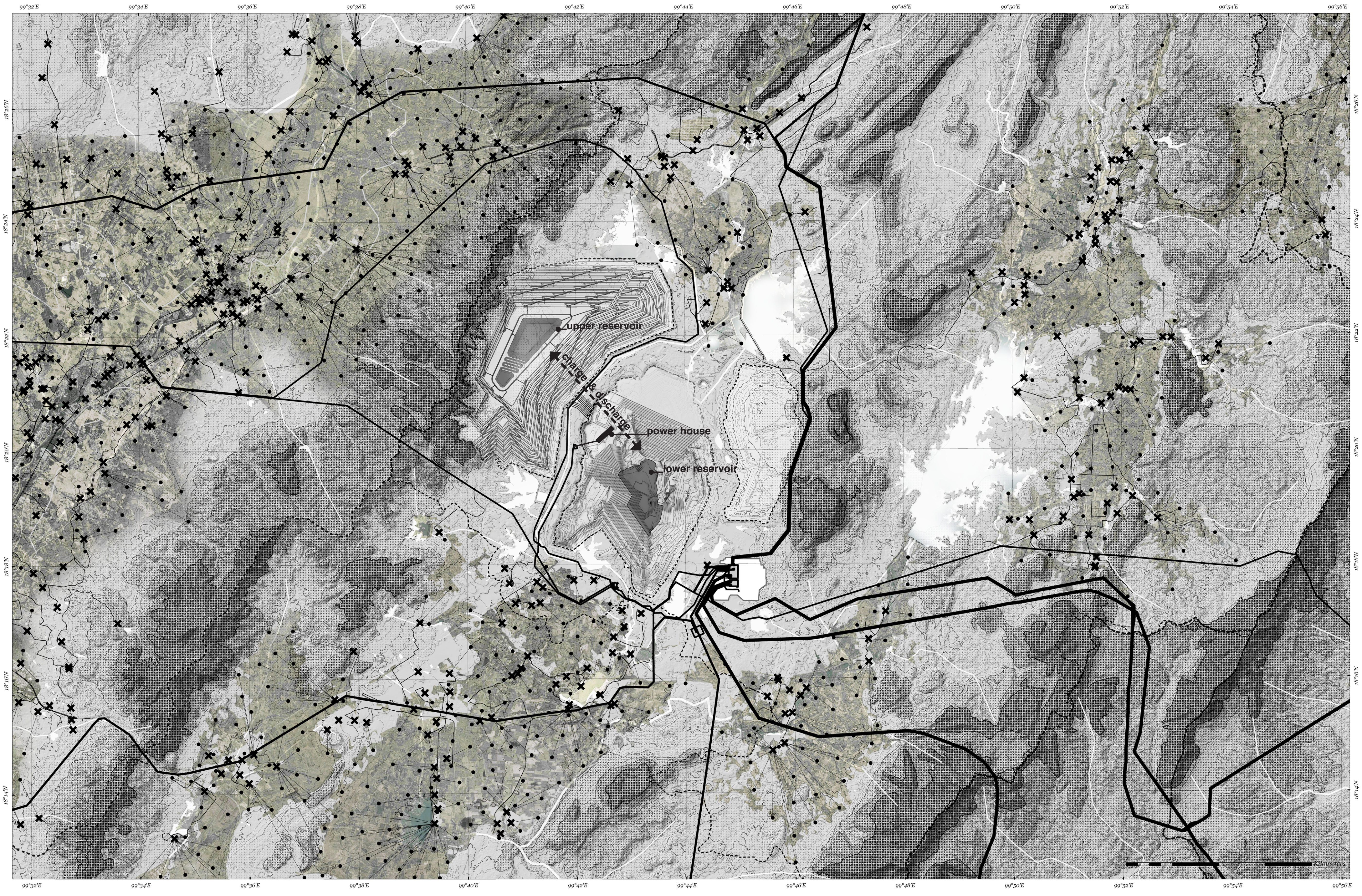
Extraction as Reclamation

The end of lignite extractions will be the birth of critical storage infrastructure for renewable energy.

by: Pavin Banternghansa
Advisor: Niall Kirkwood

Existing Lignite Infrastructure

The current transmission infrastructure is one-directional and linear.



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Renewable Energy Network

The proposal will transition into a network-based system enabled by the charge and discharging between the two reservoirs that function both as storage and distribution for the renewable energy.

