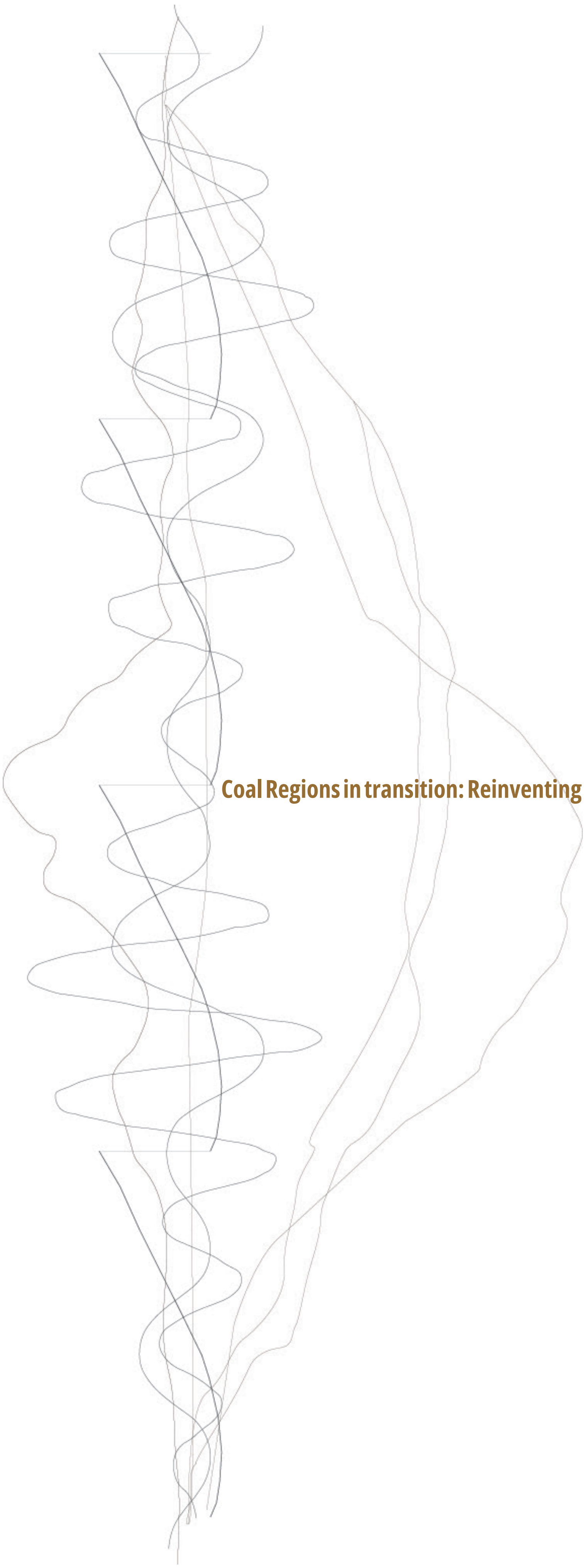

Coal Regions in transition: Reinventing the carbon economy

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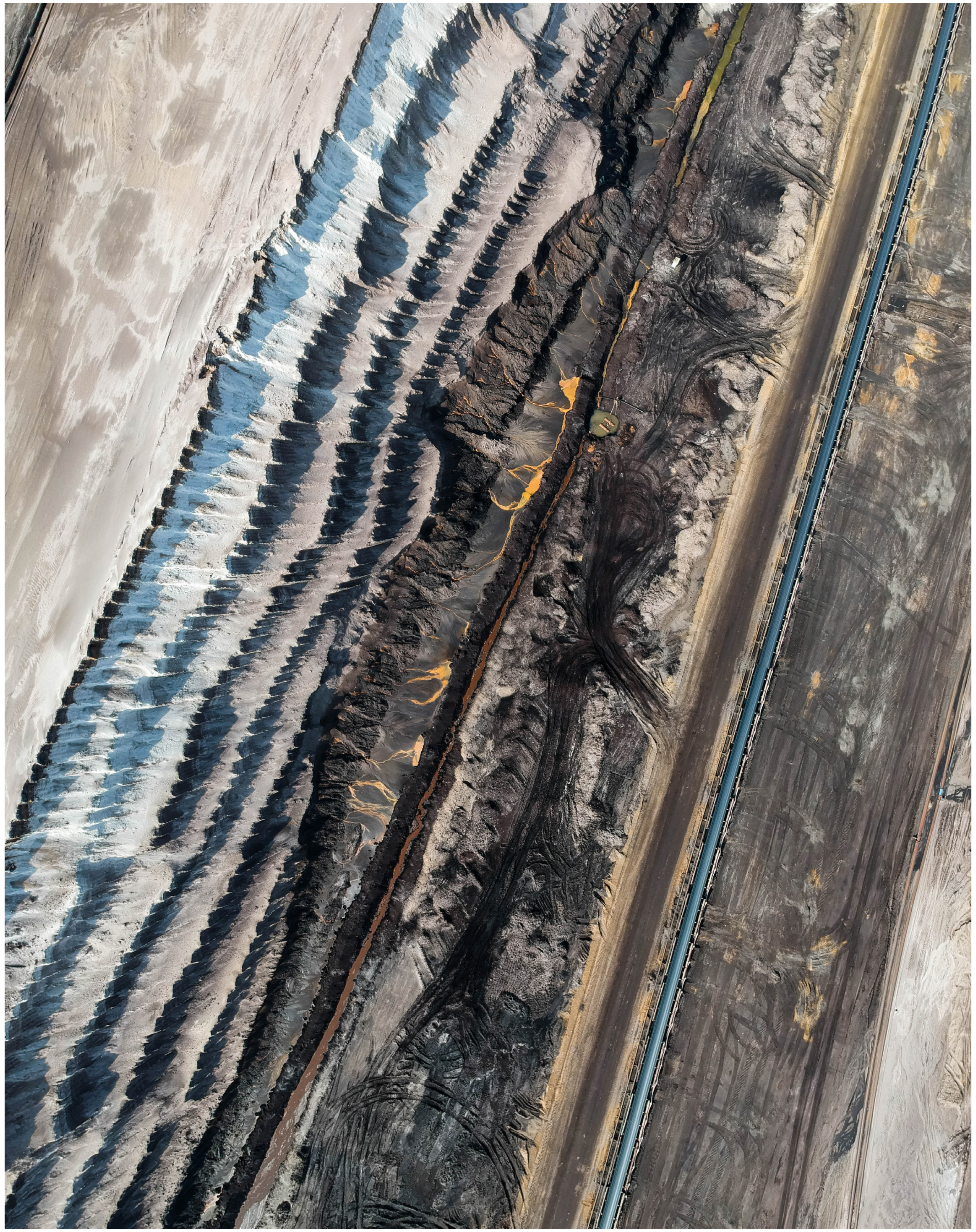


Fig 2. Tagebau Garzweiler

Almost two years ago I received a confirmation email that I had been accepted into this Master's Program. And despite my genuine happiness and relief, and the fact that 6 years of rigorous studies in Greece finally enabled me to pursue further education, I couldn't help but continuously second-guess my initial choice to start a new chapter abroad. I learned a lot in this two-year journey not just in an educational context but also about myself and now I can state with certainty that it has given me a fresh perspective and new paths to follow.

But I was never alone in my endeavors and for that, I would like to express my deepest and most warm words of gratitude to the people that encourage me and support me.

To my family – *mum*, *dad*, and my aunt *Stella* - not only for making this possible but for all their support, love, and encouragement. Special gratitude also to my dearest *grandparents* who although they are no longer with us, their profound contribution enabled me to make it that far.

To *Savvas*, that always stood by me, through thick and thin, and was also my travel companion on the field trip.

To my dearest *friends*, *housemates*, and *TT friends,* who were always there to listen to my problems.

To my mentors,

Nikos, for his unwavering support, for all the enlightening conversations and the resources that helped me learn so much and broaden my horizons.

Luca, for challenging me to try hard and focus, improve my skills, and constantly reminding me not to lose myself in the process.

To the TT tutors. To *Taneha* for all the lectures and workshops that provided us with a new set of lenses and lessons of care, that motivate us to look bravely into this world and make bold actions for a change. To *Luisa* and *Diego*, for all their guidance and advice.

ABSTRACT

The urgent need to decarbonize the energy sector marks the beginning of a post-fossil fuel era, leading among others to a significant decrease in coal production and a corresponding shift towards energy from renewables. This transition will bring changes spatially but also socio-economically and will affect primarily coal mining communities as their primary economic driver gradually declines. This thesis sets out to investigate the coal phase-out as happening in Germany, the Czech Republic, and Poland - Europe's 'coal heartland'. It focuses on the spatial aspect of it, a twofold challenge, that stems from the two contradictory conditions: the abundance of vacant land (land supply) that results from the coal phase-out and depopulating-shrinking trends in these coal regions and the spatial pressure (land demand) that the emerging deployment of renewables triggers in combination with possible unregulated land takeovers. The thesis conceives the coal regions as a systemic zone and proposes a shift to another form of the carbon economy, one based on forestry. It builds upon a timeline of actions starting from the phase-out of coal and shapes a narrative for a transition to a more sustainable and lower-carbon-intensive economy in the affected areas. The project approach this with a multiscalar perspective, zooming gradually to Lusatia, a historic region marked by many years of intensive lignite mining, an area in which four lignite extraction sites are still operating, and proposes a systemic approach to how another form of use in this cluster of mines could affect the ongoing depopulation in the area and care for the damaged and exhausted environment by fostering economic growth through sustainable timber harvesting and the creation of valuable ecosystem services that will trigger biodiversity growth. Last it looks at the area around Cottbus, where a former mine, and a currently active one, Jänschwalde mine, have shaped a unique landscape, surrounded by the characteristic pine forests of the region, and small scattered settlements. Spatial elements and their synergies are unraveled that facilitate sustainable wood production, the energy transition, and the care of natural ecosystems. The project works with a timeline spanning from 2025 until 2090, during which the area transforms as forests take over and grow while at the same time, several settlements and infrastructures decommission, depopulate, shrink and retreat. The final outcome inspires an alternative understanding of the coal regions, one described by a 'spatial growth-retreat dynamic' that builds upon the shrinking built environment and expresses itself with constant fluxes of carbon storage and carbon releases.

Fig 3. Tagebau Hambach

Ebenezer Scrooge : These are garments, Mr. Cratchit. Garments were invented by the human race as a protection against the cold. Once purchased, they may be used indefinitely for the purpose for which they are intended. Coal burns. Coal is momentary and coal is costly. There will be no more coal burned in this office today. Is that quite clear, Mr. Cratchit?

Bob Cratchit : Yes, Sir.

A Christmas Carol movie (1984)

Over the past summer, I felt that every source of media bombarded us with despairing news and dire predictions about the energy difficulties that Europe would face in the upcoming winter. Scenarios in which European cities would run with fewer and dimmer lights at night and museums with no night lighting were being broadcasted everywhere. At the same time, the German press was questioning once again the feasibility of the so-called nuclear phase-out - a program that started in the 2000s aiming to gradually shut down all nuclear power plants in the country and was supposed to be completed by the summer of 2022. However, it got extended due to an *energy crisis* (amid the war in Ukraine), but also due to the overall inability to secure the country's energy from other reserves and resources and the even bigger energy deficit that the simultaneously running coal phase-out program would cause. Energy, a commodity that we often take for granted, shook Europe's economy causing significant rises in energy bills, fuels, and all kinds of products.

The above situation sparked my interest to further study how the energy transition is shaping Europe and its future impacts. I decided to focus on the coal phase-out and the anticipated transformations that will cause. It is a study stemming from my concerns about the impact of our actions on the environment, on our often-abusive relationship with nature, which can be visualized in the extraction sites operating on a linearity under the false impression that Earth's mineral reserves are infinite for us to use.

The energy problem suddenly became the center of attention. Given also the current geopolitical circumstances, European countries, one after the other, urged to find energy alternatives and secure reserves for the winter. The energy dependency on other, non-European countries, prompts governments and EU officials to boost projects in the field of renewables. Some countries, amid the fear of running out of energy, postponed the closing of power plants (running on fossil fuels) or made energy deals with other non-European countries. The aim to decarbonize the energy sector - a necessity and agreed decision for Europe – was met upon the harsh reality of energy demand, threatening the feasibility of the given timeframe. Europe has to quickly launch renewable energy solutions that would bridge the energy gap, while countries meet their decarbonization goals.

But, where do we find enough space to deploy renewables? Isn't it common knowledge that they require a lot of space? Current trends are re-purposing former lignite extraction sites taking advantage of these large, flat, and open areas to place wind turbines and solar panels. Another advantage is the proximity to existing infrastructures and settlements, minimizing extra costs and having possible available labor. Even though the shift to cleaner energy is unquestionably important and should be accelerated, we should be very critical of this spatial takeover.

We are standing in front of a unique moment and opportunity, because of the decarbonization and most specifically the coal phase-out, we will inherit a great amount of land, valuable chunks distributed all around the world, and also in many European countries. With the current re-purposing trend we must act quickly and plan a smooth transition for these areas and the people affected by the processes, providing solutions that address the environmental impact of years-long intensive extraction, restoring habitats, and caring for the more-than-human, while building a resilient and sustainable future for all.

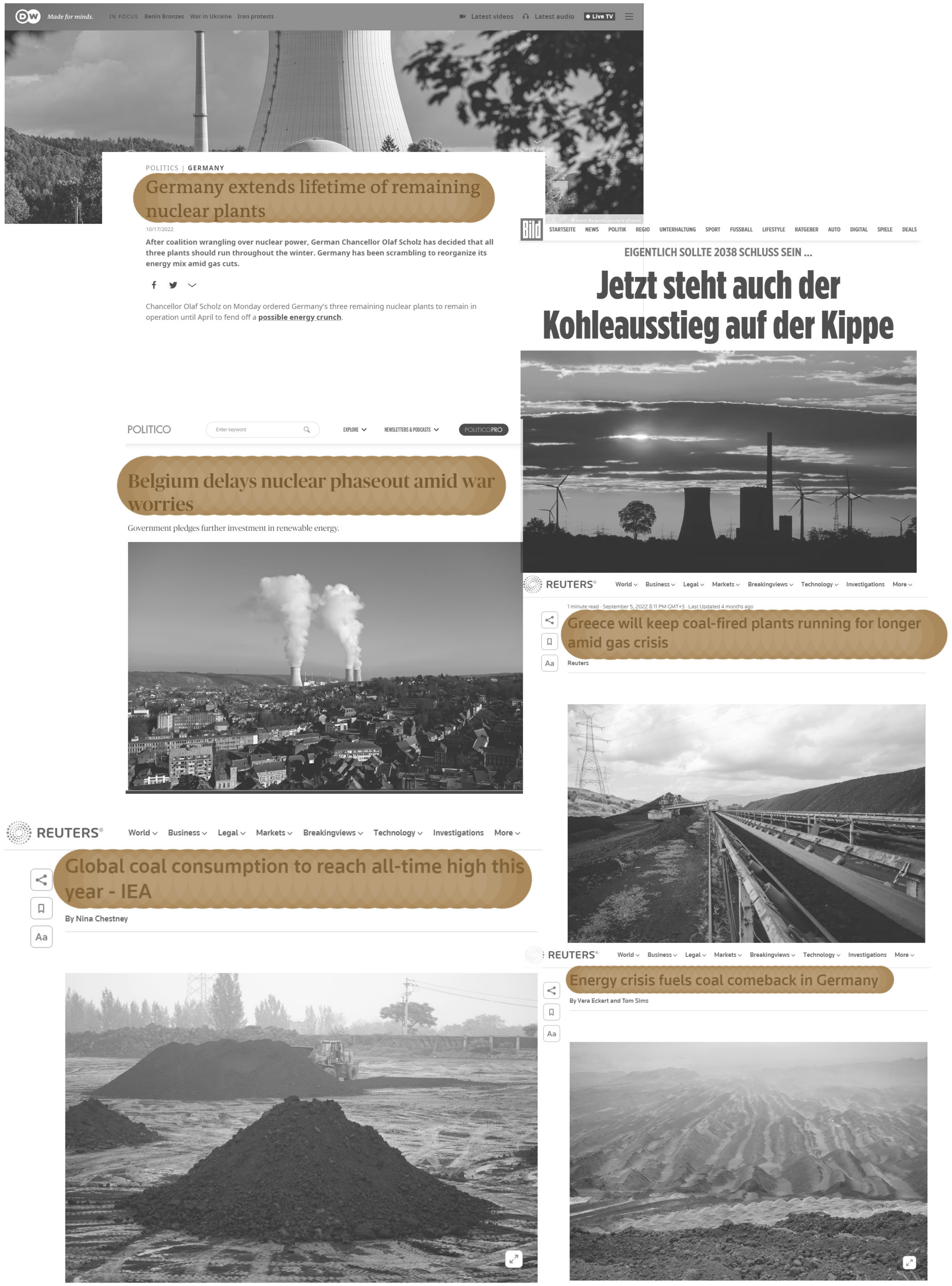


Fig 4. News headlines on the energy crisis and coal

It is of course undeniable that we are reaching earth's natural limits, however human needs of resources cannot be held back. The epoch of the Anthropocene has resulted in human systems too complex but also very fragile, that require fine-tuning in order not to collapse. But for the sake of profitability, NIMBYism, and many geopolitical factors we often fail to tackle the emerging problems united. This is of paramount importance, given that unless we change the way we live and think, we might have to live in an epoch of scarcity.

In the past years, many policies have been formed and adopted by countries all over the world for greener energy production, decarbonizing the energy sector, and shifting towards renewable sources. Since 4th November 2016, EU members are actively committed to achieving climate neutrality, by signing the first-ever universal legally binding global climate change agreement, adopted at the Paris climate conference (COP21) in December 2015. Following this, in December 2019, EU leaders agreed that climate neutrality should be reached by 2050, thus adopting the European climate law, a key element of the European Green Deal. That deal obliges EU countries to reach both the 2030 and 2050 climate goals, making Europe the first climate-neutral continent by 2050. An important aspect of this Deal is the well-being of citizens and future generations; thus, it incorporates many policies that tackle issues like food, transport, industry, and economics (Climate Action and the Green Deal, n.d.).

To become climate-neutral means that EU members must significantly reduce their greenhouse gas emissions, but also compensate for the unavoidable emissions. In this effort, they are two major milestones, 2030 and 2050, with the first one to reduce emissions by 40% (European Council, 2022b).

Phasing out coal is a major part of this process, given that about 20% of Europe's total electricity is being generated by coal, supporting 230.000 jobs in mines and power plants in 31 regions and 11 countries. Since 2012, total coal power generation has dropped by almost a third in the EU. Consequently, mines are closing down and power plants are being decommissioned in a number of regions across Europe (Coal Regions in Transition, 2022). To support this, the EU apart from setting out policies and regulations has also launched financial support, under the Just Transition Fund, to ease the social and economic consequences of the transition and ensure that one is left alone. Ceasing activities in a mine or a power plant has severe consequences, meaning that the transition should be well-planned and socially fair. It is a complex process that requires detailed planning on all the scales and involvement of many different stakeholders.

In addition, we should not overlook that this energy transition calls for renewable sources, which is proven that they not only require more space (available land) but also other mineral sources. Thus, it comes clear that the shift to renewables means that mining activities are not being ceased but rather shifted to other areas and products. New types of minerals will be needed to support the rise of renewables, like Nickel, Lithium, Manganese, and Cobalt, as rare earth minerals are essential components in the making of wind turbines and PV panels.

The new land that we will inherit from the coal phase out, is a new opportunity for the European status quo. By considering a systemic zone of "Europe's coal heart" to further investigate the coal phase-out, we come across the spatial remains of the fossil fuel era. The land acquisition makes this systemic zone full of potentials but also limitations and anticipating the scale-up of renewables there, it is a matter of time before these landscapes switch to another type of energy production. In the long term, renewables will consume less and less space, putting these areas on the spot once again. Another lifecycle would have reached its completion and these regions would be once again available for something new. For that, we must envision these regions as complex yet dynamic parcels that could facilitate

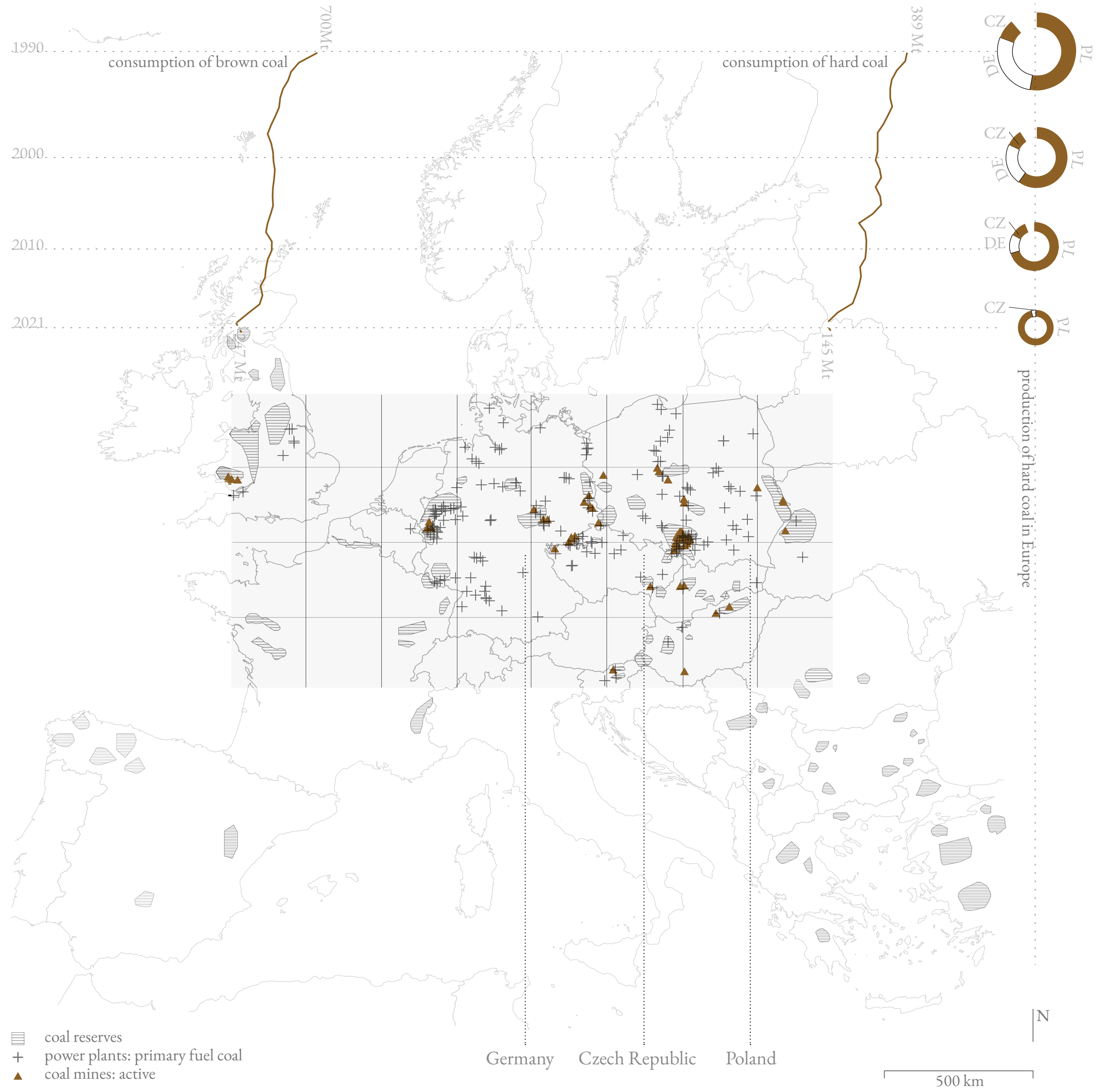


Fig 5. Coal in Europe

“In the age of fossil fuels, the production of energy, in distant grounds and underground, contributed to keeping the infrastructure of energy out of sight in territories of extraction.

[...] the design challenges of renewable energies have been recast into discourses that celebrate the sustainability of productive regionalism. Such projects bring to the forefront questions of the “politics of sharing” embodied in landscapes of production, particularly as these visions often extend beyond the boundaries of the nation-state to define new regions. How do these projects negotiate the “character” and “capacity” of regional identity while simultaneously delimiting spatial boundaries? And equally significant, who occupies the privileged insides of such productive regionalisms, and who is relegated to the marginal outsides? This micronarrative is about the politics of representation in the construction of regions of energy. It asks: what is the proposed political contract and what constitutes the form of the collective for resource sharing at the scale of the region?”

Ghosn, R. (2014). Energy Regions: Production Without Representation? Journal of Architectural Education, 68(2), 224–228.

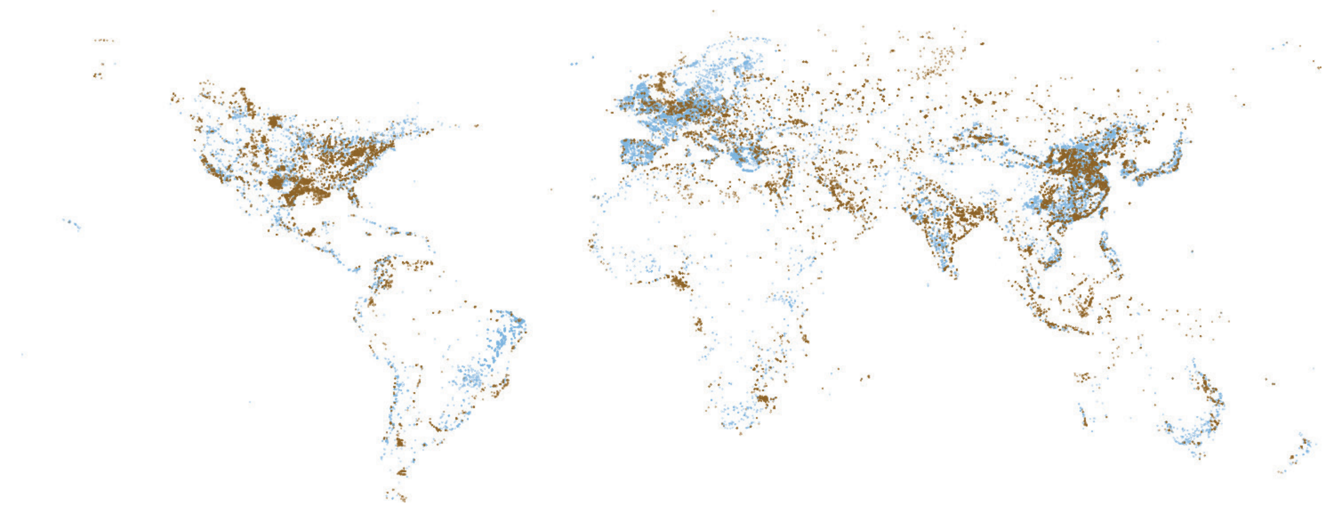


Fig 6. Global energy visualizations

As this thesis stems from the investigation of the coal phase-out it is important to define the spatial link between energy and landscape. According to Sijmons et al. (2014), every form of energy production has specific spatial interventions and throughout time, energy and space are two notions highly interconnected and, in an attempt, to involve physics, the kWh/m^2 proves that both can be quantified. The big challenge is to link landscape and energy. The landscape becomes the mediator between the new renewable energy system and the spatial interventions required for this to evolve. In that terms, the new, green energy sector cannot exist without spatial planning and spatial design.

Over many decades we have been living under the impression of the abundance of fossil fuels. This had an unprecedented effect on the way we envisioned and transformed the earth. As the fossil-fuel era is gradually coming to an end we should come up with another energy system, one that involves renewables and that calls for a rebuild of our existing habitat. Coal, gas, and oil extraction sites are most of the time 'unseen', or 'seen' by only a few. But the renewables will be way more visible (Sijmons et al., 2014).

And this is where Urbanists should jump in. The energy transition that we are facing is a challenge in many fields, one of which is urbanism. It should not be seen only through the eyes of technocrats and engineers, but as Sijmons et al. (2014) says as a 'landscape challenge'. The energy transition is a matter of space, space that we have inherited from the fossil-fuel era, and is going to be highly contested in the future as renewables deploy.

The energy transition will put extra pressure on the landscape because harvesting renewables sometimes consumes more space. The next two visuals, which can be found in the book *'Landscape and Energy: designing transition' by Sijmons et al. (2014),* show how different forms of energy will transition over time and the spatial footprint of energy (electricity).

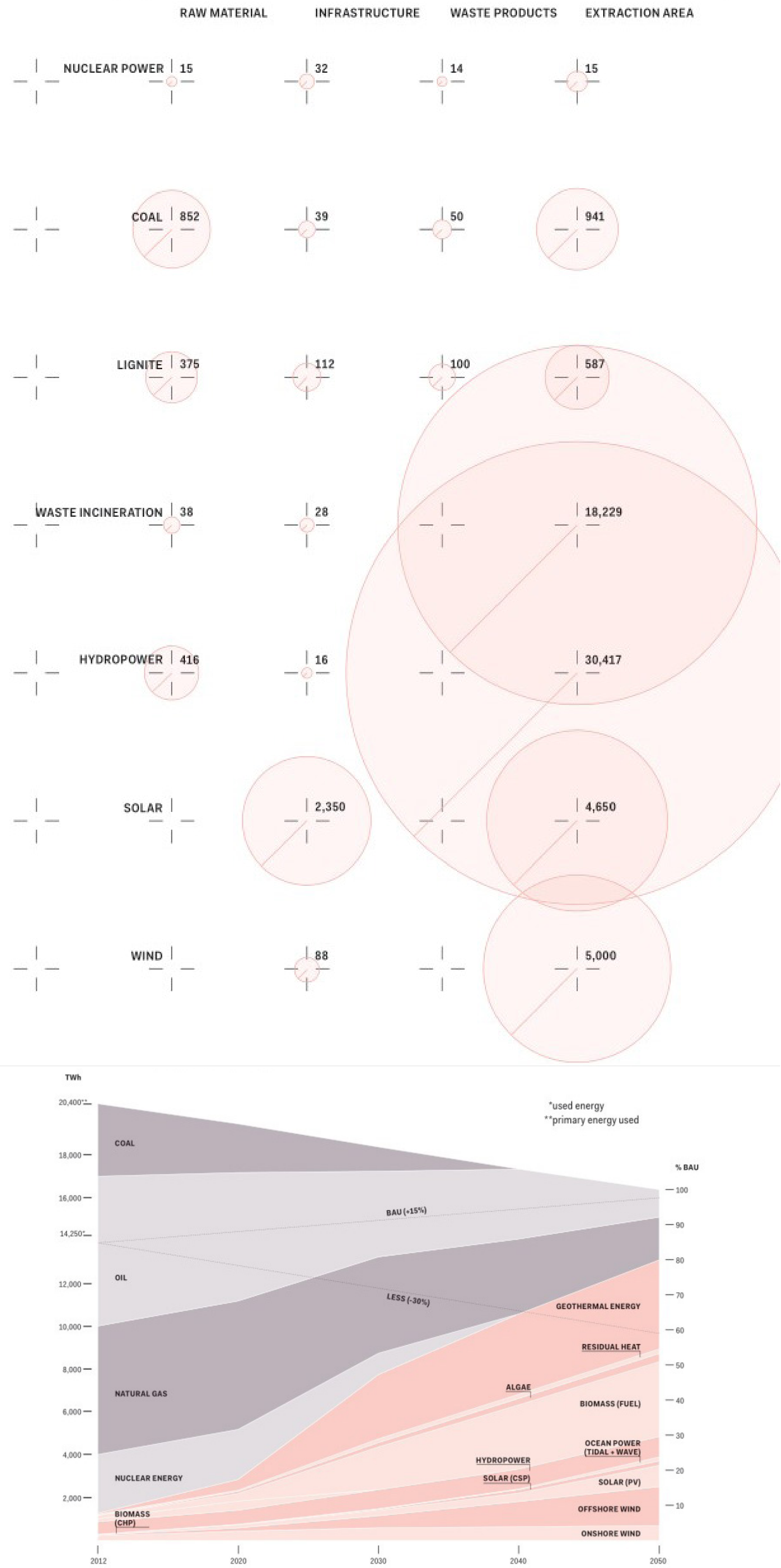


Fig 7. Spatial Footprint (electricity) and a timeline of Energy transition in Europe
from: Sijmons, D., Hugtenburg, J., Anton Van Hoorn, & Feddes, F. (2014). Landscape and energy : designing transition. Nai010 Publishers.

Another interesting approach to this dynamic duo, energy-space can be approached by the term "*terrain vague locales"* as described by Solà-Morales to describe in-between urbanized (or not) areas that had a specific economic usage or an industrial past and now fall in cycles of investment (industrial wastelands, derelict properties, abandoned). Although these sites are gradually being ignored and form a *"body of older"*, they can pose a great potential for urbanists/architects to work with (Berger, 2007). According to Berger (2007) re-valuing post-industrial, contaminated, blighted, and even *ugly* sites, falls within the interests of Urbanists and what is being observed over the last twenty years is a paradigm shift in reclaiming such areas and transforming them into another means of production. For this to occur , the first step is facing environmental degradation and pollution. In that context, coal extraction sites can fall within the two above classifications. As the coal phase-out progresses, they will form "wastescapes" in the center of Europe. Their very characteristics, the infrastructures around them but most importantly the common system under which they have been constructed and operated is this fine line that enables us to conceive them as one systemic zone and which can be re-design it. It is again part of an Urbanist's interest to look closely and built a new narrative for these sites.

To conclude, the by-products of the fossil fuel era are scattered throughout Europe, and if we choose to look at all of them (coal, oil, gas) they pose a huge scale operation, in which as they finally meet the end of their lifecycle, they must be transformed to something else. The role of an Urbanist in that context is to anticipate and envision the next societal needs/goals and propose the spatial interventions that will facilitate them.

As we approach the end of the coal era, we must face the decommissioning process of innumerable infrastructures and auxiliary structures, all parts of the coal-running machine. Such built structures are of all kinds, some are constructed more ephemeral, while others have a more permanent form, such as vehicle and equipment garages, de-constructable container offices, guarded gates, and even whole settlements. Similar challenges can apply to the rest of the fossil-fuel extraction activities that also need to be reduced or eradicated, like gas and oil.

According to Belanger (2016) looking at the past, a system of recourses, agents, and services is revealed that started in the 18th century by greatly transforming landscapes with the objective to develop essential infrastructures that supported and continue to do so urban economies. In most of these cases, these infrastructures and recourses were to be found outside the urban realm. Interestingly enough, they were remembered when they would stop functioning (e.x power shortage or flood), and upon fixing, they would continue to exist and operate invisibly. For the writer, now we must deal with all these structures, first by facing the current situation no matter how grim it looks, and then start making up for the destruction and contamination that they caused, in favor of our profitability.

"Imagine the planet as a big brownfield [...] where everything – from the air of the atmosphere to the water of the oceans – has been used, abused and reused; [...] On this planetary surface, waste is the impetus for improved production, enhanced consumption, and intelligent exchange. Brown is the new green." What this calls for are the need to reclaim and revalue decommissioning infrastructures, a process that will stimulate new urban economies, will shape new spaces, and generate new geographies (Belanger, 2016).

To better understand the decommissioning process of any given infrastructure it is important to break it down to its very form, specifically to three characteristics: standardization (designed for efficiency and economy), mono functionality (singular land use that limit or excludes any other connections, thus it becomes segregated from other biophysical, economic, and social elements) and permanence (inflexible to change, however, keep a vulnerability to unexpected hazards, disasters). At the same time, Belanger (2016) argues that any reading of infrastructures should be challenged in terms of density and compactness, growth and permanence, and stability and security. On top of that, he states that the landscape of biological processes and natural resources which are integral to larger, regional systems, cannot and should not be segregated from the discourse or design of urban infrastructure.

In the center of Europe, Germany, Poland, and the Czech Republic, still share an important "coal heart", that supports the current state of this region. Given the coal phase-out, the dynamics will drastically change in the region. Germany, even in 2021, is the biggest brown coal (lignite) producer. Together with Poland, the biggest European hard coal producer for the same period (Coal Production and Consumption Statistics, 2022), and based on the report 2017, they had more than half of Europe's capacity in coal and they produce respectively 54% of Europe's emissions from coal activities (Rocha et al., 2017). It comes without saying that the coal phase-out, together with Germany's ongoing nuclear phase-out will pose a drastic change. Reliance on other fossil fuels from Russia, a major energy exporter to Europe, is out of the question after the European sanctions following the war in Ukraine (European Council, 2022a).

The three countries have all signed in favor of the coal phase-out, each country committing to a different end date. Amid the energy crisis, Poland has already pushed forward the end date and Germany reopened coal power plants that were characterized in security standby mode (RWE, n.d.). According to EU data, the Czech Republic aims for 2033 and Germany for 2038. That means, in the next 11 to 16 years, this high carbon-intensity region, must find ways to cover the energy gap by utilizing more and more renewables.

Coal mines in the area vary depending on the geology of the coal deposit, as it exists in coal seams or coal beds underground, and based on Hilt's Law, the deeper the coal seam the higher the ranking of coal. In the area, there are three types of coal, lignite or brown coal, sub-bituminous coal, and bituminous coal. Lignite is the lowest rank of coal, used mainly for electricity generation and its composition dictates that it travels small distances, forcing power plants to operate in proximity to the mine. Sub-bituminous coal is also used for electricity. Last, bituminous coal can be divided into three more categories, each revealing different uses very useful in a range of industrial processes and also in the steel industry (Turgeon & Morse, 2022).

The type of extraction is very important to understand how the area has been shaped and therefore the opportunities and risks of its future design. According to the American Mine Services (2019), surface mining is usually the most common one, in which terrain surface is removed until the deposit is exposed because it is often more cost-effective without involving gouging tunnels, shafts, and water pumping. In the open-pit mine, the overburden is being moved nearby, forming an artificial hill. The pit is not a static entity, it changes over time, by expanding to wherever the coal seam is. That highlights the constant altering of the landscape.

For underground mining, making shafts into the earth is needed to reach the deposits. In the longwall mining process, an automated mechanized coal shearer, moves along the 'coal seam' in great depths. As the coal is removed and moved away via a conveyer, the shaft is "removed", filling again the void. This method of course might cause surface subsidence (Department of Environmental Protection, n.d.).

In Germany, the last 10 operating mines are lignite open-pit sites, and also in Czechia, apart from one bituminous underground coal mine. In Poland, there are found lignite, sub-bituminous, and bituminous coal mines and consequently, there are surface and underground operations as well.