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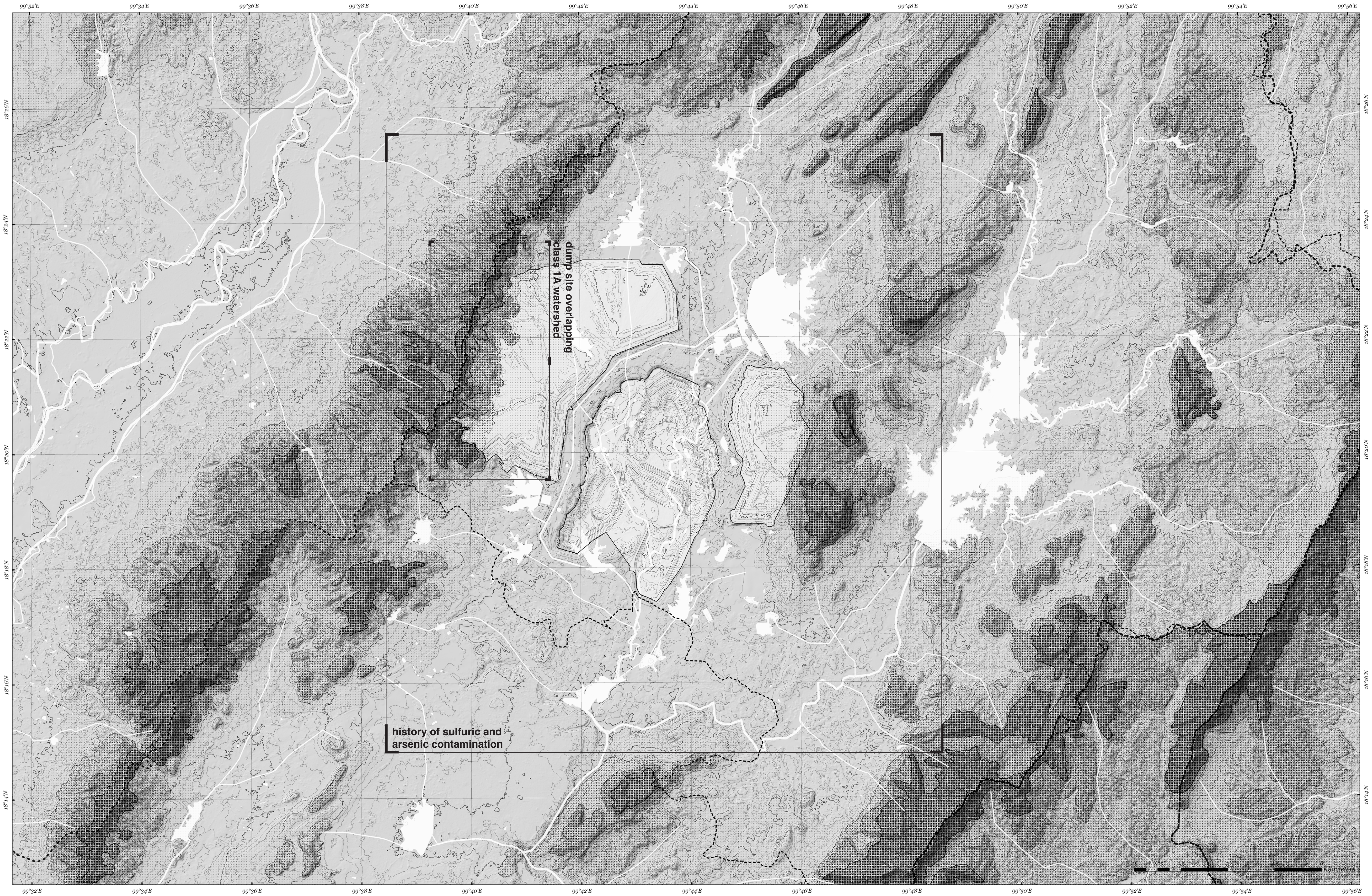
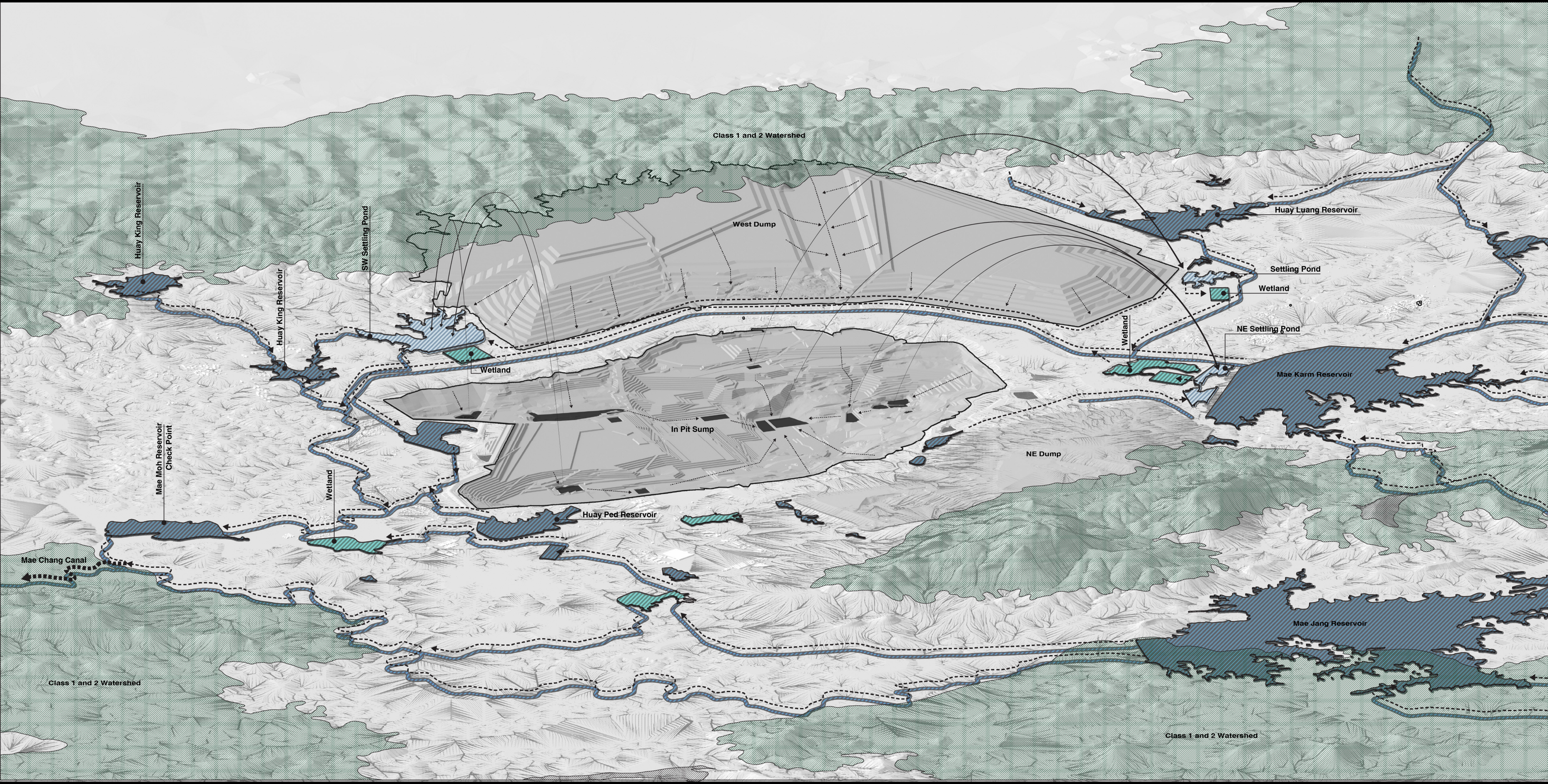
Advisor: Niall Kirkwood



Site Complexities

My proposal also recognized two key environmental tensions: its location that overlaps with a 1A classified watershed and its history of sulfuric and arsenic contamination.



Existing Hydrological Network

The existing hydrological network transfers water from the pit sump to surrounding settling ponds, wetlands, and reservoirs that function as filters and checkpoints before flowing out of the site.

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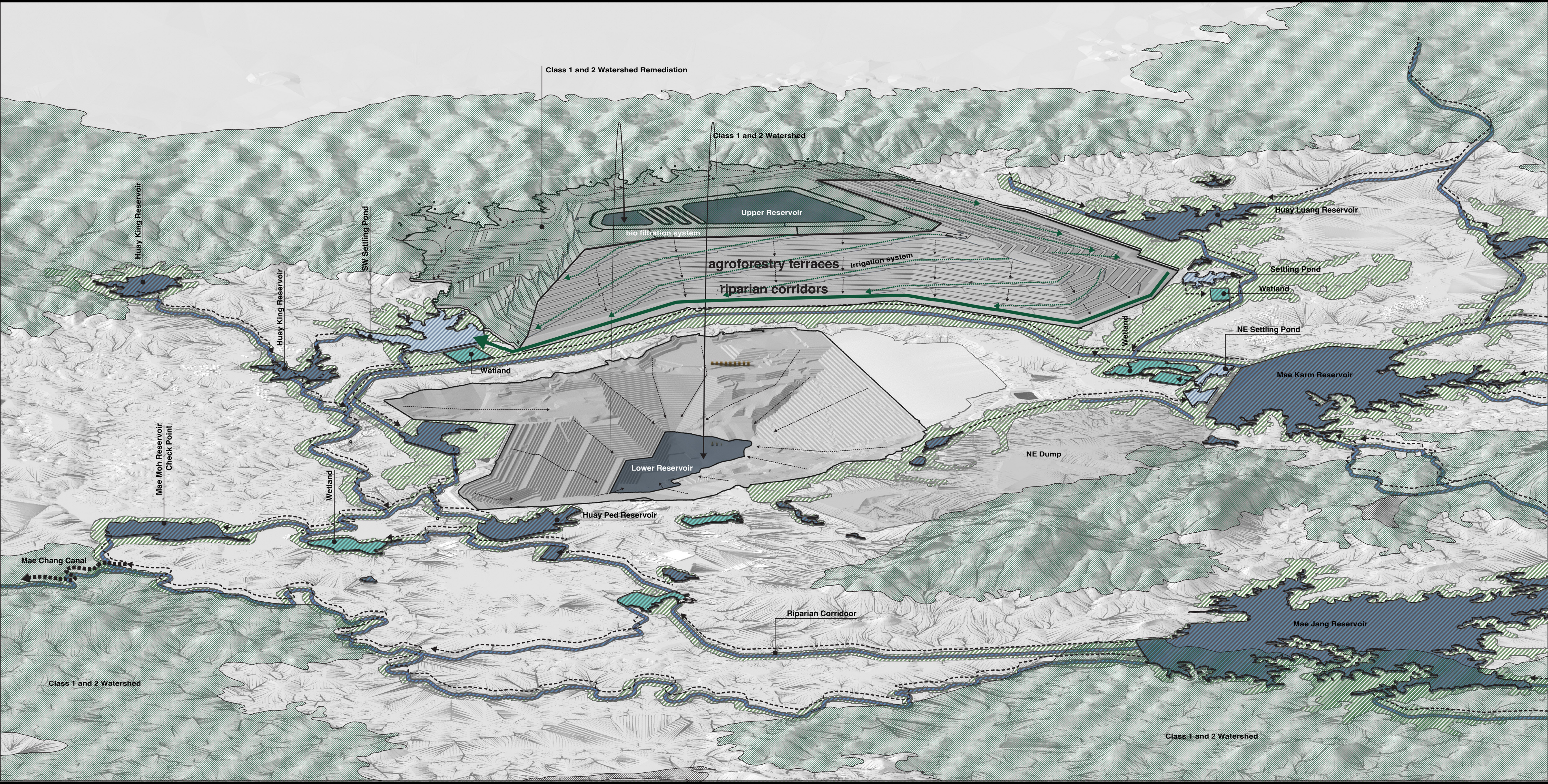
Advisor: Niall Kirkwood