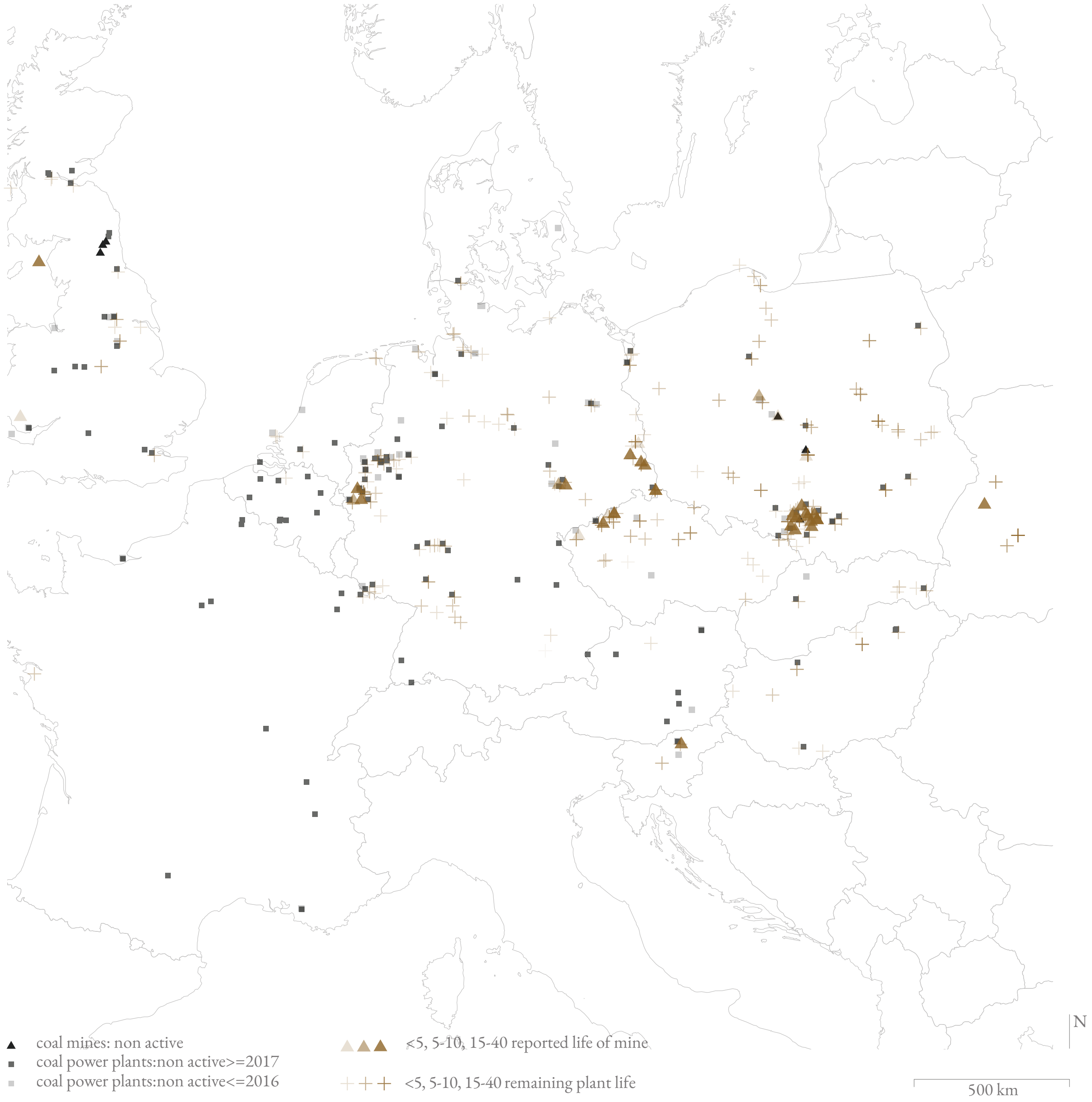


Fig 8. Coal mines/plants in Central Europe

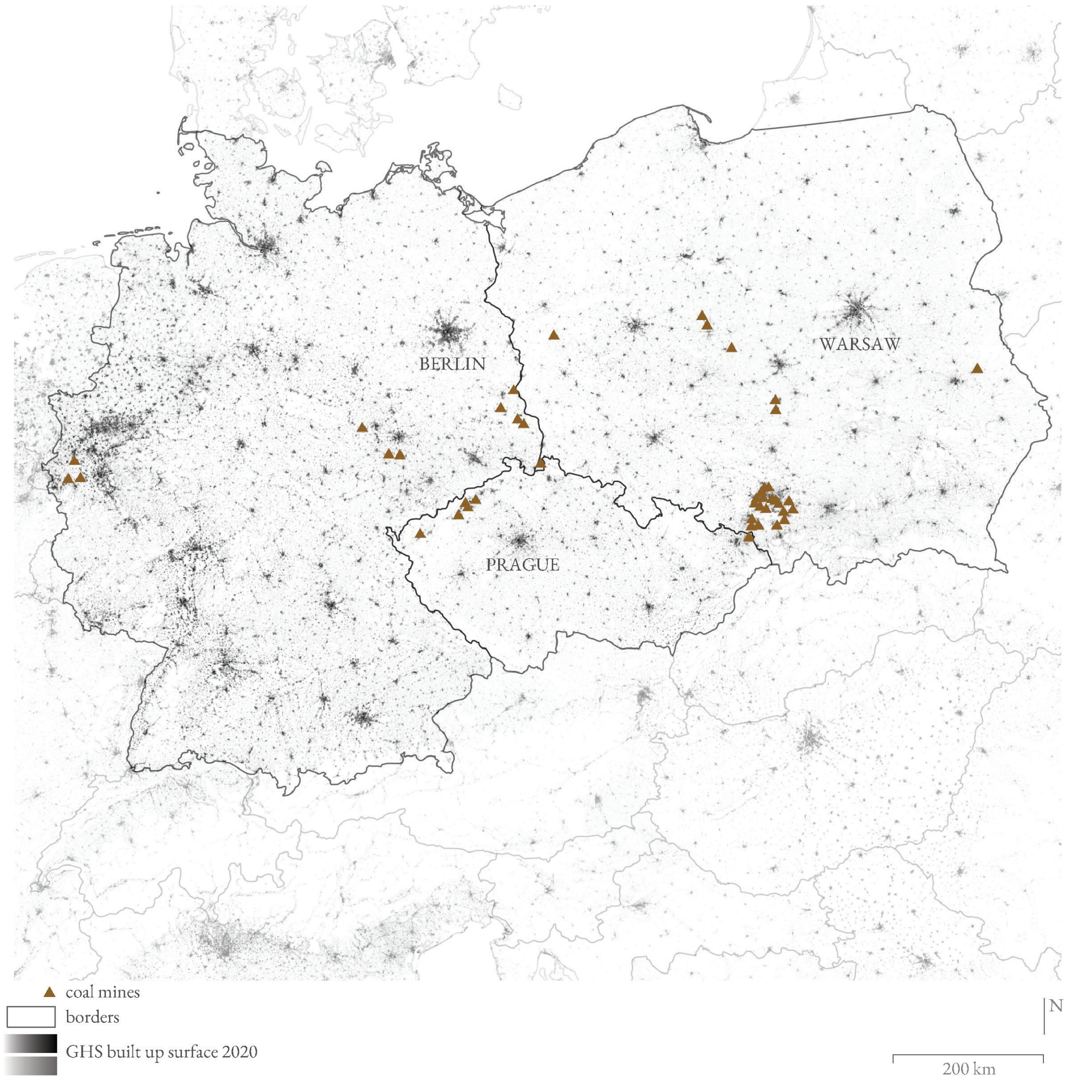


Fig 9. Coal 'heartland'

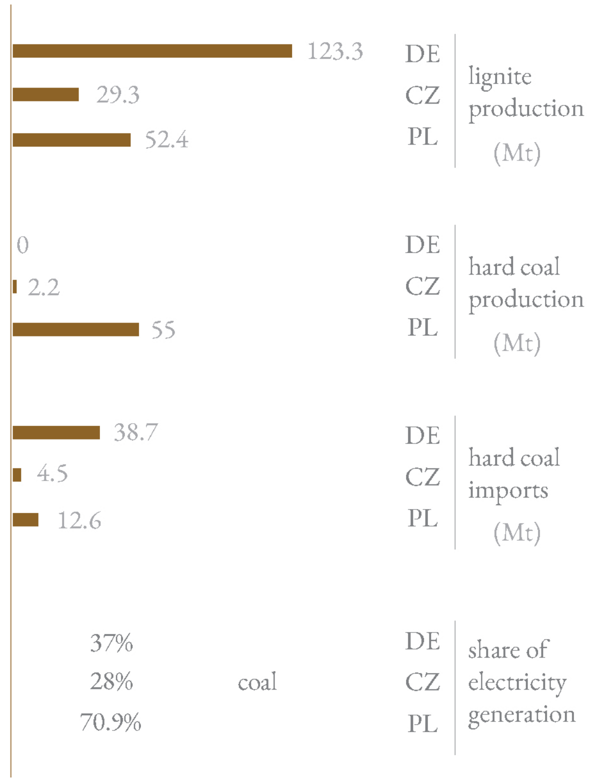


Fig 10. Coal activity (2022)

Fig 11. Map of Eneropa | source AMO - Roadmap 2050

Until this point, there have been many references to the fact that the coal phase-out in Europe must be a collective effort for a transition – with collective meaning that countries are involved and actually engage with each other, not just by signing the same climate agreements. In the case of Germany, Poland, and the Czech Republic that is of paramount importance, taking into account that the three of them have different strengths and weaknesses, thus different competencies levels. The coal phase-out is a complex process that requires fine-tuning mostly at the economic, social, and political levels. If one of the three can already deal with it on its own, that might not be the case for the other two. This is already noticeable, as it is arguably fair to say that Germany is moving quickly towards decarbonization compared to Poland. The countries involved in this transition should engage in open and constant dialogue, sharing information and exchanging know-how.

This cooperation is not a new idea. In 2010, AMO contributed with a compelling graphic narration of *"Roadmap 2050: A Practical Guide to a Prosperous, Low-carbon Europe"*, where the zero-carbon power sector in Europe is presented. The main takeaway of this is the *"complete integration and synchronization of EU's energy infrastructure"* so that *"Europe can take maximum advantage of its geographical diversity"* (OMA, 2010). The map of *"Eneropa"* on the left depicts a new, redefined European territory as a new energy region, that integrates and exchanges energy from renewable sources. That of course changes completely the geopolitical energy(scene) of today.

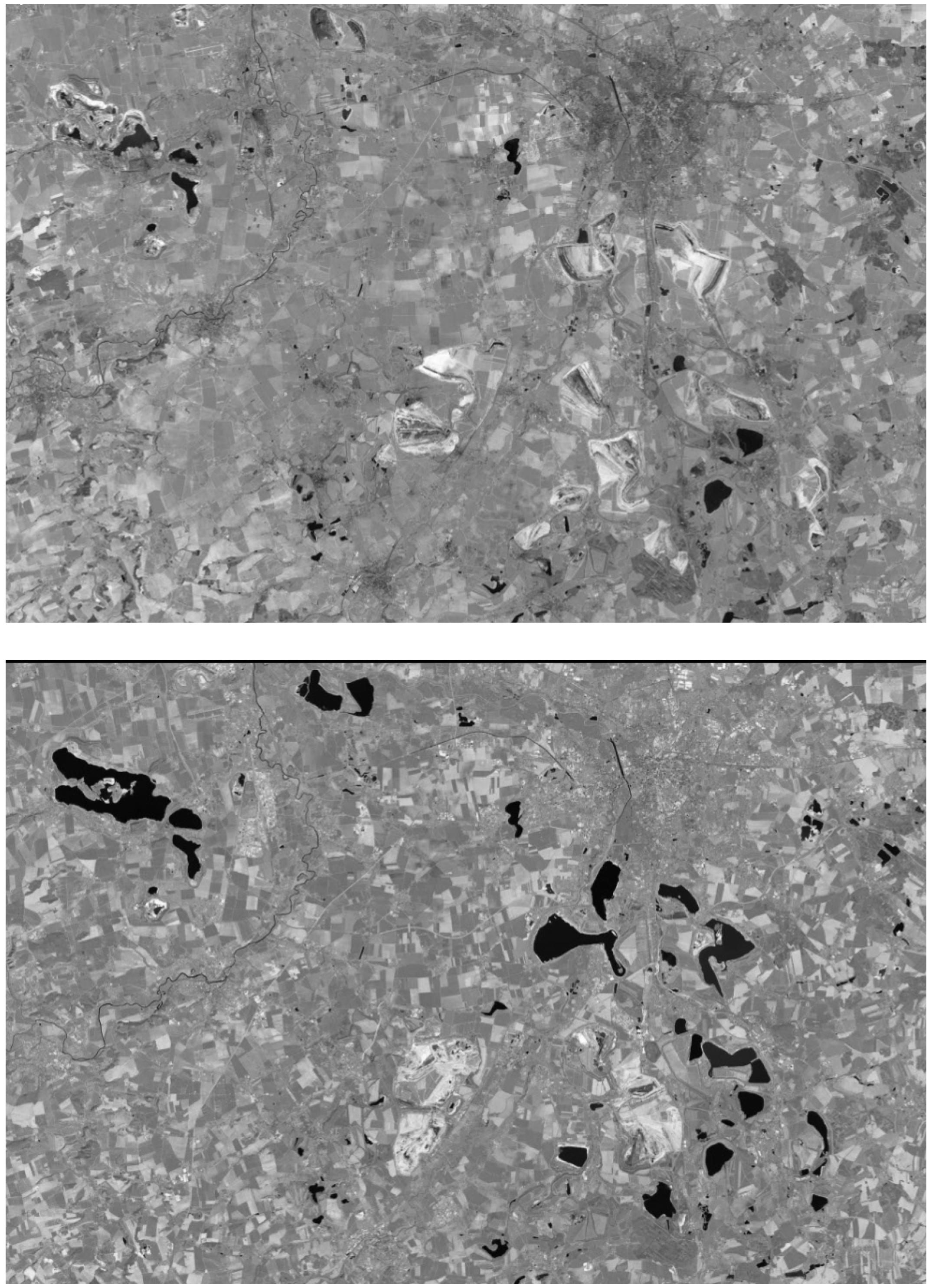


Fig 12. German mines outside Leipzig transformed into lakes - Images of Change by NASA

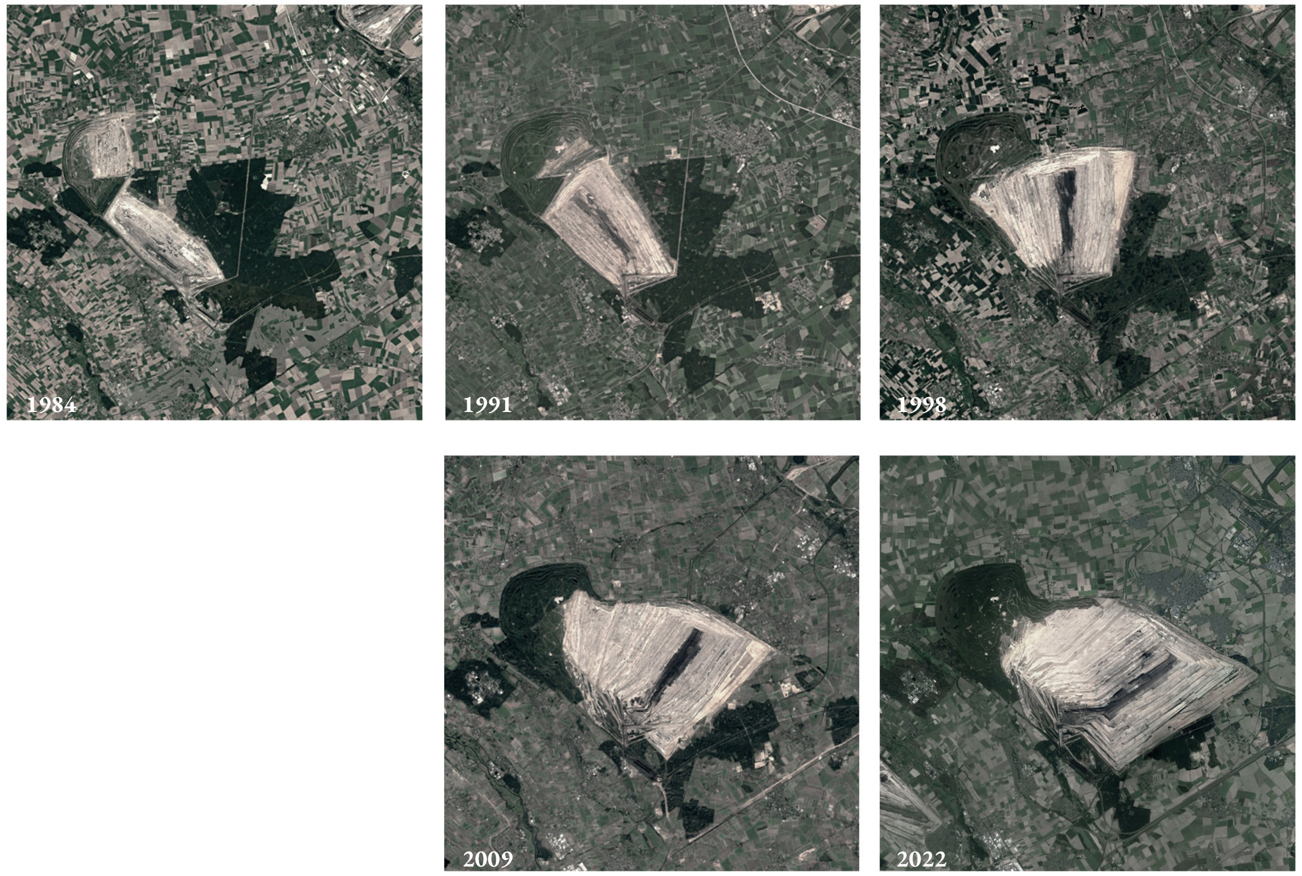


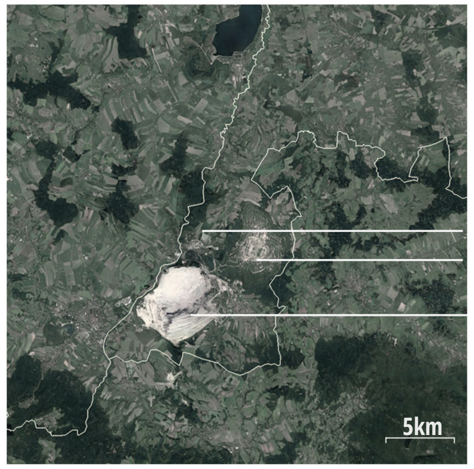
Fig 13. Hambach mine in Germany |1984 - 2022

"Entrained in the 97 kilotons of energy flowing from the earth each year is a stream of waste products. These hidden flows are integral to the process of extraction and are mobilized along with the energy resource but nonetheless must find places of disposal. Mining and quarrying are estimated to move more than 57 billion tons per year worldwide: that's ten times as much as glaciers and a little more than the amount moved by water erosion each year. The extraction of energy, then, involves not only the appropriation and liquidation of the underground and its channeling to distant markets but also the terraforming of a whole landscape as large volumes of material are sorted and separated into flows with dramatically different social valences.[...] The result is the classic residual architecture of extractive landscapes – spoil heaps, waste ponds, slag piles, tank farms, tramways, stacks and flues clustered around the hole – a landscape of sorting, dispatch, and abandonment that materializes abstract calculations of value.

The creation of new energy landscapes and the abandonment of traditional sites are two sides of the same process, an insatiable drive toward the end of the earth that has seen the extractive frontier constantly redefined."

Bridge, G. (2009). The Hole World: scales and spaces of extraction. New Geographies 2: Landscapes of Energy, 43–48.

Land transformations



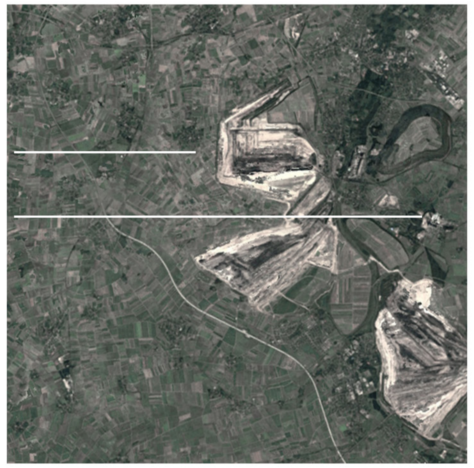
Turów brown coal mine, PL

The following cases pose examples of land transformations taking place in the coal regions. These land transformations that manifest mostly at the periphery of the mines or the mines themselves, have also significant consequences on every form around them affecting infrastructures, settlements, agricultural land and mostly forests. By looking at the land transformations we can estimate the possible threats and conditions on site and identify areas that require our attention.

Turów mine is located in a piece of land tucked between German and Czech territory. As it grows it follows the shape of the borders. Recently the mine came to the fore when neighboring countries complained that its activities were causing water shortages in Czech villages and possible soil subsidence in the German city of Zittau.

The case made it to the European Court of Justice, where Poland was ordered to cease all functions. However, the mine still operates, possibly until 2026, while the EU imposed a fine for every day that the mine is operating (Order of the Vice-President of the Court in Case C-121/21 R: Czech Republic v Poland, 2021).

The displacement of people is often the case in many mines around the world. In this particular one, it is estimated that more than 42.000 people were forced to relocate for the sake of the mine. That applied also to motorways A41 and A61.