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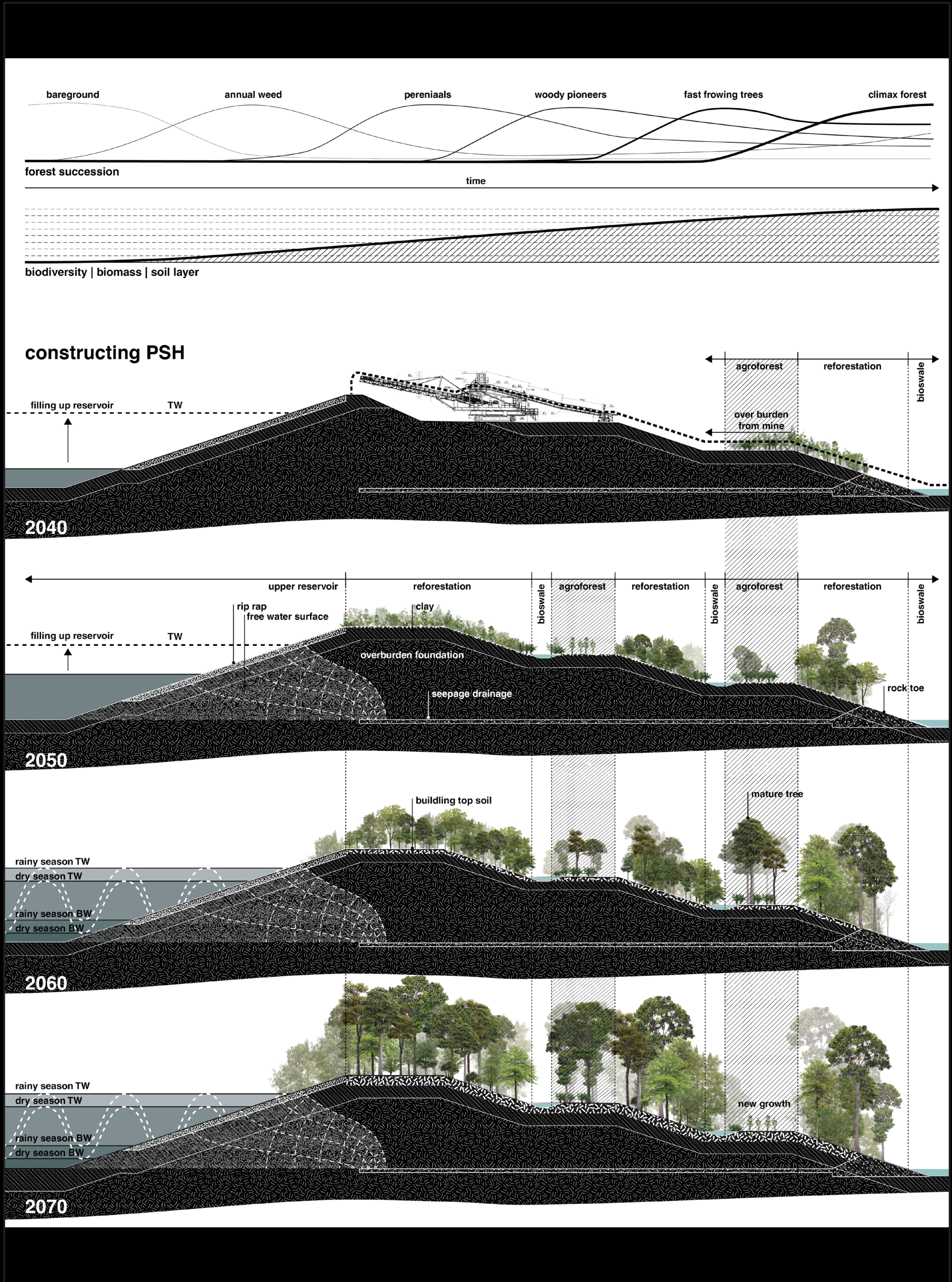
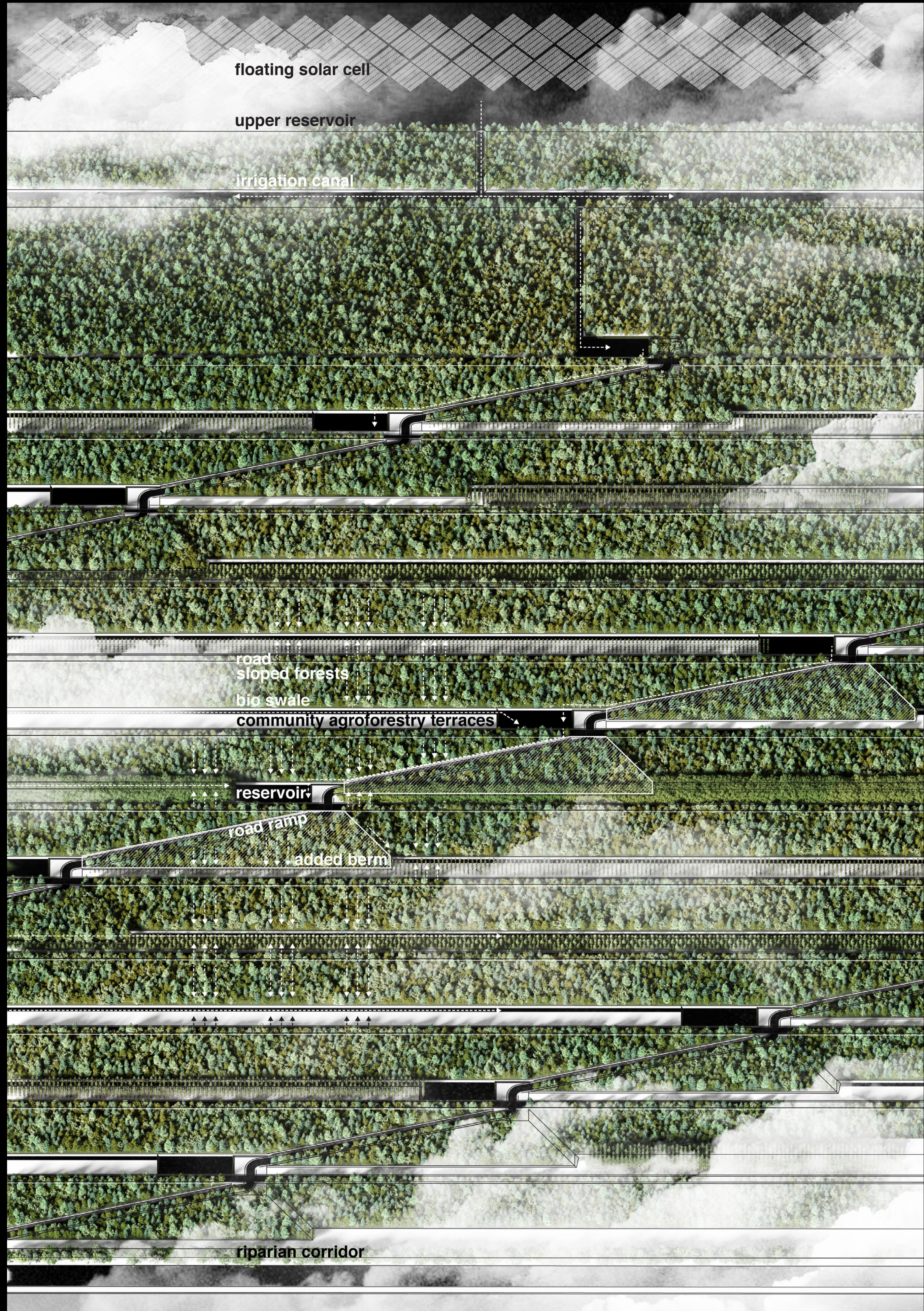
Blue Green Infrastructure Proposal

Here I proposed a system of blue-green infrastructure that utilizes flows between the upper and lower reservoirs to store and generate electricity whilst remediating water through its biofiltration cycle. The water is also used as irrigation for watershed remediation and agroforestry terraces along the dump site. The run-off are channeled through the riparian corridors into riparian corridors.

by: Pavin Banternghansa
Advisor: Niall Kirkwood





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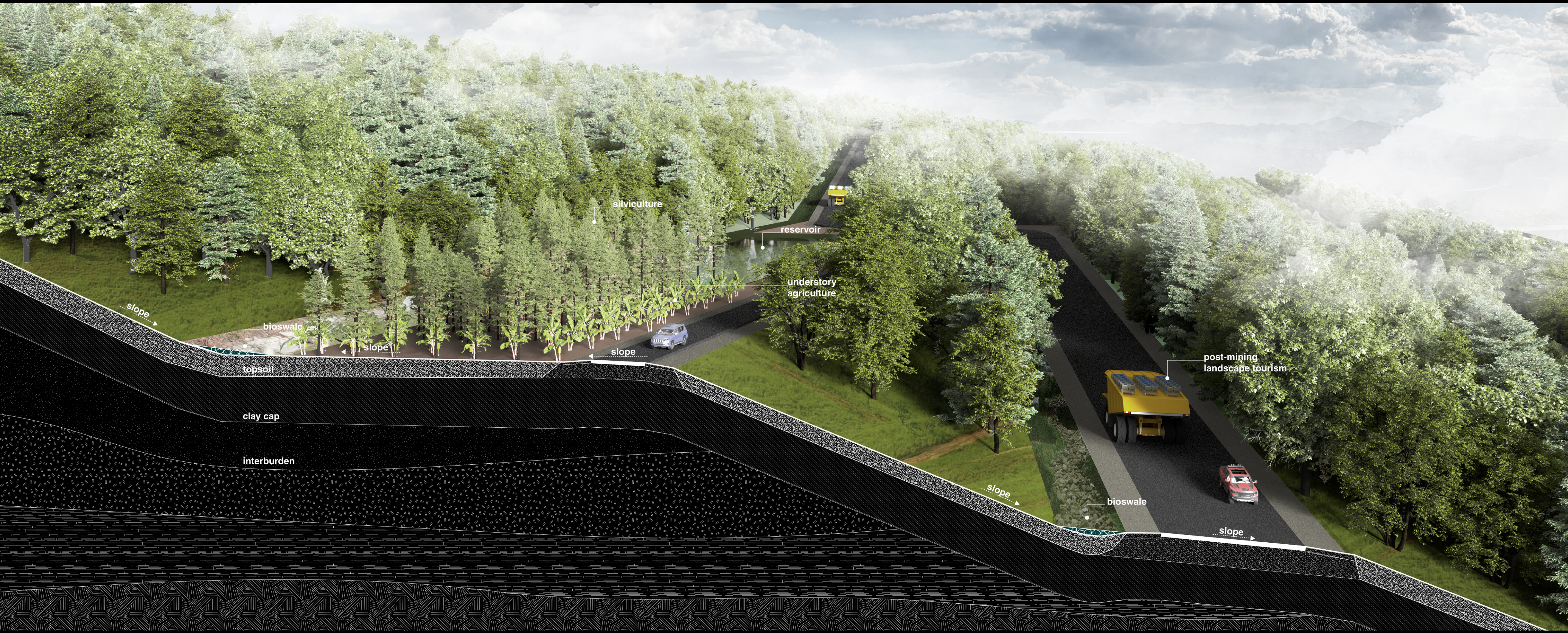
Community Agroforestry Terraces

by: Pavin Banterghansa
Advisor: Niall Kirkwood

The extracted leonardite of the overburden functions as topsoil, providing fertile grounds for the agroforest and reforestation efforts, while the clay functions as an impermeable homogeneous earth dam structure. The proposed vignette portrays how water will be filtered down through the irrigation canal to the bioswales and stored in systems of smaller reservoirs to irrigate the proposed community agroforestry terraces.



Community Agroforestry Terraces

The project gives new purpose and meaning to extraction, in which this 'act' on the land is not merely extractive, but through alternate land processing and forming, extraction as reparation.

by: Pavin Banternghansa
Advisor: Niall Kirkwood

Holistic Operation

As a holistic operation, the proposal harnesses the transformative potential of land that "does justice to all of the landscape's ingredients."

by: Pavin Banternghansa
Advisor: Niall Kirkwood

“The energy transition inevitably leads to striking changes in the landscape, which have a far-reaching effect on the familiar agreements, both the formal and the informal ones… **The landscape becomes the mediator between the new energy infrastructure and the space in which this infrastructure will be placed.**”

Landscape and Energy, Dirk Sijmon (2014)