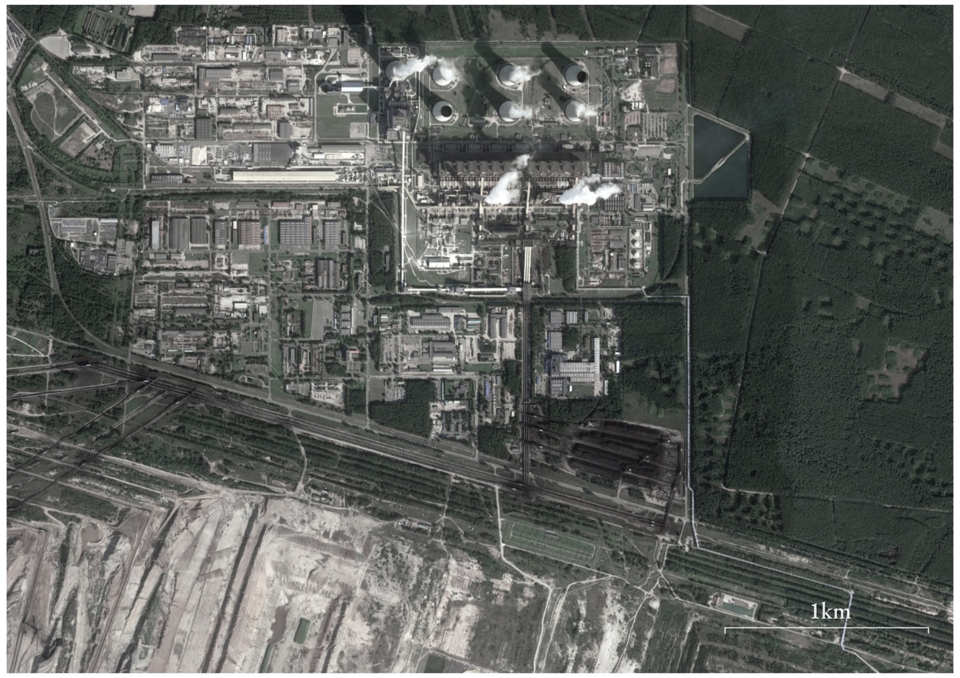


Garzweiler brown coal mine, DE

former Klettwitz Nord mine, DE

With two out of the three solar parks already connected to the grid, the Energiepark Lausitz will eventually produce 300MW. There are already wind parks. Future projects involve hydrogen production and recharging stations for vehicles (Windkraft-Journal, 2022).

Fig 14. Aerial images from mines in Germany and Poland



It is the biggest coal-fired power plant in Europe with a capacity of 5102MW, with 13 units, and has been operating since 1988. It consumes around to 42Mt of coal. Following the coal phase-out, it will gradually be decommissioned, one unit after the other, between 2030 - 2036 (PGE Mining and Conventional Energy SA, 2017).

Belchatow power plant, PL

While investigating the "coal zone" it is important to identify factors and agents that play a crucial role even in the background of the coal phase-out. In this report these factors can be grouped in two themes, environmental and socio-economic and in the fourth chapter they can be seen through the "Dual Challenge - Forests and Retreat". Looking at the bigger picture of the coal regions the socio-economic impacts that this report focuses on are the demographic change, the unemployment ratios and the possible emigration flows, but while zooming in the sites of interest it basically unravels the depopulation and shrinking trends. Concerning the environmental impact of coal mining, it is important to understand the depth of the alterations in the landscape that the mining processes cause in order to anticipate the state of the coal fields after the end of their lifecycle and thus determine the reclamation, but also initiate a conversation about the ecosystems and their role in the re-invention of the carbon economies in the coal regions.

Demographic change is an important factor to look at, as it affects among others the economies and infrastructures. According to the latest European reports (Department of Environmental Protection, n.d.) over the past 50 years, life expectancy steadily rises, fewer children are being born and immigration rates are higher than emigration. The end result however is that the EU population is decreasing. In fact, the European report states that the population continues to grow until 2029 and then slowly decline. The population decline after 2030 is a problem that most of European countries will have to face and especially in rural areas. Summarizing the report, the aging population, the declining birth ratios, and the increasing life expectancy lead to a shrinking workforce. Additionally, rural areas are to shrink significantly, challenging regional economies and infrastructures. The map on the right page is an attempt to map the population change (projection) and start thinking more in this duality of grow and shrink. Using data available from the GHSL (Global Human Settlement Layer) population grid from the 2030 was intersected with same grid from the 2020 and color coded under two themes, areas that grow (red) and areas that shrink (light blue).

It is important to link the coal sector with the above as it cannot be seen outside the social and economic context. Frequently is overlooked how the ongoing shrinkage of the coal sector will impact the employment and the economy in regions that extract lignite and hard coal. To understand the full consequences of the coal phase-out, it is important to comprehend the coal region as a complex systemic zone. The closing of mines terminates jobs not only directly, but also indirectly due to the so-called multiplier effect – jobs that arise, mainly in the private sector supporting the mines, like transportation companies, retail shops, hotels, etc. Often local communities tend to be deeply dependent on mining activities, as it is a common pattern for settlements to arise nearby them, providing them with a working force. The closing of a mine will abruptly shutter this defined relationship. Other factors worth mentioning that affect the number of jobs are the level of automation and digitalization but also the educational background of the workers (Mononen et al., 2022).

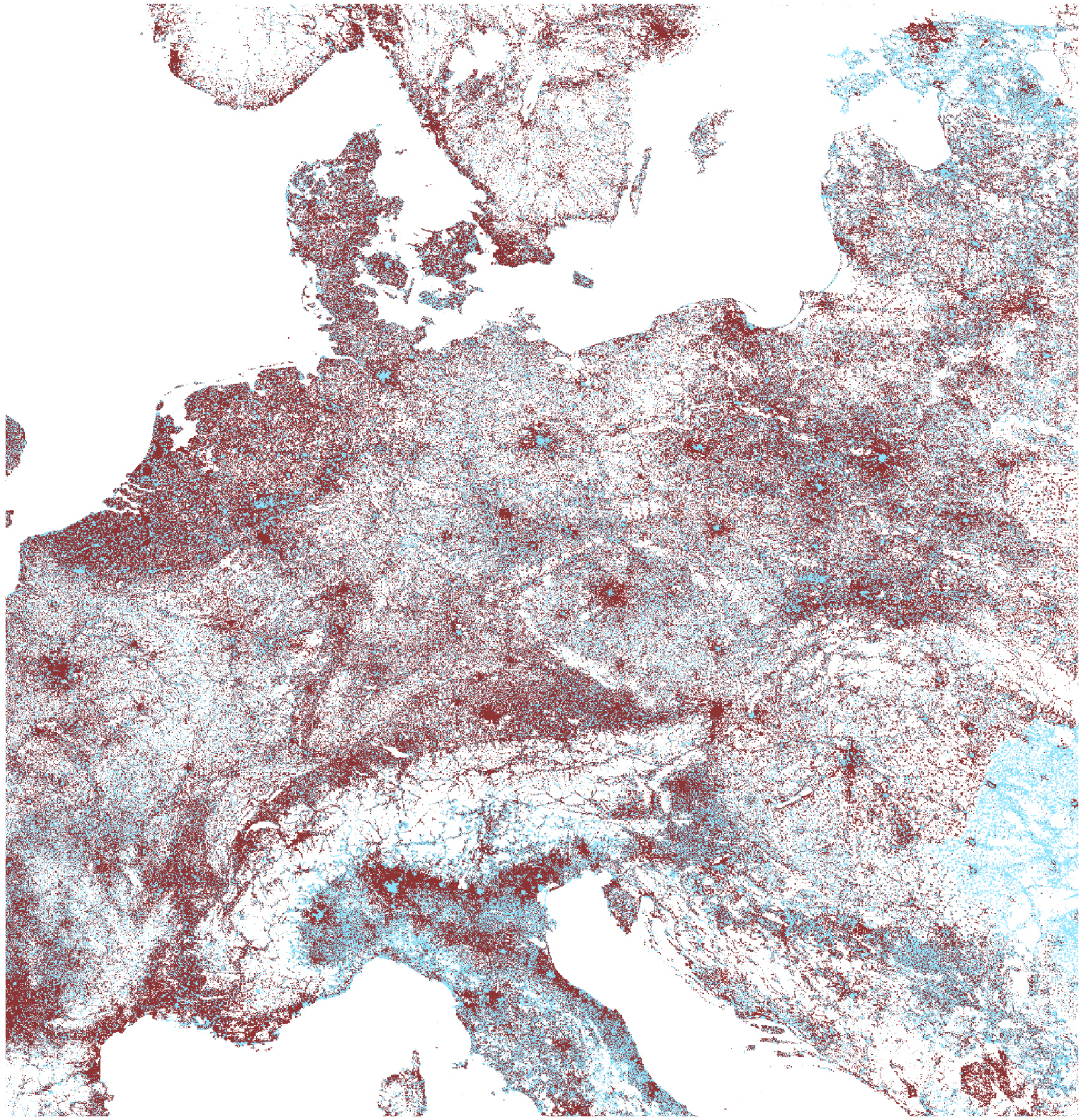


Fig 15. Population change between 2020-2030

Based on the above, many questions are being raised; can we mitigate the loss of jobs in the coal sector with new jobs in the renewables? are the coal regions to be abandoned as people flee for other areas with better employment opportunities? can strategic rural development revitalize the coal regions? In the report written by JRC (2018), by 2030 it is estimated that 160.000 direct jobs will be lost in the coal sector, but opportunities will arise through carefully planned regional restructuring processes anticipating the rising of renewables. Germany, Poland, and the Czech Republic are considered to be hit the hardest.

Another interesting factor to look at is that in Europe's "coal regions" the presence of coal deposits and the extraction activities that followed had negative effects on the development of other economic sectors – it is often the case that they have lower GDP/capita than the national average. The coal phase-out will bring this up even more and will be even more amplified in regions with already high unemployment rates. The paper states that reactivating the coal mines will not only ease the environmental impacts but will benefit the local economy. It stresses the importance of diverse new economic activities and the belief that the energy sector can still pose a driver for growth. In that sense, the current practice of turning mines into solar parks could mitigate future job losses by acting as re-employment opportunities. Finally, closed mines could further foster the ongoing energy transition with geothermal and hydropower applications. However, in the context of this thesis, we explore how re-activating the mines as part of a sustainable wood economy could benefit the areas of interest.

To conclude, the coal regions will have to deal with unemployment rates, population decline, and thus an overall shrinkage (settlements/infrastructures) that will impact furthermore the local economies and may lead to higher emigration flows. This is an important aspect to take into consideration when designing them and it is an integral part of this thesis project.

On the following page the photographic material targets the aforementioned. Looking at the image on the left, we are reminded of the case of Hambach mine, in North Rhine-Westphalia: Since 2012, a group of activists built treehouses and started living there in an attempt to oppose the destruction of the forest, one of the oldest and most diverse forests in the country, hosting thousand-year-old trees and abundant wildlife species. The actions culminated in 2018, with major protests, and in 2020 the decision was made and the last 200 hectares of the forest were saved (Deutsche Welle, 2020). Similar is also the case of Garzweiler mine in North Rhine-Westphalia in the proximity of the Hambach mine: In 2022 and 2023, the protesters set out to save the village of Lützerath from demolition for the expansion of the mine. In the end, the settlement that dated back to 1168, was demolished in early 2023. (Ingmar Björn Nolting, 2023)

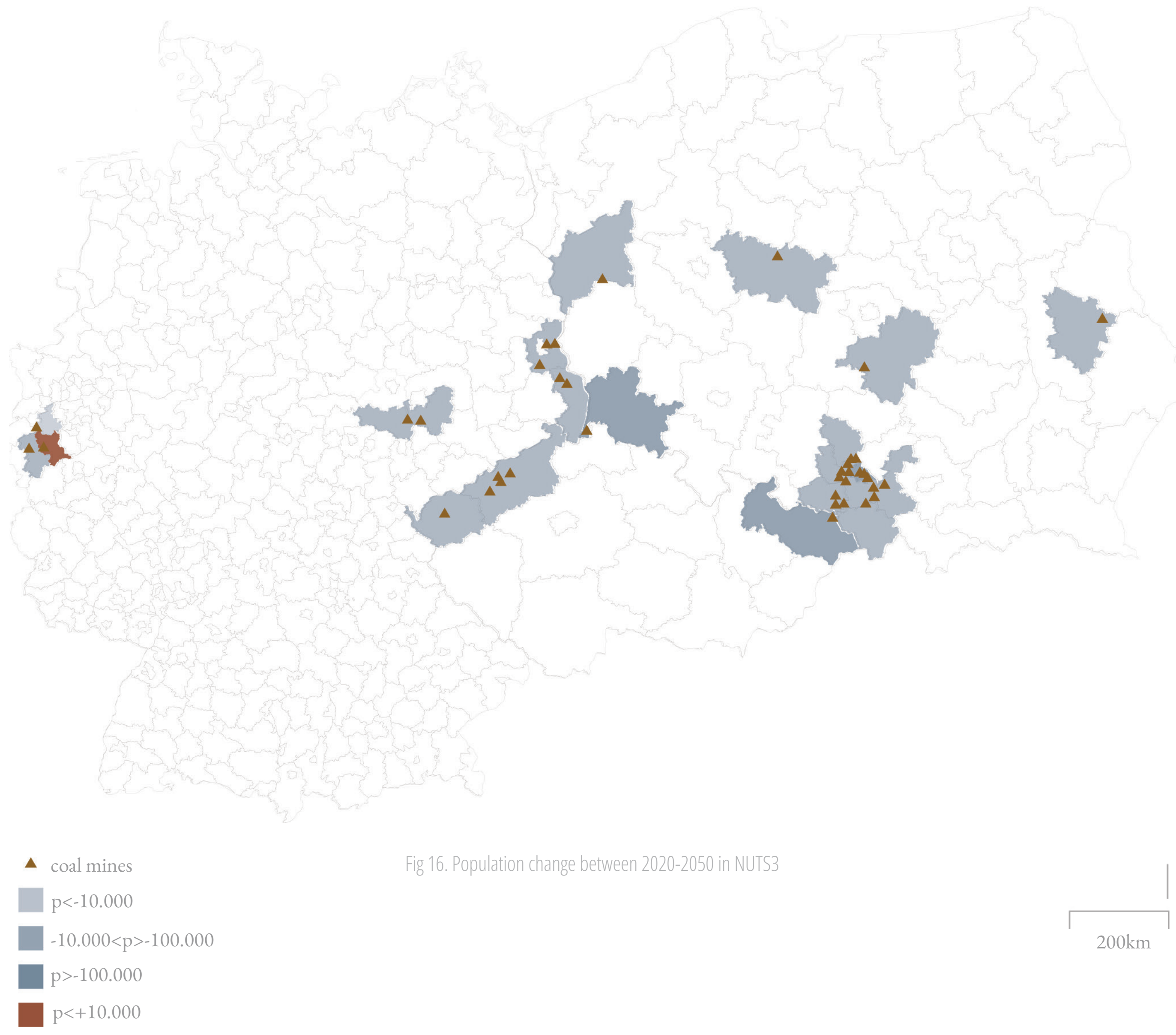


Fig 16. Population change between 2020-2050 in NUTS3

Fig 17. The treehouse protest camp in Hambach Forest, Germany | 21.09.2018

Fig 18. The treehouse protest camp in Hambach Forest, Germany | 27.10.2018

Fig 19. Miners demanding protection because of the coal phase out | 24.10.2018

Fig 20. Demonstrations to stop the destruction of Lützerath, Germany | 08.01.2023

The end of mining leaves behind a significant environmental footprint. Coal extraction has direct and indirect environmental impacts, affecting water, land, air, biota, and people. They can be seen on different scales, from regional to global scale. During the exploration phase, the environmental impacts are often less significant than the other phases, but it is important to understand that even this phase, if not planned correctly, may affect habitats. The construction phase marks changes that vary from site to site and the type of mine, as open pit mines usually bring a greatly visible footprint; the topography is being changed and vegetation is stripped down. Underground mines, although they can "hide" all the environmental changes, they pose high risks of toxic leaks and they have often been associated with fatal accidents. The last phase of a mine, its closure, is perhaps the most neglected one and is often related to inefficient water management.

Concerning land impacts, the mine and its surrounding infrastructures (water and energy lines, roads, and rail networks) occupy vast spaces and are sometimes blamed for natural habitat destruction, like deforestation, erosion, and alteration in the soil, leading to negative effects on the local biodiversity.

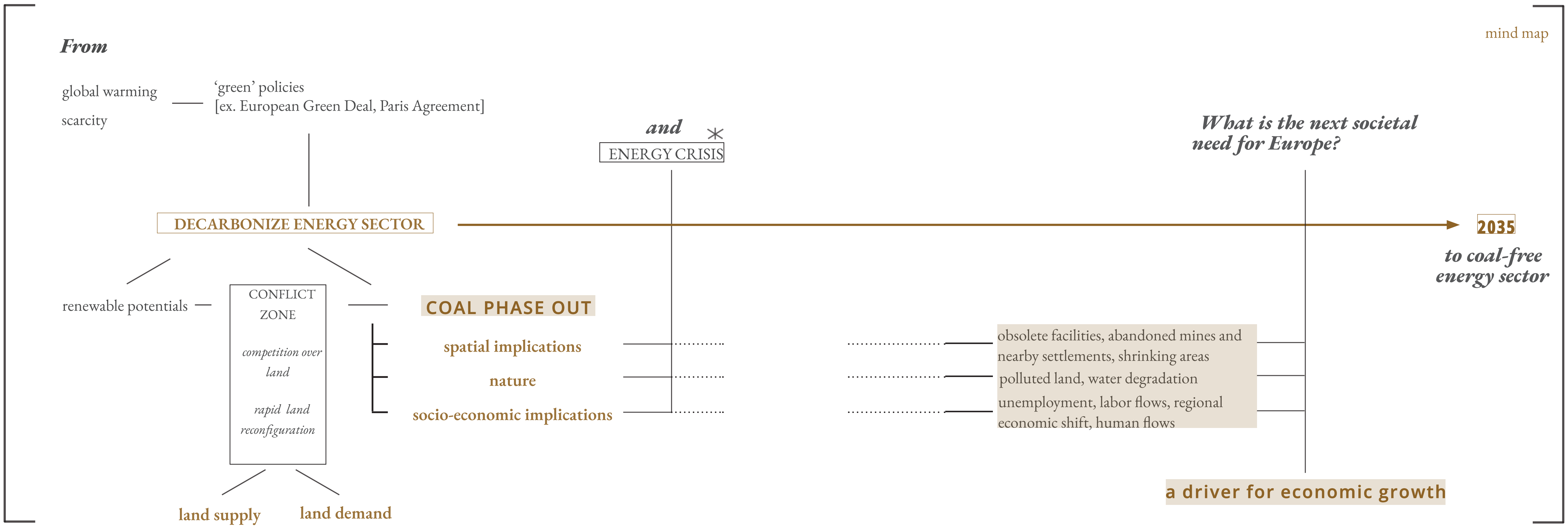
Any change regarding the land uses impacts the hydrology, by affecting the absorption rates, the flow, and the quantity of the runoff water and increases the risk of contamination. The deforestation in the area, which is essential in the creation of the mine results in increased surface runoff and erosion and also endangers aquatic organisms. In addition to that, mining activities demand water and can cause water scarcity in nearby areas. Some other impacts worth naming are gas emissions, light, and noise pollution, and even land vibration. In any case, every phase in the life cycle of a mine should be treated with care by all living organisms and nature. As we inherit vast areas of former mines, evaluating the conditions and the degree of pollution will greatly affect the future planning of these areas, as well as the feasibility of every project.

In the context of this thesis, we should indicate the case of the Lusatian Lake district: It is located in an 80km area spanning from northeast Saxony to the southeast of Brandenburg, where several former opencast lignite mines were transformed into artificial lakes. These lakes aim to compensate for years of environmental degradation and also boost tourism, by making the areas more attractive while offering accommodation options and a plethora of sports activities.

To conclude, mine reclamation practices aim to bring back the pre-mining conditions, by stabilizing slopes, removing waste, debris, machinery, and any unnecessary infrastructures, handling erosion, and re-cultivating the area. These practices are also combined with the creation of lakes, aiming at the long-term creation of more diverse ecosystems and also the de-stigmatization of the area.

Fig 8. Different stages of mining

Fig 21. Abandoned quarries, future lake Zwenkau, Germany, Sep 2009 from Atlas of Places by René Zieger "Retired Soil"


mind map
From
global warming
scarcity
'green' policies
[ex. European Green Deal, Paris Agreement]
and
ENERGY CRISIS
What is the next societal need for Europe?
DECARBONIZE ENERGY SECTOR
2035
to coal-free energy sector
renewable potentials
CONFLICT ZONE
competition over land
rapid land reconfiguration
COAL PHASE OUT
spatial implications
nature
socio-economic implications
obsolete facilities, abandoned mines and nearby settlements, shrinking areas
polluted land, water degradation
unemployment, labor flows, regional economic shift, human flows
a driver for economic growth
land supply
land demand

The urgent need for decarbonizing the energy sector is causing rapid transformations, not only spatially but also economically affecting large groups of people. In the context of this thesis, this takes shape in fragile, over-exhausted extraction sites in Germany, the Czech Republic, and Poland; operational landscapes pushed to their limits. **The coal phase-out is an open call for change, to rethink relationships and bonds among energy (operational landscapes, infrastructures, and natural recourses), territories, humans, and nature and explore new manifestations of carbon economies, more sustainable and equitable for all, human and non-human.**

The post-mining landscape as posed in this thesis has two challenges, an unavoidable depopulation/retreat/shrinkage and greatly altered/burdened ecosystems. This dual challenge leads the way to a new interpretation of carbon economies with key elements of their very characteristics, forests, and urban fabrics.