EXTRACTING REPARATIVE POWER

redistributing power in post-mining transition

by: Pavin Banternghansa

Advisor: Niall Kirkwood

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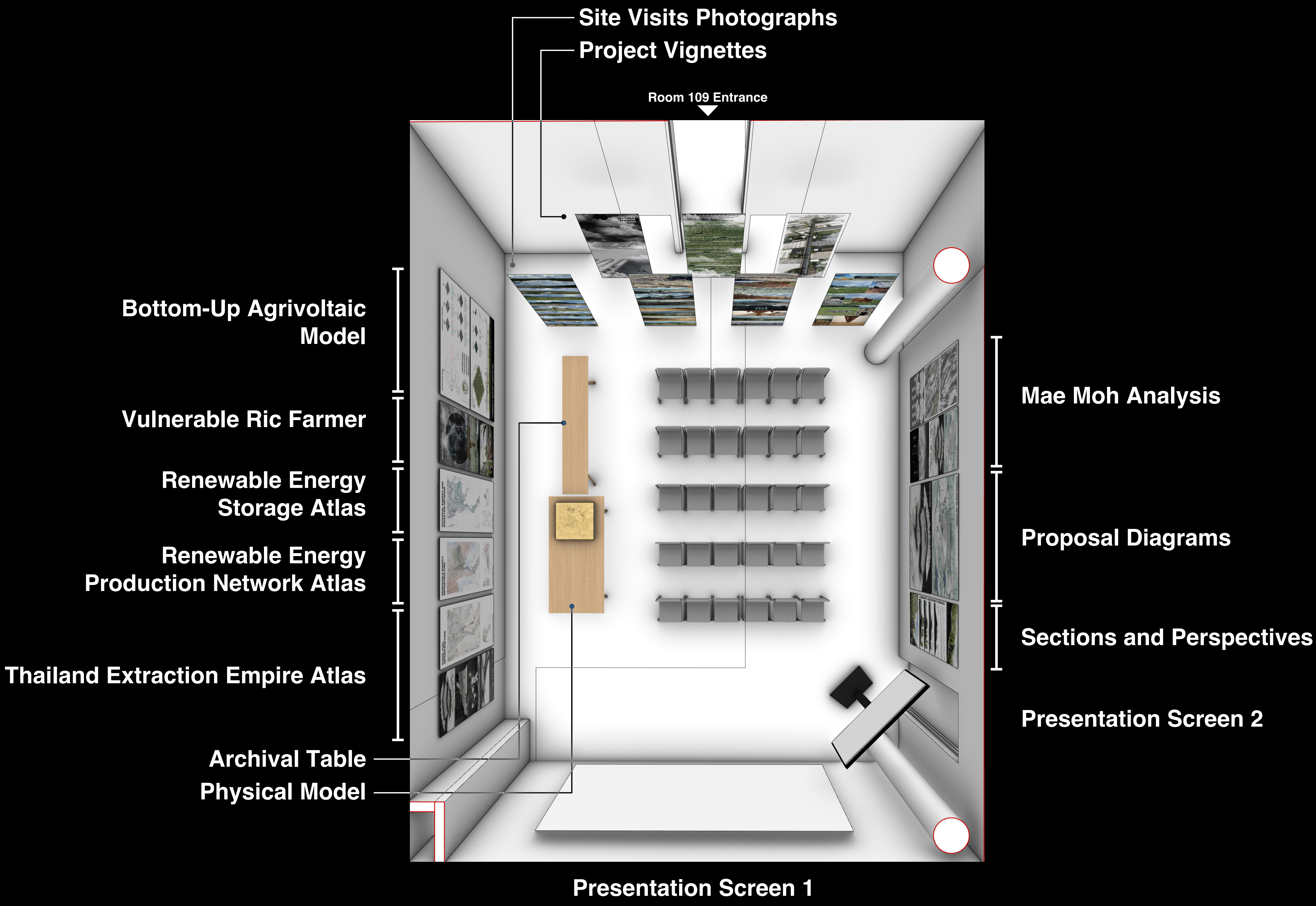
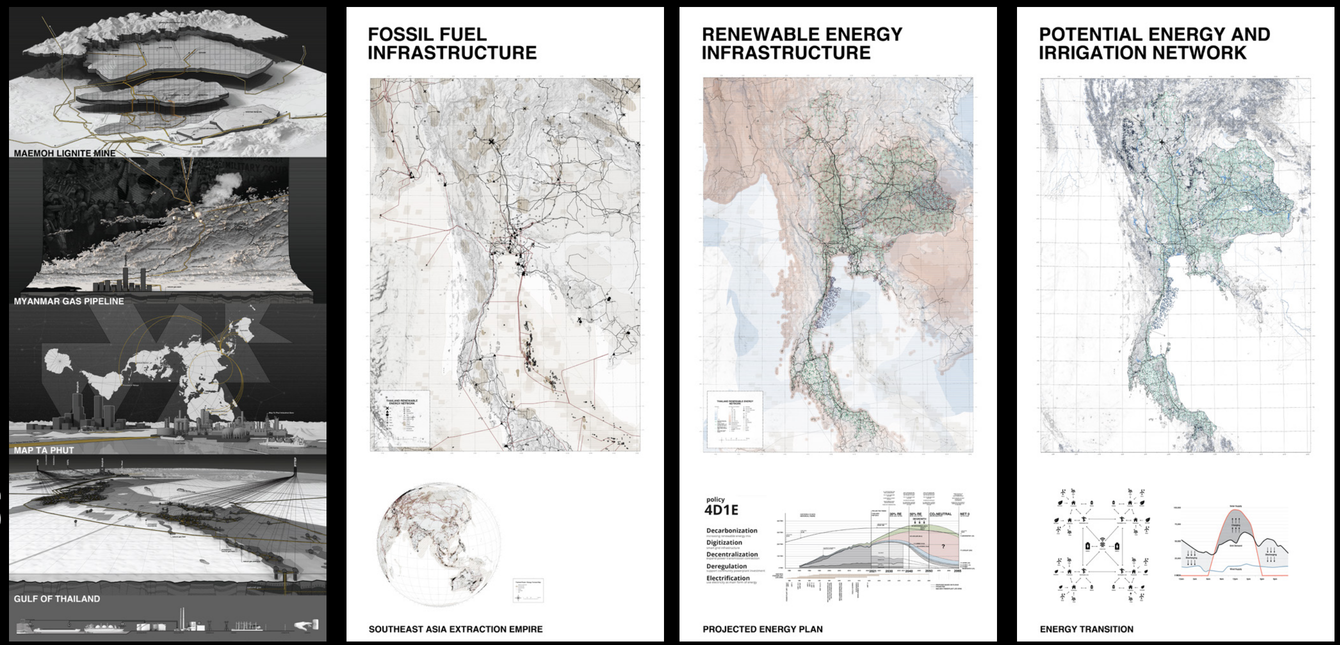