A condition we know: The coal phase-out is in progress, however, each country has different goals to meet and thus different speeds, even regions within the same country react differently, a lack of concrete strategies allows space for ambiguous interpretations and market-driven actions. Allowing “flexibility” and “indeterminacy” in that case would only work in favor of those who plan to take advantage of the sites and their potentialities. For that the “coal regions” need a well structured strategy that could foster change and growth, introducing the spatial context under which intervention could take place.

A condition we anticipate: Why should we focus on forestry? Why should we find alternatives in carbon related activities? As has already been mentioned, the coal regions, mostly rural in this context can been seen through the lens of ecosystems (forests) and an overall shrinking. Seeking for an act of “clearance” - a term discussed within the TT studio - an driver for growth could benefit the affected areas and that could be manifested through sustainable forestry, given the local capacities on top of the gradually growing demand for wood.

Goals

The post-mining landscapes require our attention and of course taking proper care of the exhausted landscapes is of primary importance. Taking this step for granted, this thesis tries to investigate how the coal regions and most specifically the mines, the forests and the nearby settlements could be parts of a system that through various synergies driven by biodiversity and forest grow and a demand for forestry, could formulate a new narrative for the coal regions.

How can we systematically transform coal mining regions by introducing a productive, post-coal carbon economy?

Q1
What are the spatial transformations needed in the post-coal mining landscape that can facilitate forest and biodiversity growth while fostering sustainable forestry?

Q2
How to repair the post-mining landscape based on the capacities of the current ecosystems?

Q3
How to design in a depopulating shrinking the post-mining landscape?

De-industrialization and Brownfields
Operationalized landscapes
Urban decline
Modernity and life-cycle of infrastructures

Theories and Urbanism

Alan Berger
Drosscape: Wasting Land in Urban America (2007)

Dirk Sijmons
Landscape and energy: designing transition (2014)

Pierre Bélanger
Landscape as infrastructure: a base primer (2016)

Rania Ghosn
New Geographies 02: Landscapes of Energy (2010)

Rahul Mehrotra and Felipe Vera
Ephemeral Urbanism: Does permanence matter? (2017)

Daniel Ibáñez, Jane Hutton and Kiel Moe
Wood urbanism: from the molecular to the territorial (2019)

Energy transition
Coal phase-out
Shrinking cities
Rural development
Forests ecosystems
Biodiversity growth
Sustainable forestry
Habitat protection

Policies/Reports

EU coal regions: opportunities and challenges ahead
Policy report JRC112593 (2018)

Clean energy technologies in coal regions
Policy report JRC117938 (2020)

Recent trends in EU coal, peat and oil shale regions
Policy report JRC123508 (2021)

Shrinking Cities
Policy report JRC126011(2022)

A long-term Vision for the EU's Rural Areas - Towards stronger, connected, resilient and prosperous rural areas by 2040
Document 52021DC0345 (2021)

New EU Forest Strategy for 2030
Policy report by European Commission (2021)

Biodiversity Strategy for 2030
Policy report by (2020)

Connectedness
Regenation
(Alter) Biopolitics
Indeterminacy
Terraforming

Sustainability and biopolitcs

Q6 Seminars Positions of Care
TT studio (2023) Taneha K. Bacchin

Foundation
Explorations
Field Trip
Dual Challenge
Design
Conclusions

Motivation + **Relevance** coal phase-out, energy transition and new spatial demands

Problem Field exploitation of natural resources, post-mining landscapes

key words: carbon economies, shrinking cities, forest ecosystems, sustainable forestry

location: central Europe: Germany, Poland and the Czech Republic

problem statement: The coal phase-out is an open call for change, to rethink relationships and bonds among energy (operational landscapes, infrastructures, and natural recourses), territories, humans, and nature and explore new manifestations of carbon economies, more sustainable and equitable for all, human and non-human. The post-mining landscape has two challenges, an unavoidable decline/shrinkage/retreat and greatly altered/burdened ecosystems. This can lead the way to a new interpretation of carbon economies located in post-mining regions with key elements of their very characteristics, forests, and urban fabrics.

Theoritical Framework

Drosscapes, Operationalized Landscapes, Shrinking Cities, Sustainable Forestry

Research Question

How can we systematically transform coal mining regions by introducing a productive, post-coal carbon economy?

Q1 *What are the spatial transformations needed in the post-coal mining landscape that can facilitate forest and biodiversity growth while fostering sustainable forestry?*

Q2 *How to repair the post-mining landscape based on the capacities of the current ecosystems?*

Q3 *How to revitalize such regions that face depopulation, economic decline and an overall shrinkage?*

Approach research by design

Methods

Literature Review, Analytic Cartography, Speculative Cartography, Strategic mapping, case studies

Outcomes

Design on three scales, local interventions, territorial vision (cluster scale), greater regional area

Conclusion

Evaluation, Reflection, Ethical considerations

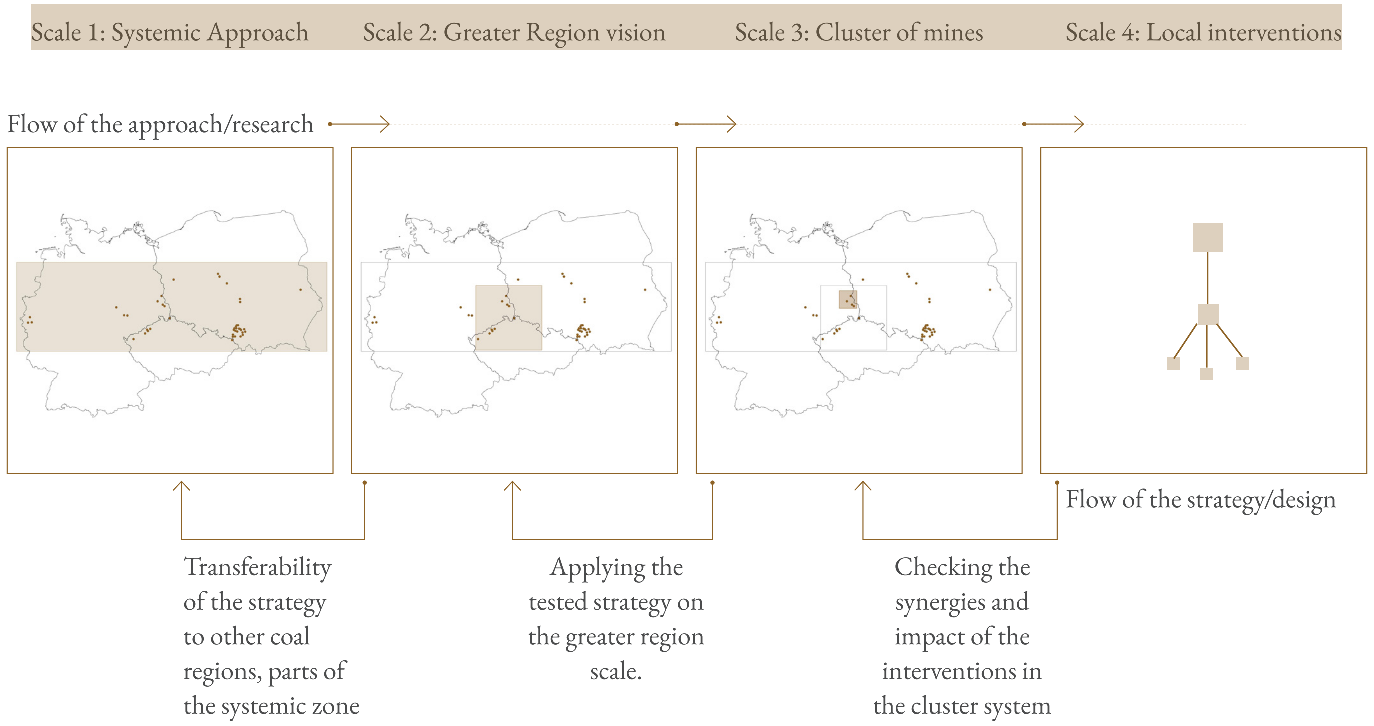
For this thesis, the methodology used is very much related to our studio approach. The academic year started with Studio Intensives, during which the studio's lectures introduced us to two concepts – accumulation and clearance. We began by trying to visualize these, later trying to map a palimpsest, and after that drawing our own understanding of composition, alternation, and limits. The final step was the transposition, an early attempt to think of the changes we propose. During the Studio Exploration (Geographical Urbanism) we were introduced to the matrix city, more-than-city, human, more-than-human. We explored how we can visualize these while producing our own matrix and a synthesis drawing of our future intentions.

As we started the second quarter of the graduation year, the lectures focused on exposing us to a variety of topics and the seminars under the theme Positions of Care were supporting the drawing exercises Lines of Inquiry. For the exercises, as we needed a location, I decided to focus only on Germany. The reason behind my decision was the availability of the data, my familiarity with the given context, and the linguistic understanding that enabled me to explore literature in German. The tools, thinking, and approach that I used to produce the Lines of Inquiry for the case of Germany could be applied to the other two countries. The series of drawings that are presented in the next chapter 'Explorations', reveal gradually the complexity of the coal phase-out and underline conflicts and potentials.

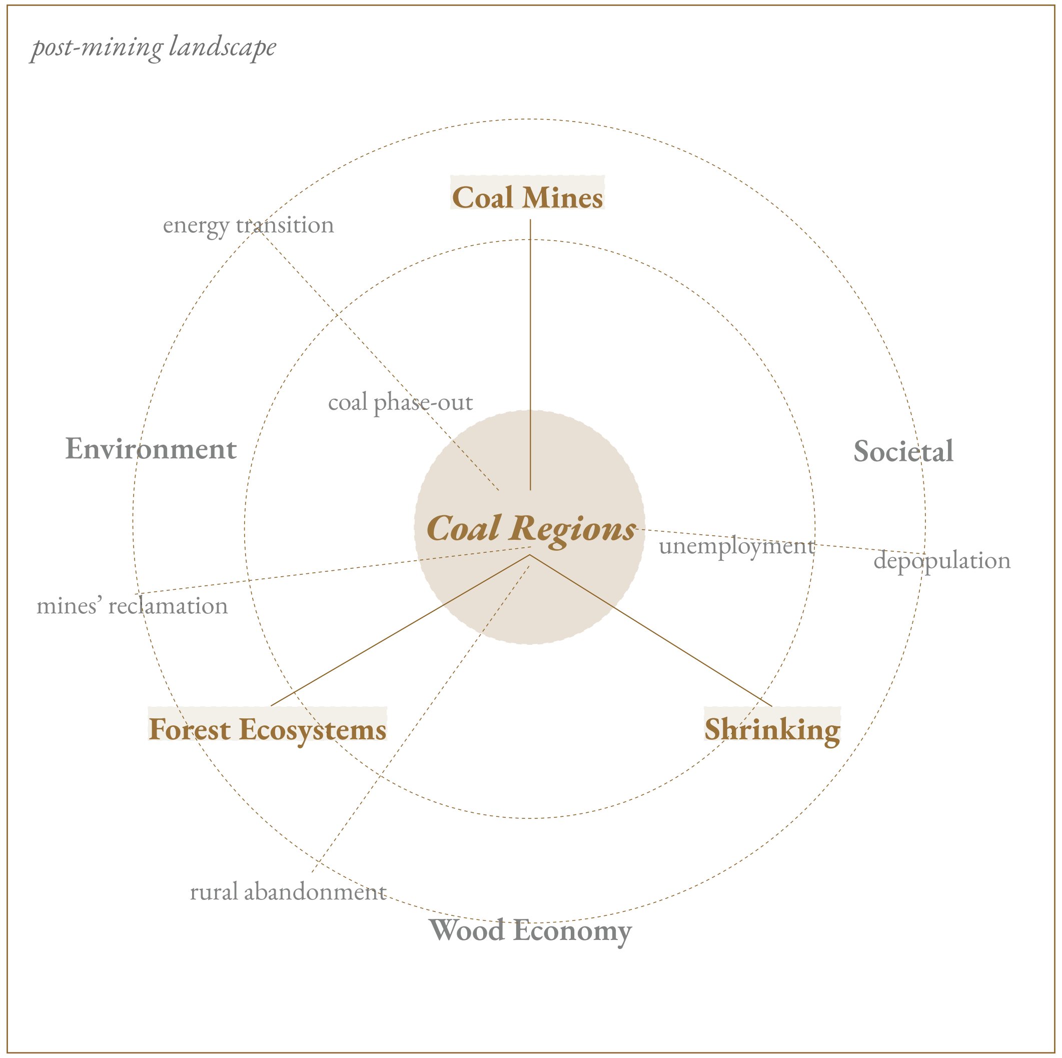
Defining the scales of the project: This thesis starts with the hypothesis that grouping the coal mines and auxiliary infrastructure of central Europe (DE, CZ, PL) in one systemic zone, would unlock a new understanding between energy and landscape and new potentials for the post-mining landscapes and energy transition. That is the scale of the framework. The next scale that needs to be defined is the greater regional scale, the transboundary area of the three countries, which is used to contextualize the coal phase-out and start exploring the local conditions as defined in the Foundation chapter. Next, the regional scale (the cluster of mines in Lusatia) is used to test the strategy and the synergies among the mines. The last zoom-in, comes with different scales and focuses on local interventions. The multiscalar approach used in this project is required to maximize the applicability in other parts of the systemic zone.

Having a clear understanding of the scales needed, I started investigating the dual challenge of the area, as further implied in the Foundation and Explorations. While doing so, I decided to postpone my field trip until after the p3 stage, so as to visit the area where most of the local intervention would occur, around Cottbus. Coming back from the field trip, I focused on exploring the duality (urban retreat and forest growth), in chapter 4. Chapter 5 focuses on the strategy and chapter 6 on the design, of all the aforementioned scales. From the regional strategy (cluster of mines) in Lusatia, it zooms in on the local interventions to zoom out of the systemic zone and draw conclusions on the applicability of the project.

Concerning the chosen literature, the research begins with theories and methods on urbanism shifting gradually towards wastescapes and operational landscapes. It also includes a critical overview of policy documents related to the coal phase-out on a European and national scale that combined with analytic cartography (monographies and lines of inquiry) explores current conditions on-site. An important part of the research is theories on sustainability and bio-politics.



Transferability: *Q1: Are the same interventions still relevant?*
Q2: To what extend the strategy as proposed for the Lusatia's cluster can be re-applied in other regions?



Tackling complex issues requires critical thinking, an act of observing, listening, questioning, reporting, reasoning, and forming conclusions. This chapter is an exploration of the coal mining practices that have shaped Europe's "coal heartland". It is a bridging chapter between the thesis's Foundation and the following chapters that further zoom in.

The Monographies of Coal Regions aim to understand processes in space through time by questing among others:

How can we imagine coal regions after the coal phase-out?

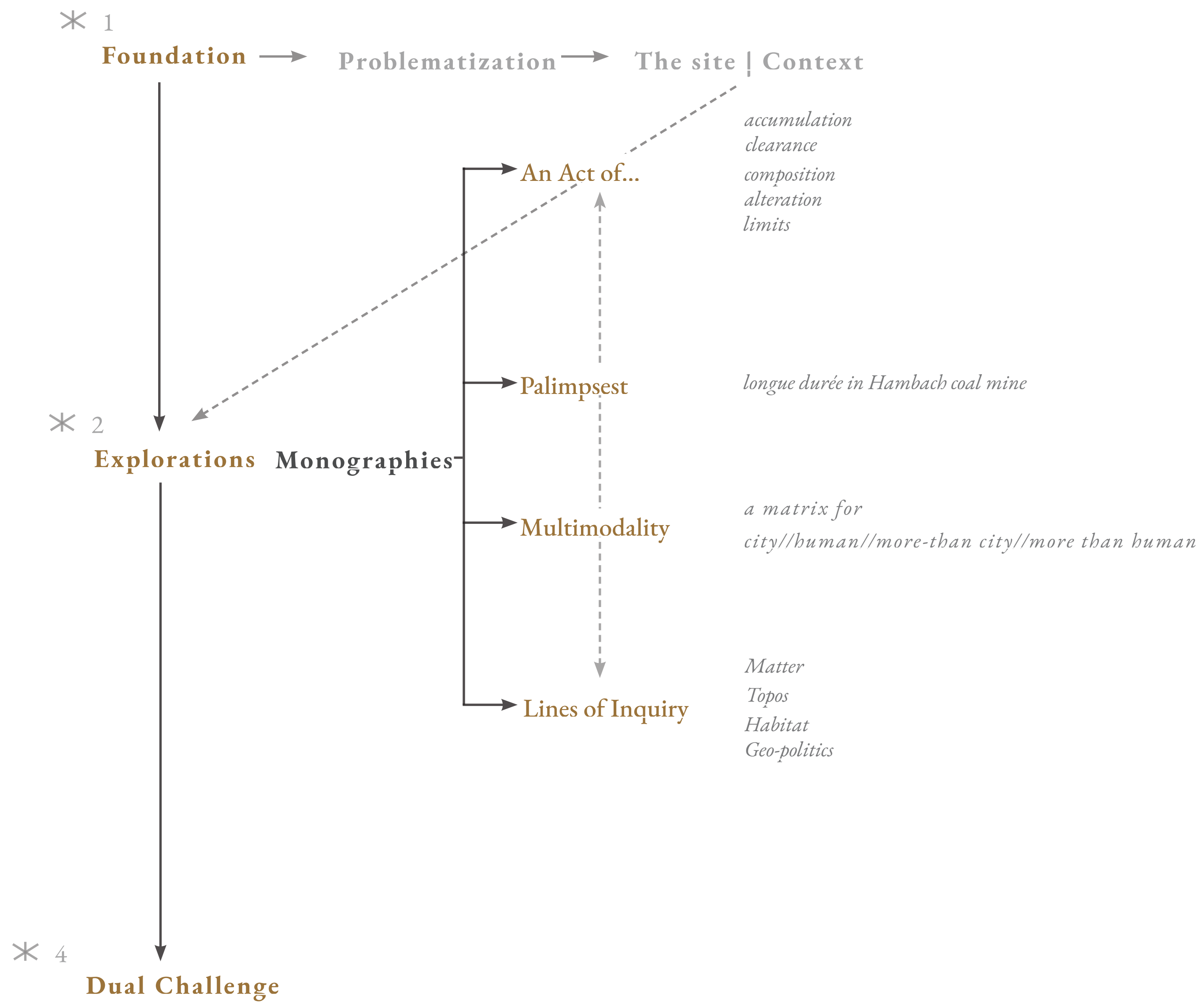
Who are the current and future agents and how do they operate?

What is the impact of coal mining and how does it affect the future?

Through different scales the drawings attempt to visualize existing conditions by studying coal in various ways, as an energy product, as a catalyst for the economic and social development and evolution of regions, as a time landmark, and as a factor of environmental pollution and degradation...

The following three drawings, composition, alternation and limits explore coal extraction sites in Germany and more specifically in Rhineland. The composition sets the background image as a mosaic of elements, rivers, quarries, industrial land uses and nature. The alternation focuses on the Hambach mine and uses sections to spatialize the "terraforming". The limits show current trends and serve as an early attempt to engage the economy in the topic.

The palimpsest or long duree, looks at the last three coal mines in the area, Inden, Hambach and Garzweiler and categorizes the elements around them into permanent, persistent, addition and subtraction. Since the first human presence in the area, Cologne, Düsseldorf and the water bodies were important elements that shaped today's growth-thus they are classified as permanent. The mines and quarries are considered an addition, they appear, grow and gradually go smaller and hide under piles of overburden again. The subtraction is the settlements that over the years have been relocated or destroyed completed for the mines to expand. Last, the ancient Hambach forest is an indication of persistence through time.



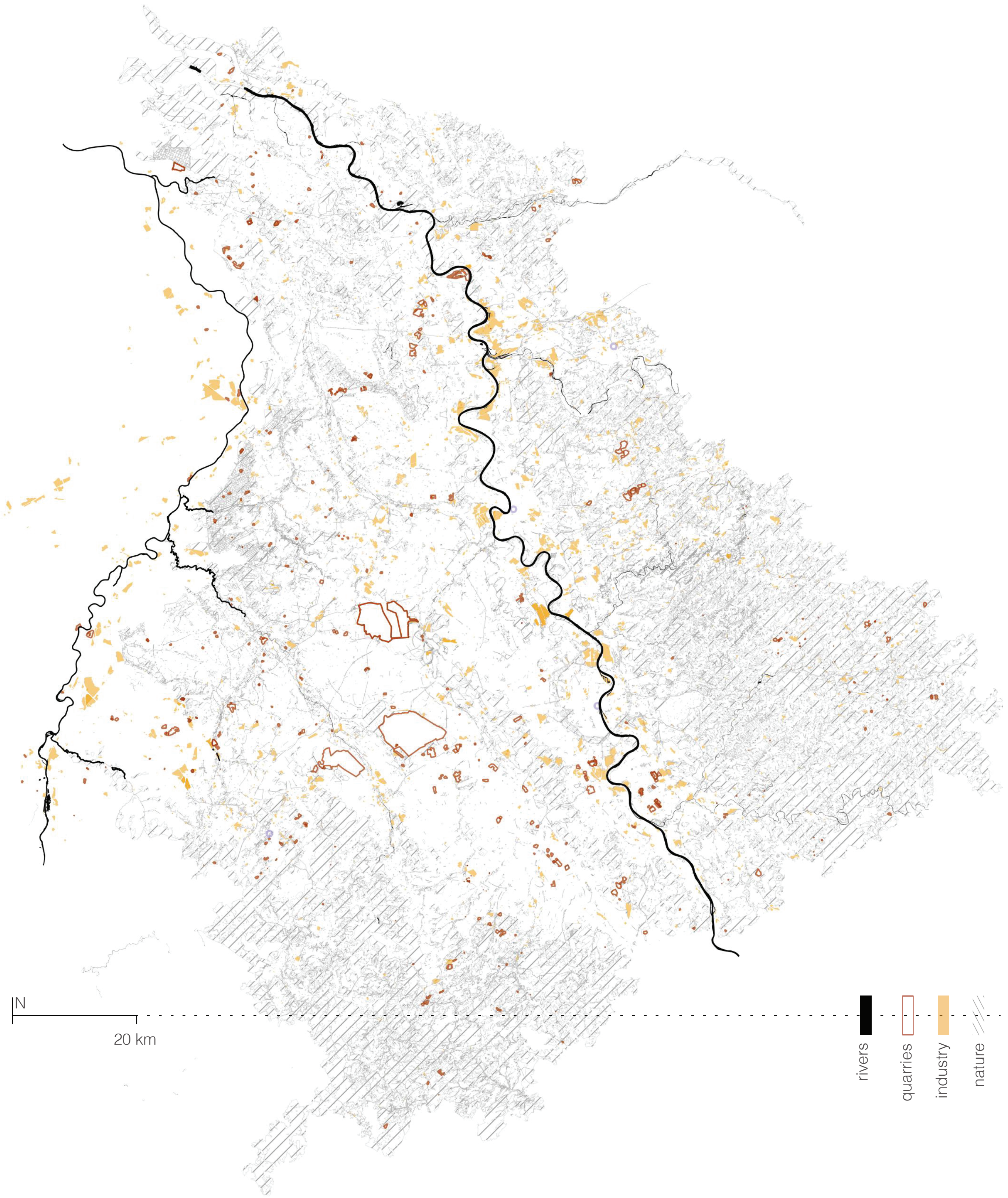


Fig 22. Composition in Cologne & Düsseldorf region

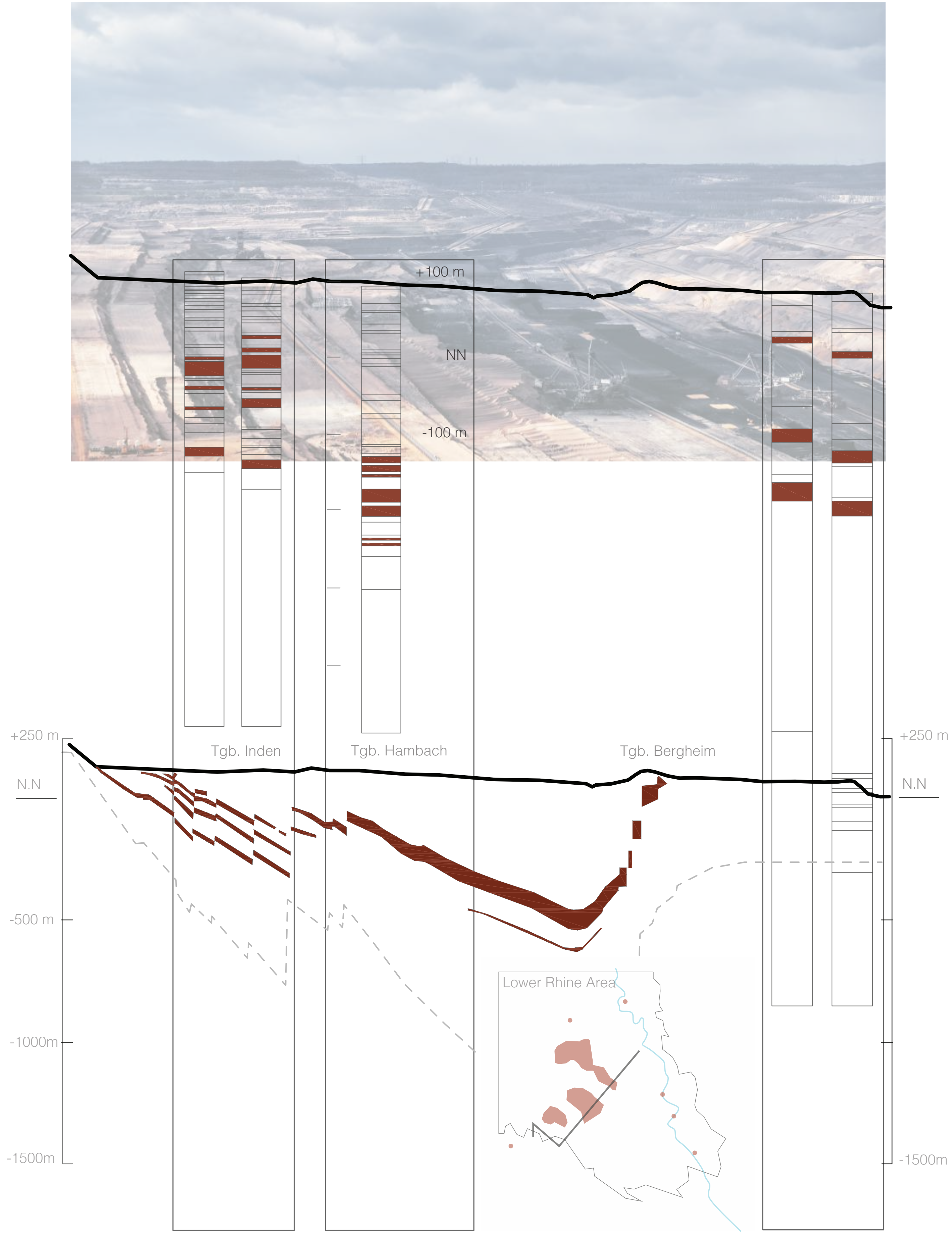


Fig 23. Alteration in Hambach Mine, Germany

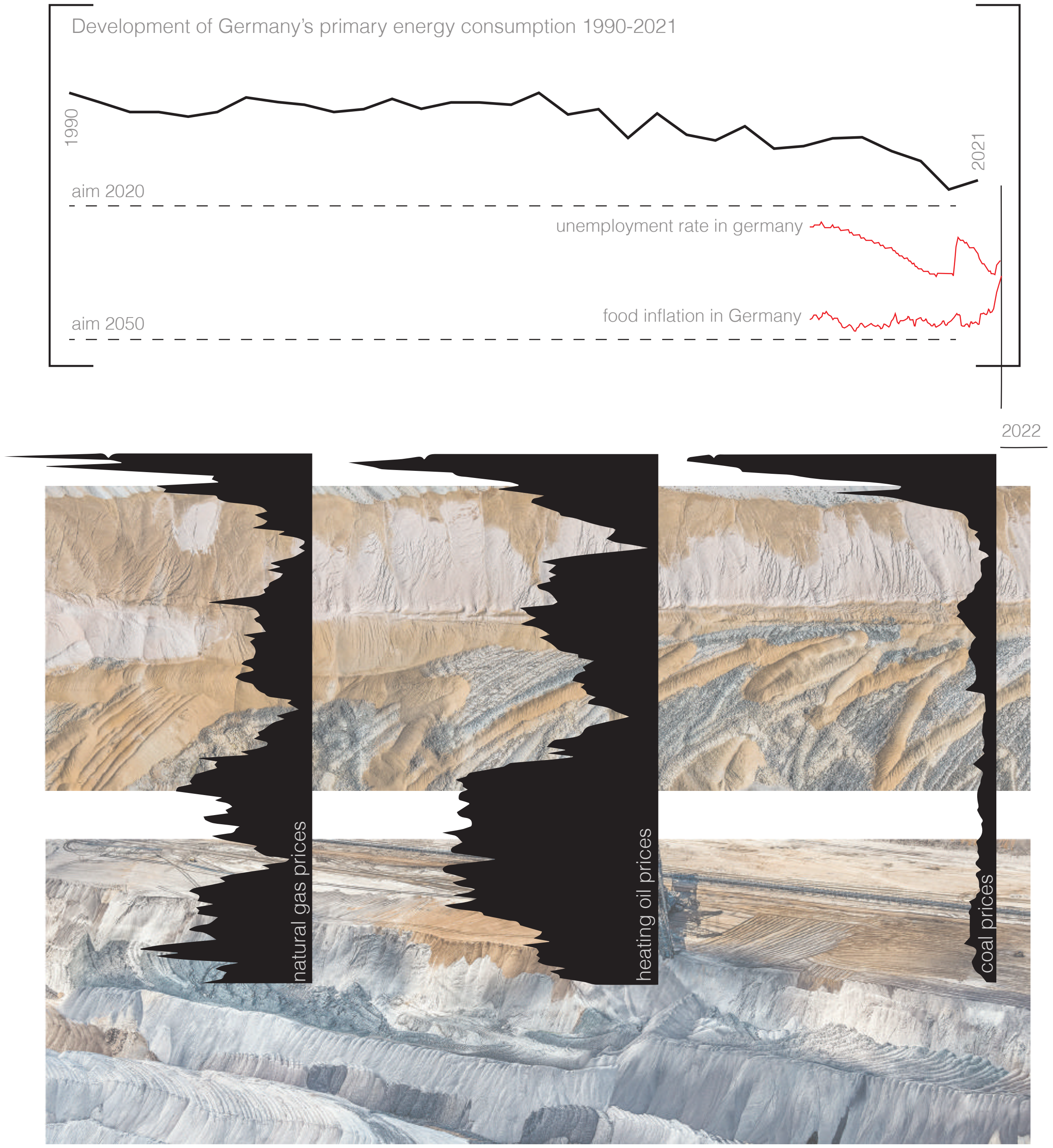


Fig 24. Limits in Germany

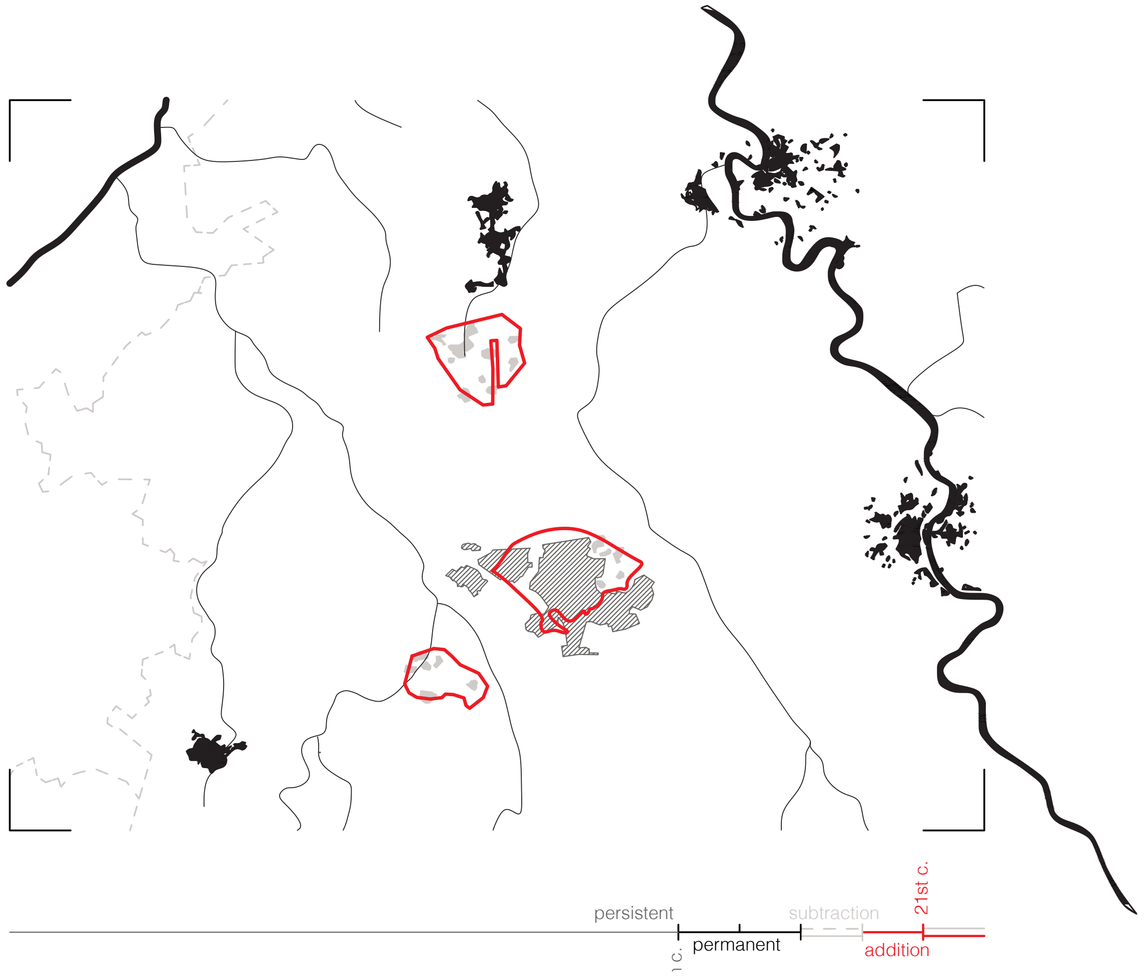


Fig 25. Elements of palimpsest

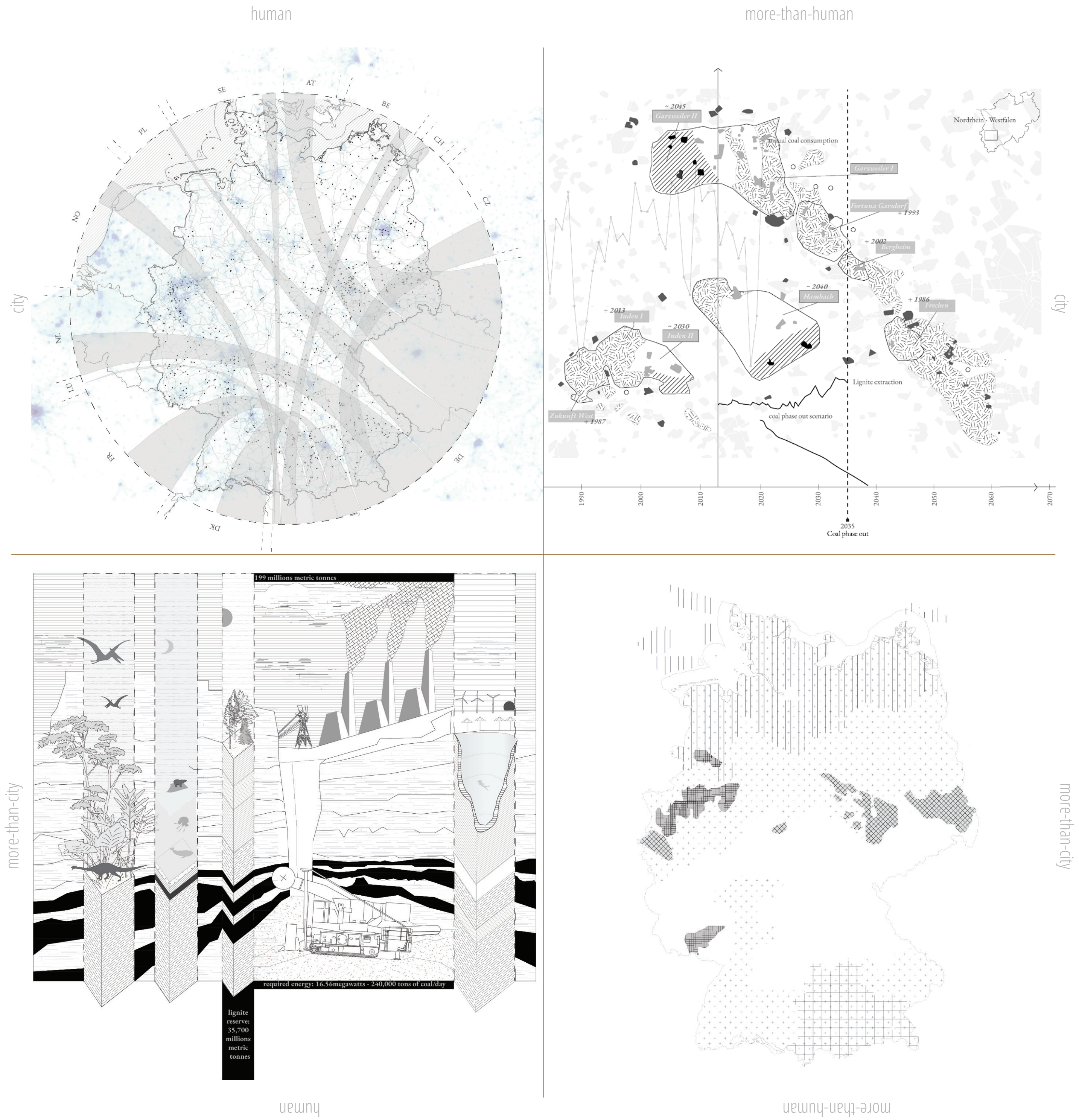


Fig 26. Matrix of Investigations

Multimodality is the matrix of investigations that was proposed during the Geo-urbanism studio, a matrix that explores city, human, more-than-city and more-than-human elements. The relation between city/hinterland has been widely explored and the role of the non-city spaces in the urbanization process is debated a lot. The prevailing city-centric approach, puts these spaces second, after cities, whereas their contribution to city's growth is undeniable, making us rethink a city's capability to power itself without these specialized but profit-driven landscapes. The four drawings focus in Germany and investigate through different locations and scales the coal mining landscape.

City//Human: a gradient of blue colors depicts the population density, the black bullets power plants and on top of that a flow diagram draws energy exchanges between Germany and it neighboring countries.

City//more-than-human: in the location of the three remaining coal mines in North Rhine-Westphalia, the drawing is a palimpsest of mining activities, former mines and active ones, re-cultivated areas, relocated and destroyed settlements and future plans, all together showing the complexity of the coal phase-out.

More-than-city//human: sections through time, from the formation of underground coal seams to Anthropocene and coal extraction and to the future.

More-than-city//more-than-human: map of energy potentials in Germany. The map illustrates opportunities and possible conflicts for renewables in different states.

MATTER

Carbon is one of the most abundant elements on earth -it is found in the atmosphere (combined with oxygen it forms carbon dioxide) but also underground as hydrocarbons (coal, oil, and natural gas) - and it is its abundance and its diversity of compounds that make it so important. Coal was formed millions of years ago by pressure and heat buried dead matter. These geological processes have resulted in a gradient of substances, from peat to lignite, bituminous coal, and graphite. Coal as a fuel, starts its journey from extraction sites to processing units and later power stations, where is converted to electricity and then feed into the power grid. Its extraction and use are commonly known to be harmful to people but also a great threat to the environment. In the past years, many policies have been formed and adopted by countries all over the world for greener energy production, decarbonizing the energy sector, and shifting towards renewable sources of energy. This shift marks perhaps the end of the fossil fuel era and the beginning of a coal phase-out.