Exhibition Layout

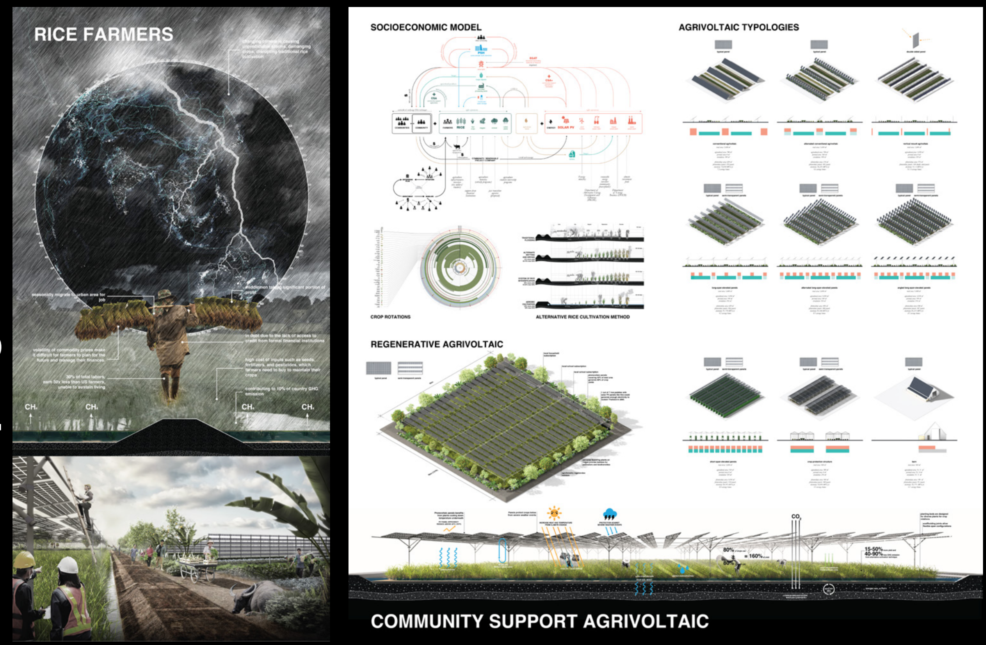
Vingettes

Energy Transition Atlas

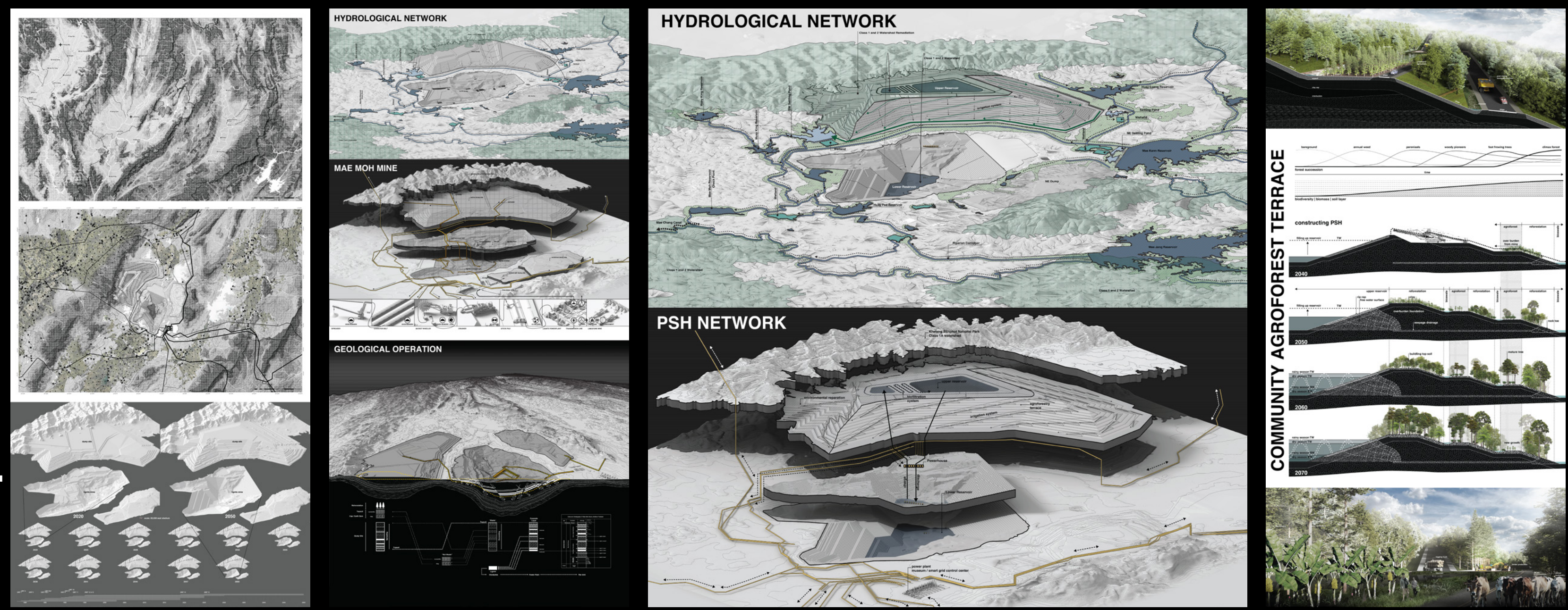


Site Visits Photographs

Bottom-Up Agrivoltaic Model



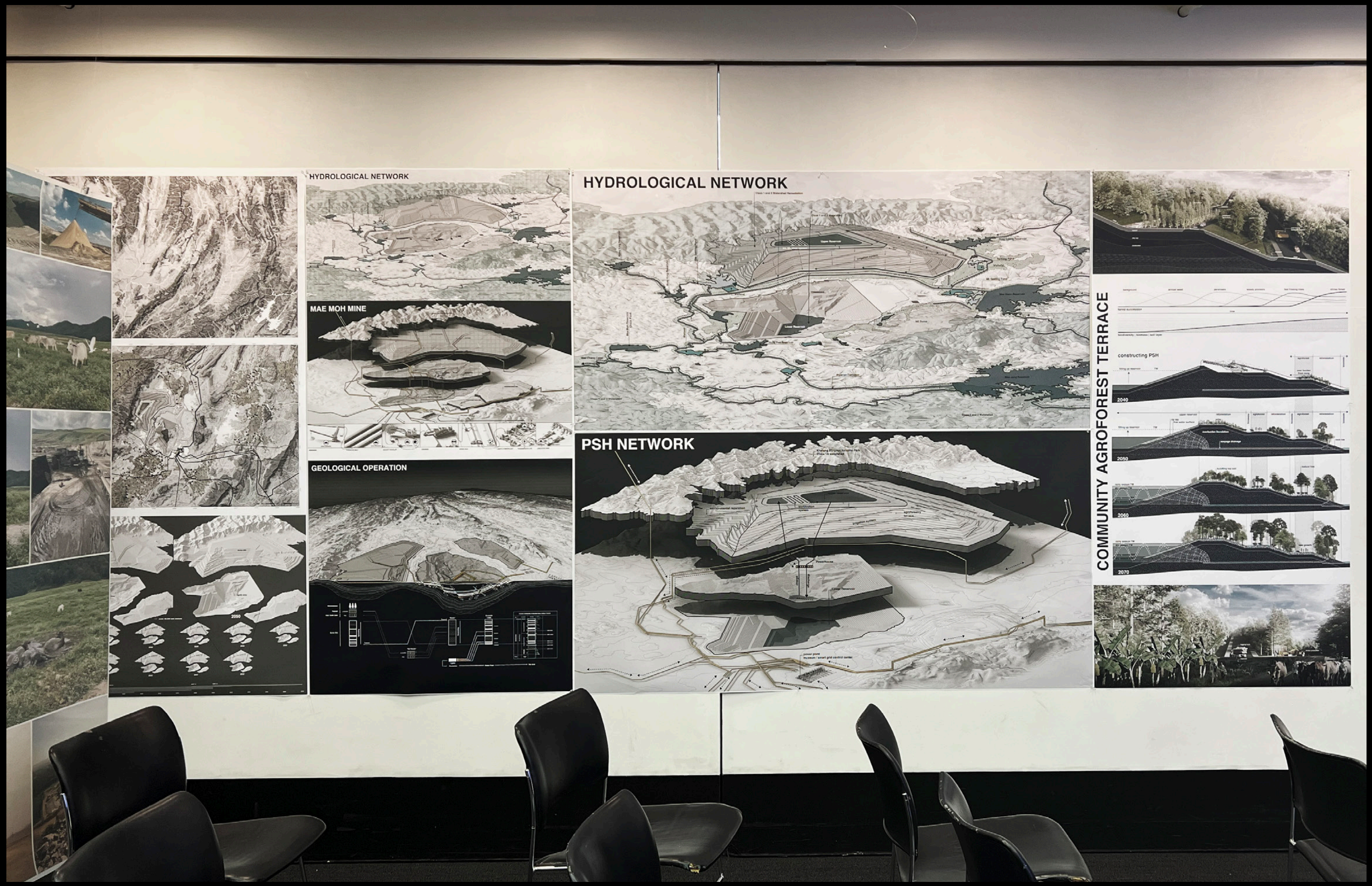
Mae Moh Analysis & Proposal



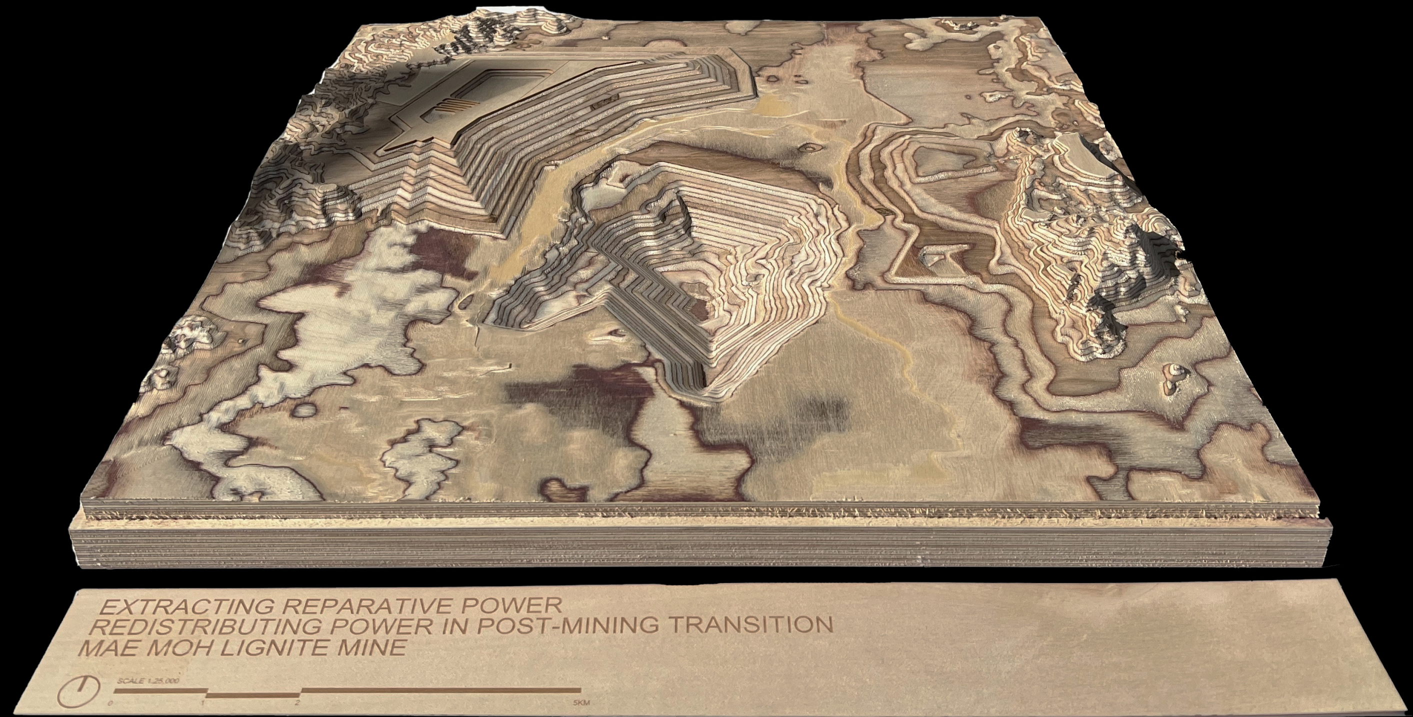
Presentation Panels

Rongqing Liu, Thanaporn Lam, Pitchapa Setpakdee, Aurapim Phongsirivech, Rachaya Wattanasirichaigoon, Rattanin Peewsook, Nakakamol Chueathue