For the layer *Matter*, carbon is being investigated. A carbon cycle helps to identify threats to the current ecosystems. The *Alternation* draws upon the byproducts of one part of this carbon cycle, the energy production from lignite to electricity. Energy production and consumption are not static numbers and constantly change and readjust to cover human needs. The energy map of Europe depicts the carbon density or the amount of carbon dioxide emissions per kWh. Looking at the energy sources for electricity production, coal is still being used intensively. At the same time, energy from renewables is gradually growing. The earth's core becomes the center of *Limits* drawing. Years of exhausting extraction activities that left behind underground hollows and depleted alienated territories now pose new opportunities for gathering and storing carbon dioxide from the atmosphere. At the same time, through carbon sequestration, forests contribute to the removal of carbon dioxide from the atmosphere. Once sequestered the carbon is stored in the forest (biomass, soil, litter) forming carbon stock.

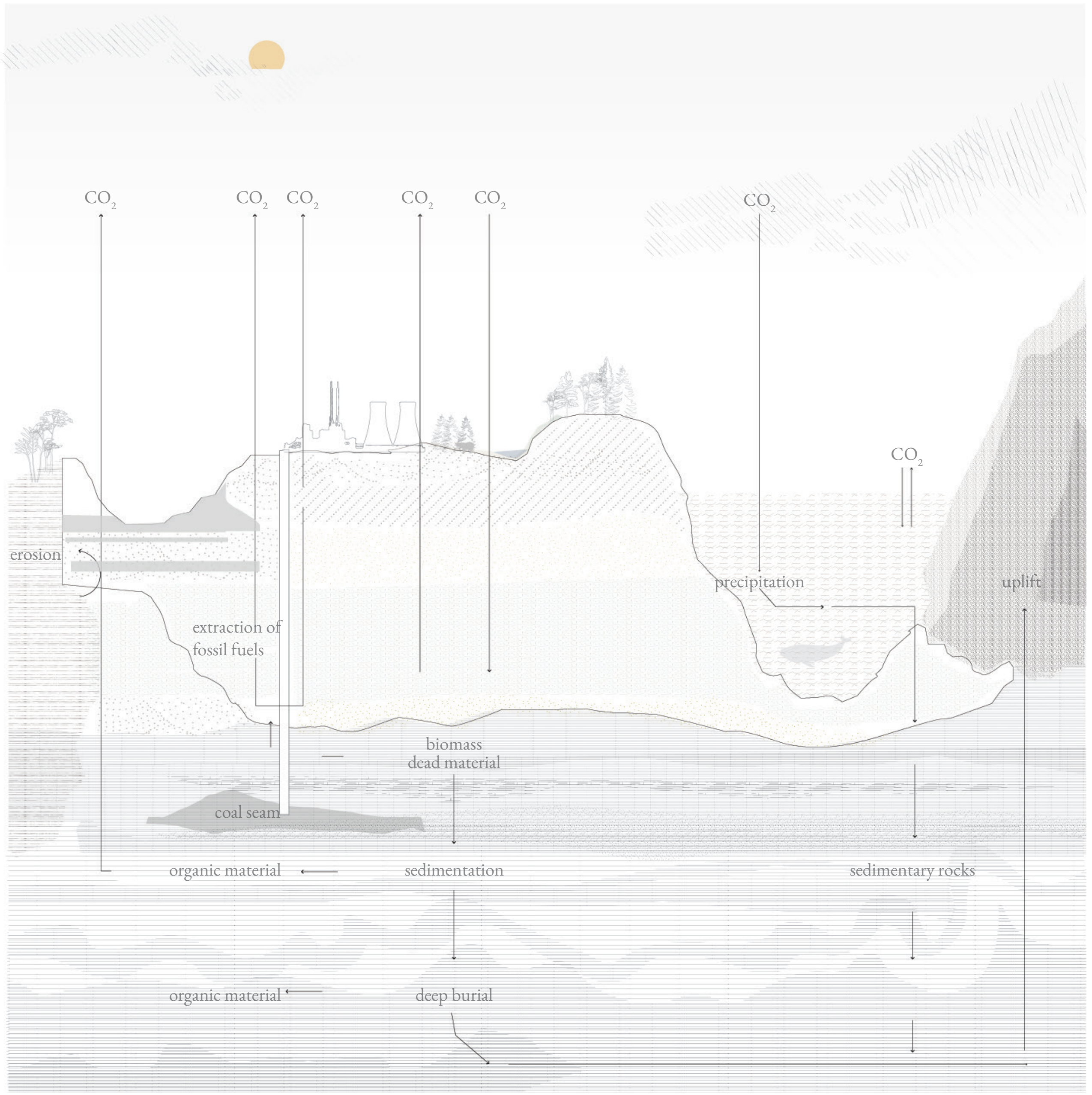


Fig 27. Matter composition

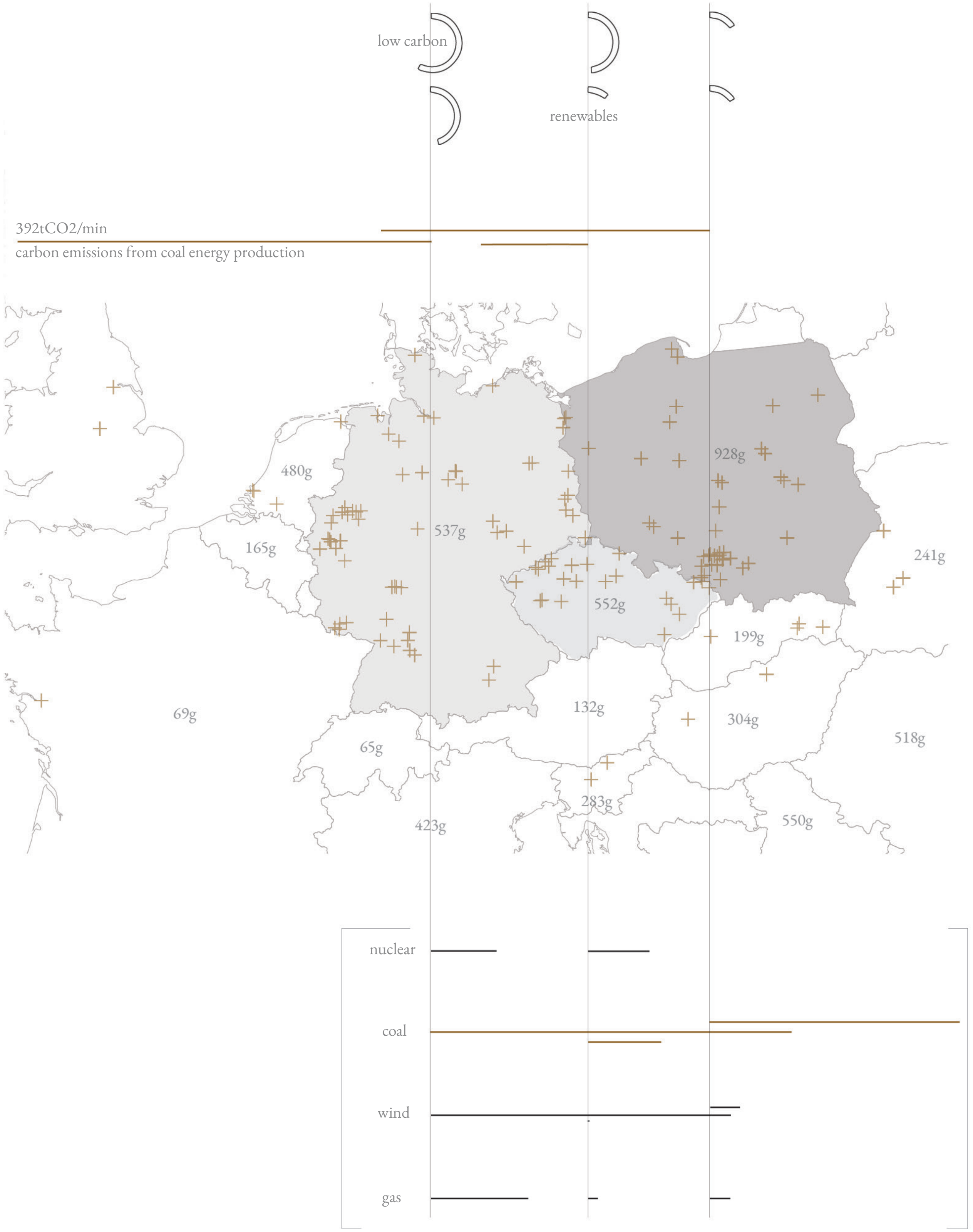


Fig28. Matter alteration

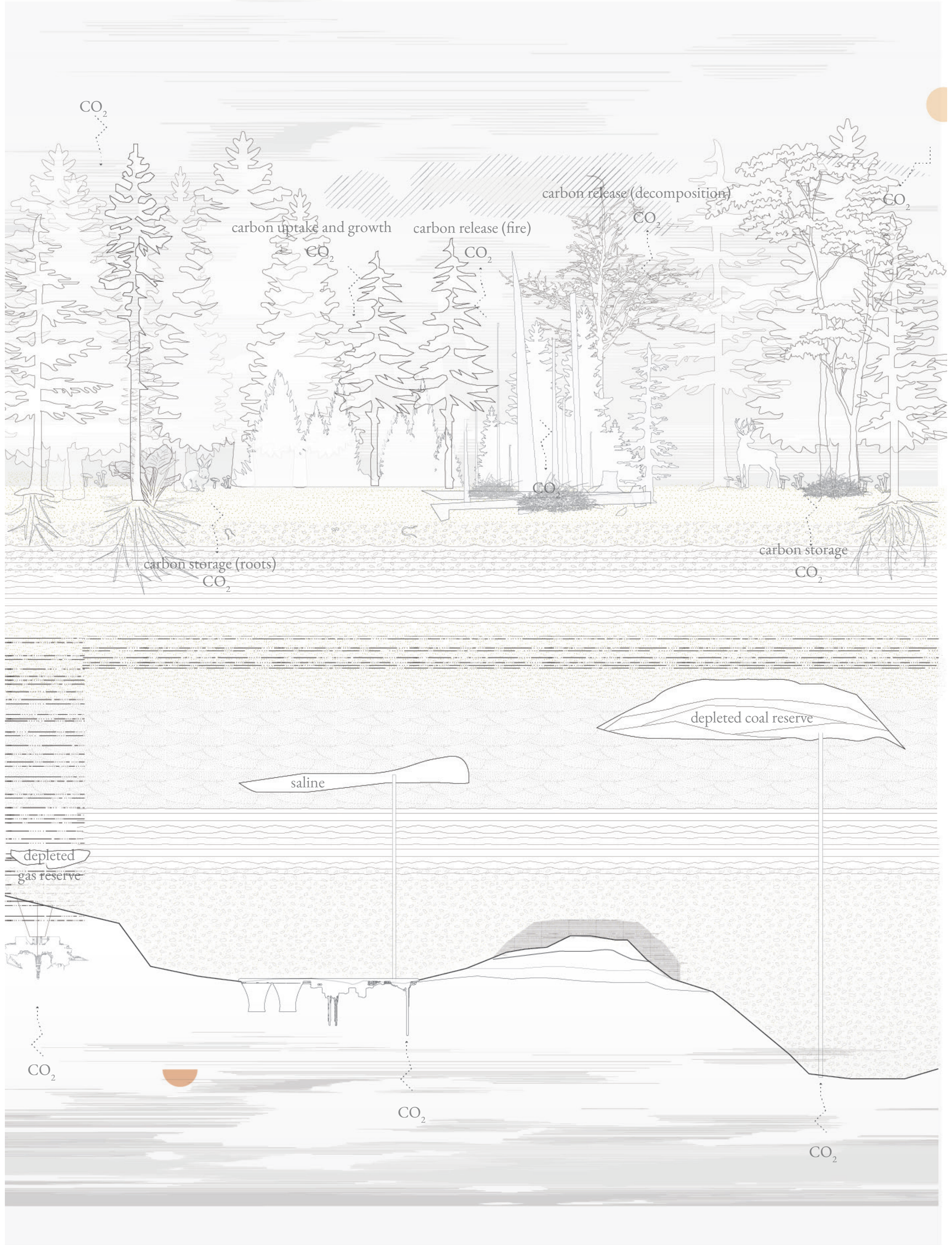


Fig29. Matters limits

TOPOS

For *Topos*, the investigation focuses on a cluster of three operating mines in Germany, Hambach, Inden, and Garzweiler. The *Composition* gives hints of the life cycle of infrastructures and related/supportive elements around the mines. Settlements can be seen emerging only to be relocated or destroyed for the sake of mines' expansion. This investigation was influenced by the recent demonstrations that happened in Germany when one mine that was due to close at the latest in 2035, started the destruction of a nearby settlement, bringing up issues of life cycle and expiration not only for the mines and their infrastructures, but also for the settlements and subsequently people. *Alternation* looks closely at the evolution and horizontal expansion of the mines through time. *Limits* are being expressed through a technical sheet, comparing the spatial footprint of energy production in the area, from mining to production, offering also an indication of how the energy transition to renewables will spatially affect the sites and the amount of energy produced in the area.