Exhibition Crew



Exhibition Photos



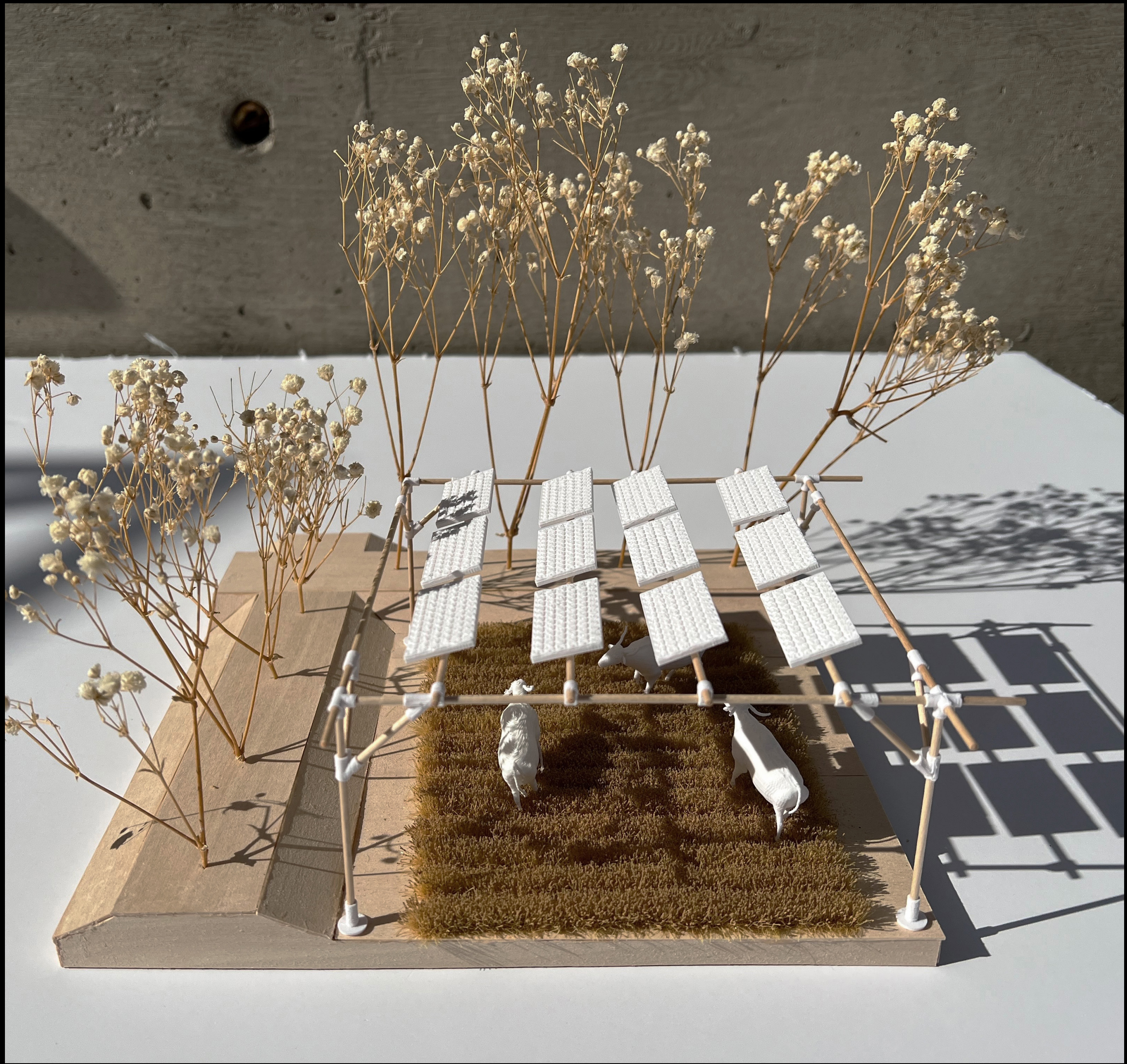
Mae Moh Physical Model

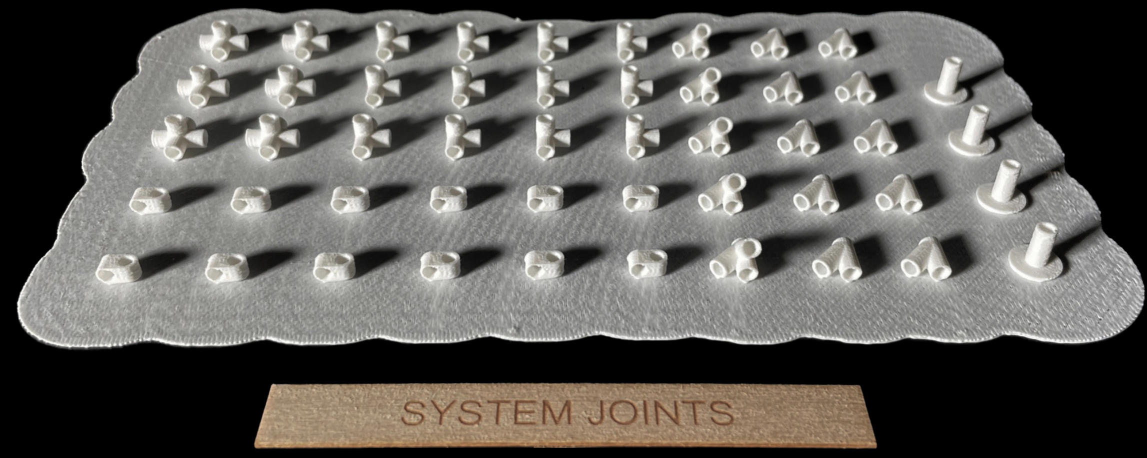
Types of Coal

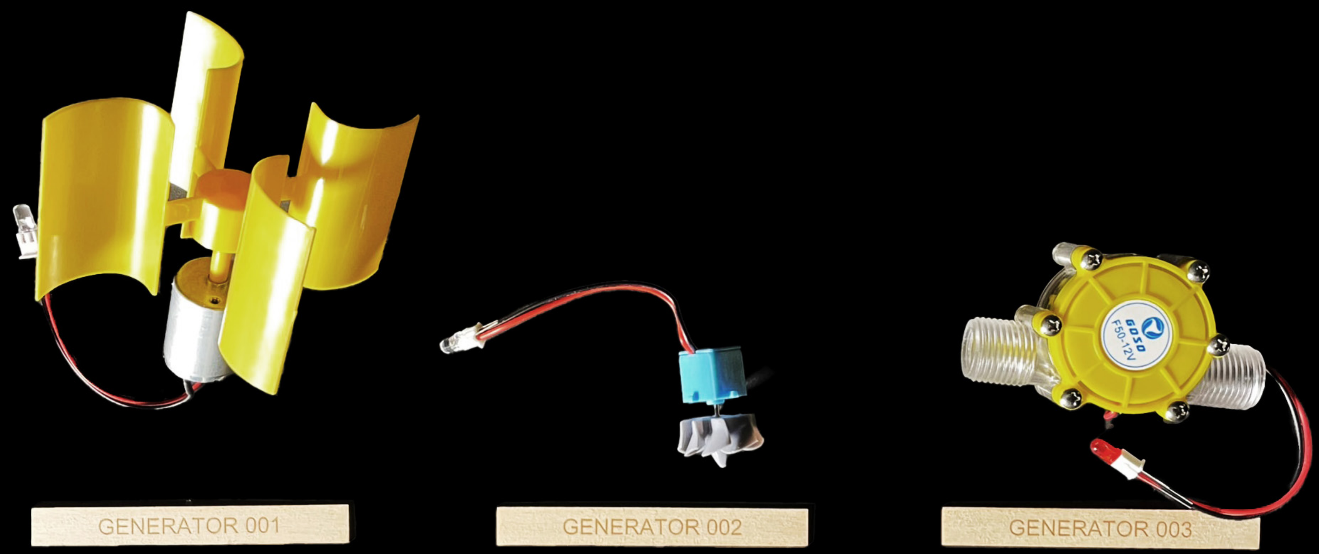
Mae Moh Physical Model

Exhibition Photos and models

Agrivoltaic







Water Buffalo

Hydrogenerator

Exhibition Photos and models

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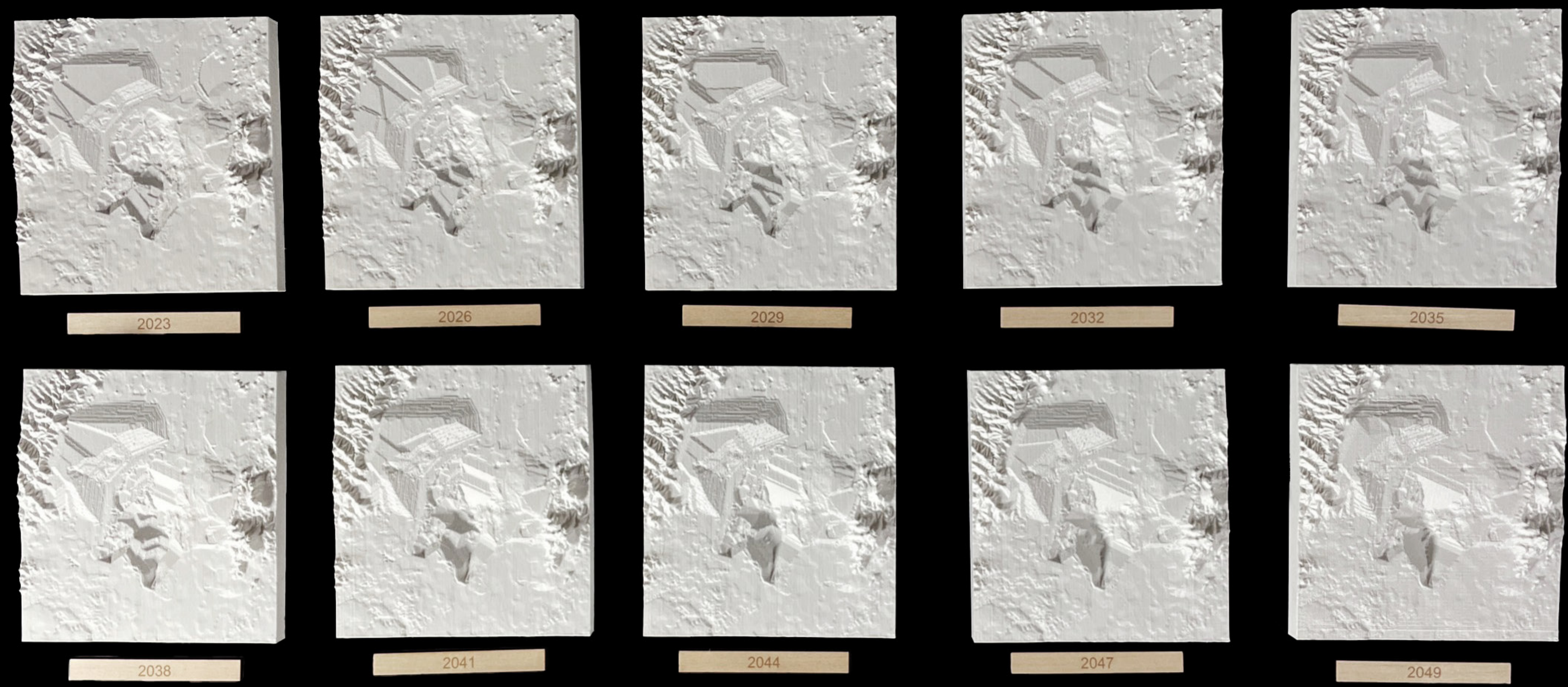
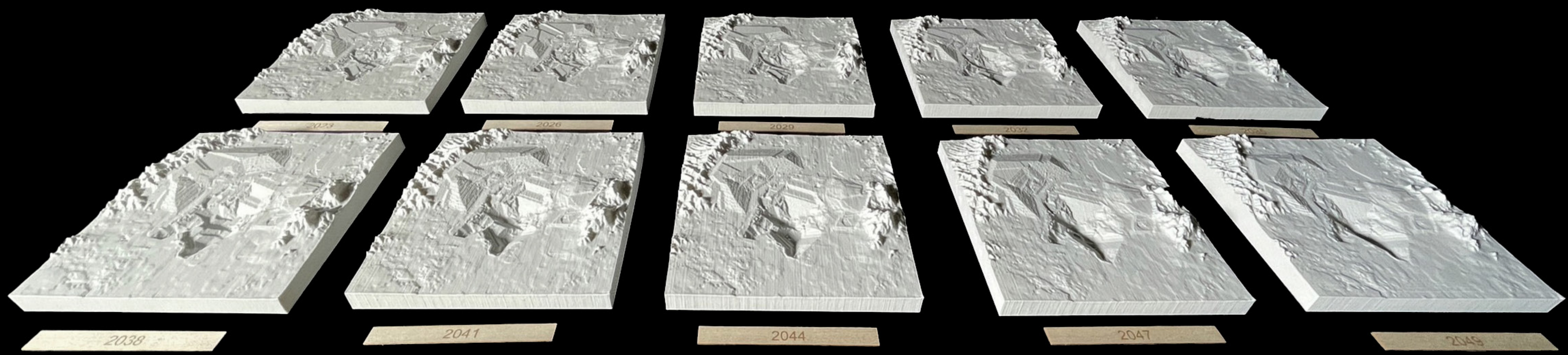
Advisor: Niall Kirkwood





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Excavation

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Advisor: Niall Kirkwood