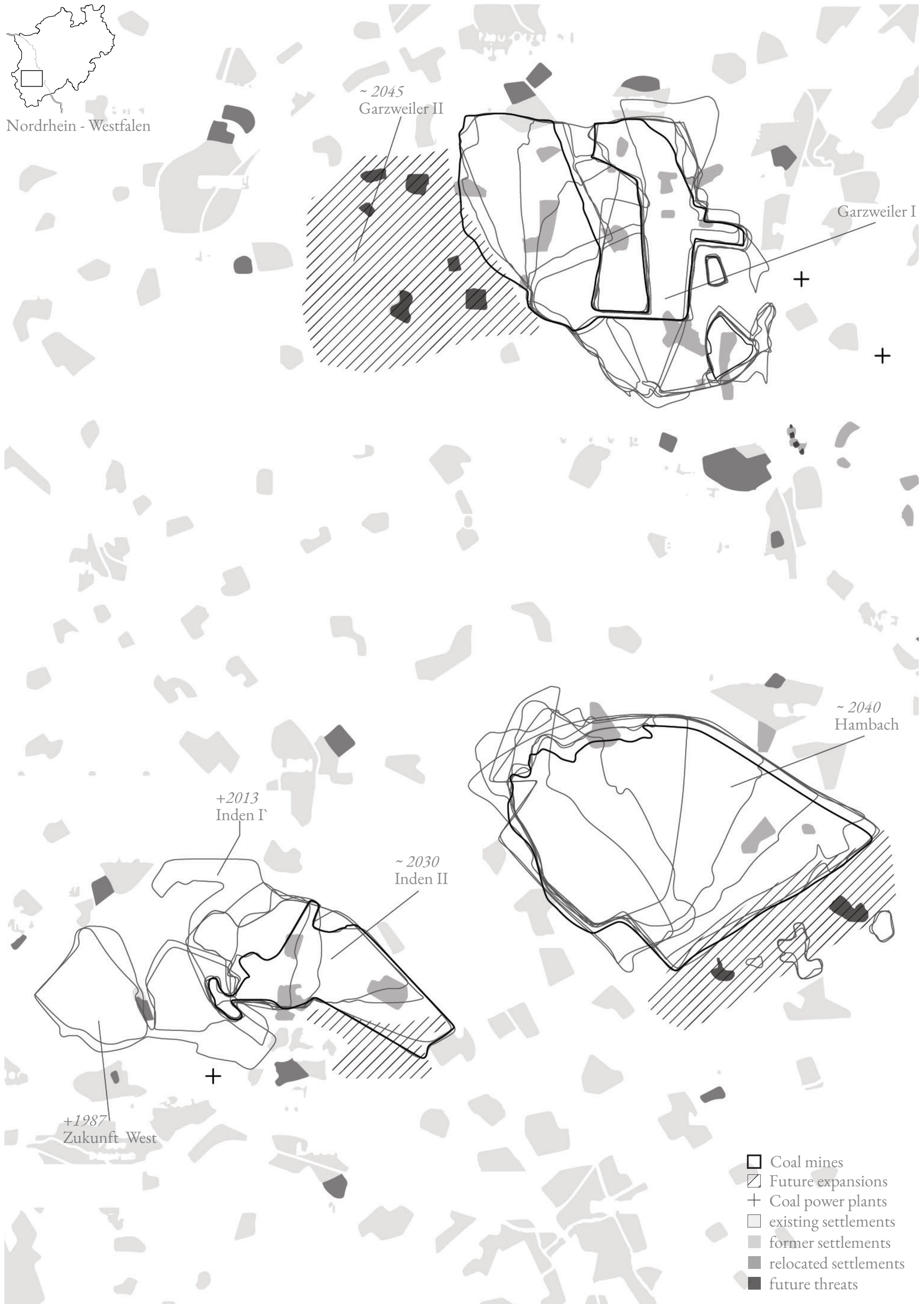


Fig 30. Topos composition

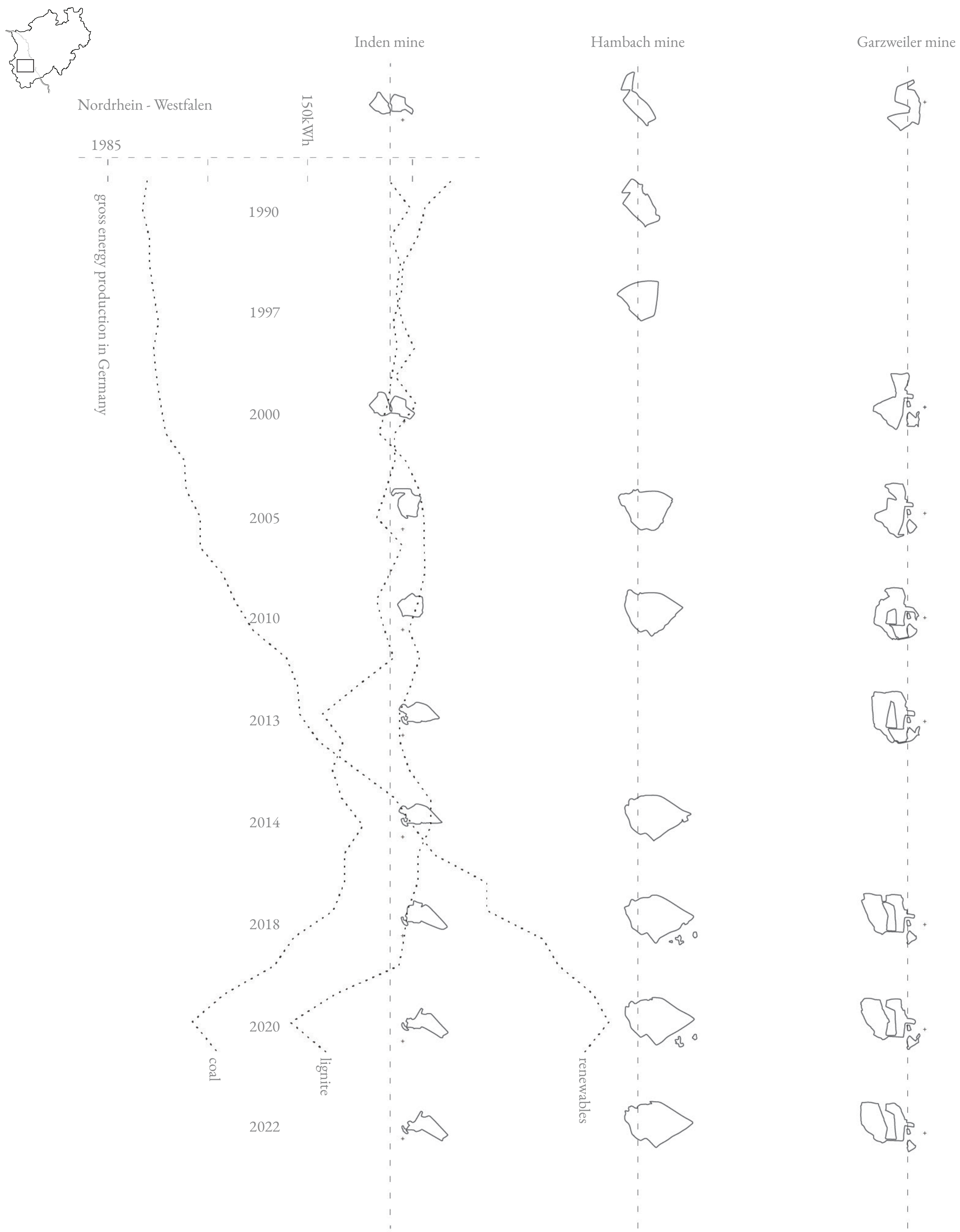


Fig 31. Topos alteration

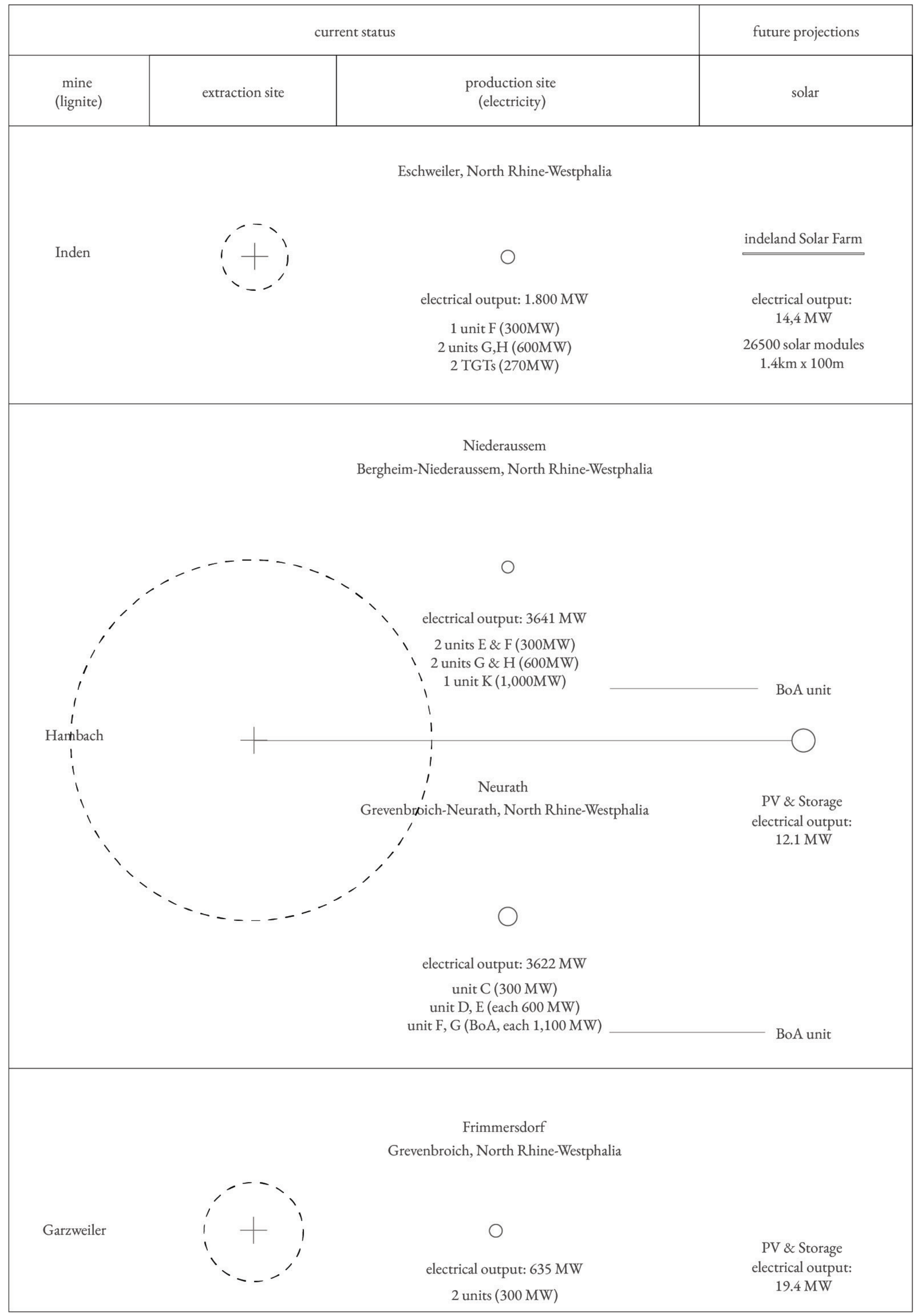


Fig 32. Topos Limits

HABITAT

The *Habitat* layer is the investigation of the interdependence between landscapes of coal-extraction and their surroundings as well as their impact upon them. The mines, harsh and strictly delimited, are subject to continuous movements, such as horizontal and vertical expansion, displacement of land and adjacent settlements, water pumping and diversion, as well as deforestation and tree planting. Each of these actions affects the environment to varying degrees, but it is the permanence of these impacts that shape the territory and greatly affects biodiversity.

The *Composition* looks at the land cover around the mines and focuses primarily on forests. Three different layers of forests, coniferous, broadleaf, and mixed forest are being identified and together with agricultural land and water shape a colorful mosaic, one that is bound to change its colors throughout the seasons. The *Alternation* drawing shows the tree gain and loss, from 2000 until 2020, and aims to uncover the primary drivers for this change. Around the mines, this change is more evident, as deforestation is required before extraction begins and usually at the end of the mine's life the areas are covered and trees are planted. *Limits* define spatial areas of possible threads and conflicts. For that three layers are being used, riparian zones, protected areas (Natura 2000), and forest landscape integrity index based on Grantham (2020).

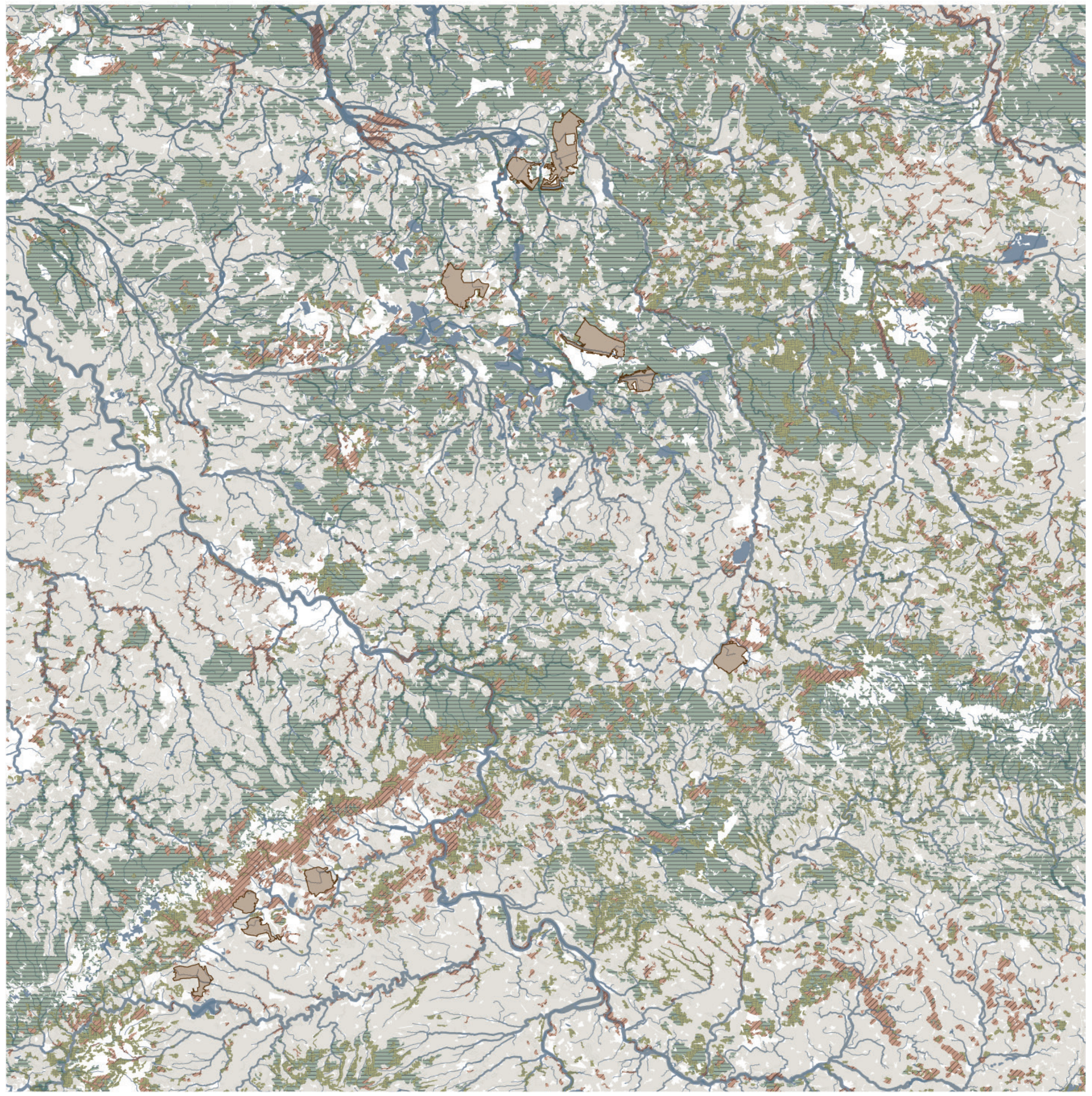


Fig 33. Habitat composition

Fig 34. Habitat alteration

Fig 35. Habitat limits

GEOPOLITICS

This is an investigation of the current coal/lignite socio-economic trends for the three countries, Germany, Poland, and the Czech Republic, and the transition that is gradually happening as coal mines and power plants close down.

The *Composition* map depicts current imports and exports attempting to trace the geo-dependencies around coal as an energy commodity. The *Alternation* map takes into account the future energy plans and deals, that revolve around Europe's effort to close the energy gap while shifting from fossil fuels to renewables. The alternated energyscape is a shift in the trading market, leading perhaps to the formation of a new era of geodependancies. The socioeconomic changes that will be triggered by the coal phase-out and the new energy deals, will change drastically the current labor market, resulting in high rates of unemployment, unevenly distributed throughout Europe. This transition requires fine-tuning so as not to leave anyone behind.

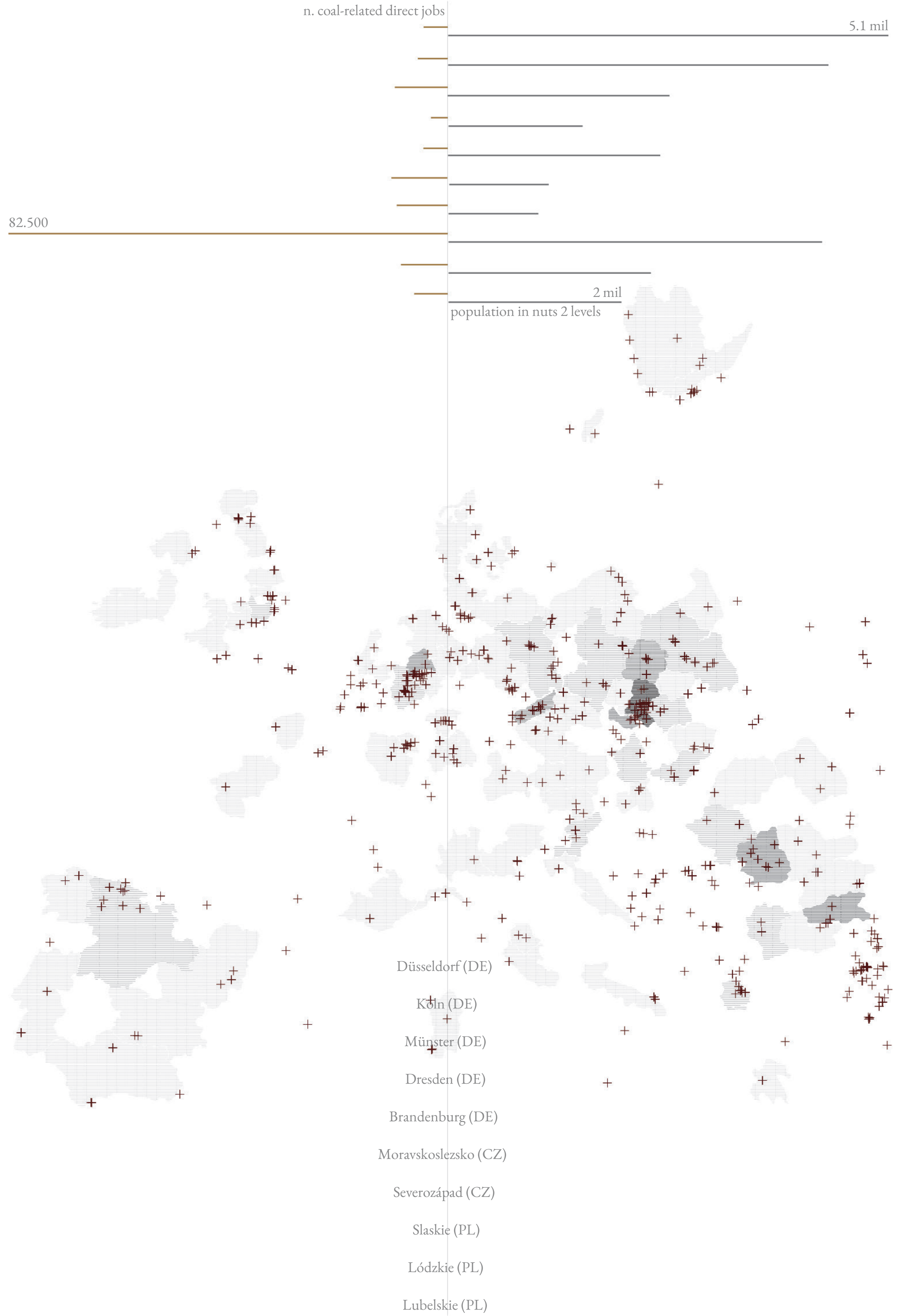


Fig 36. Geopolitics limits

Fig 37. Geopolitics composition

Fig 38. Geopolitics alteration

The explorations made clear the complexity of the coal phase-out. It is not only a transition in the energy (re)sources, but also one that shakes the current economy of coal regions and greatly affects other countries with which they conduct business. It will result in the decommissioning of facilities and settlements, it will spike the unemployment rates, and it will leave behind areas at great risk and in need of immediate regeneration. All the above factors are equally important and together they create a tapestry on which we need to work to reduce environmental impacts and any other negative consequences.

The elements that were explored are layers that shape the current territory and layers that have accumulated over time and put pressure on each region. What shall be the act of clearance? An act that comes by conceiving all the sites as part of one zone, that terminates 'violent' land uses and attempts to redefine the coal regions by scraping away their own identity.

This chapter gave an overview of the situation at hand, and although the drawings are mostly focused on Germany, the same approach can be reapplied to the cases of Poland and the Czech Republic. The multi-scalar approach of this thesis, that was even introduced at this very chapter aims to keep track of changes, risks, and opportunities that are happening because of the transition without fixating on one scale or location.

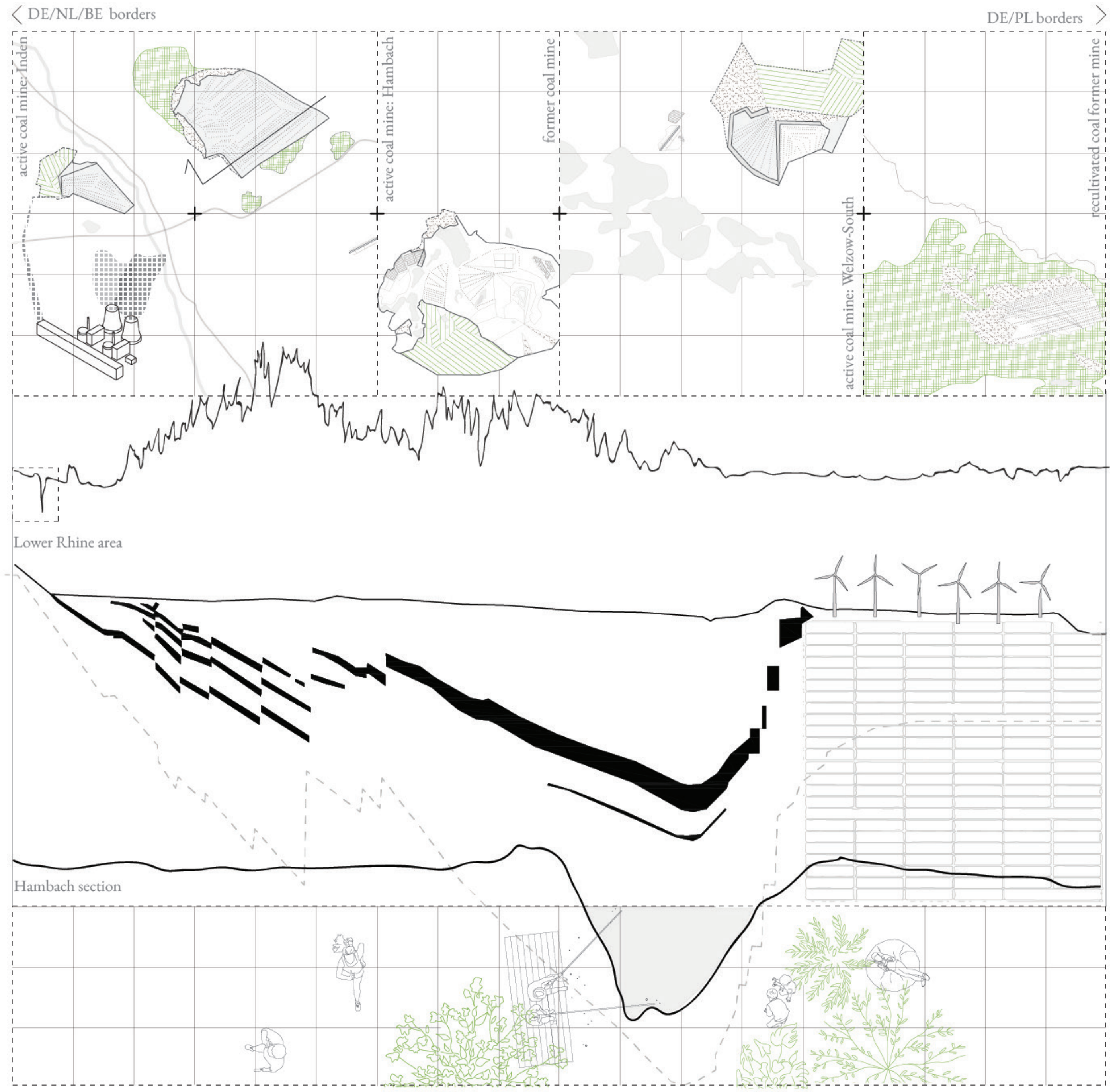
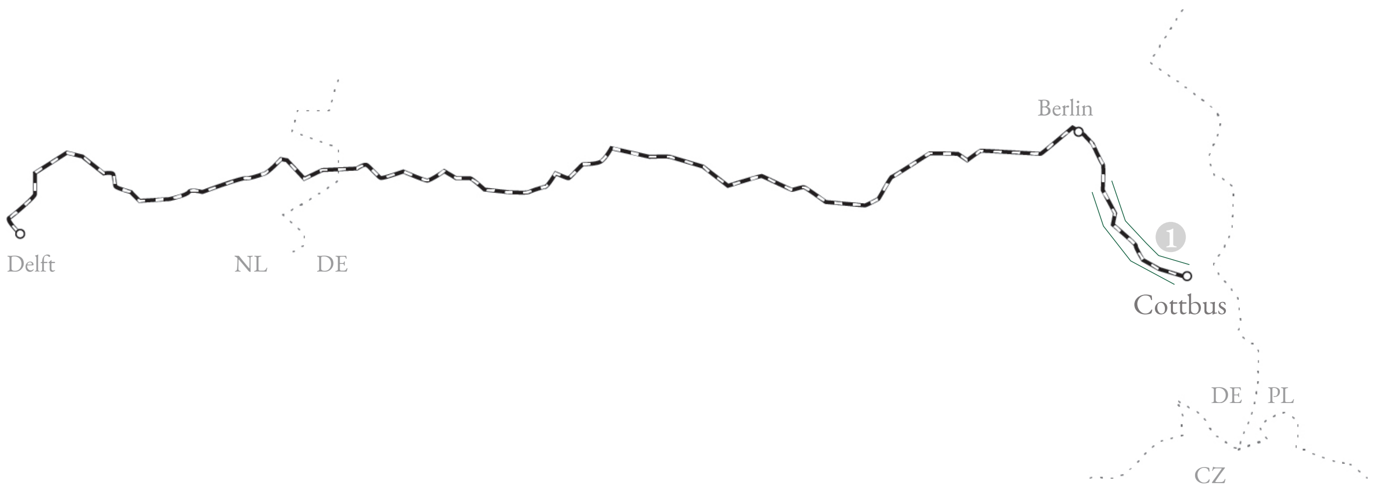


Fig 39. Early stage synthesis drawing


Berlin
1
Delft
NL
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Cottbus
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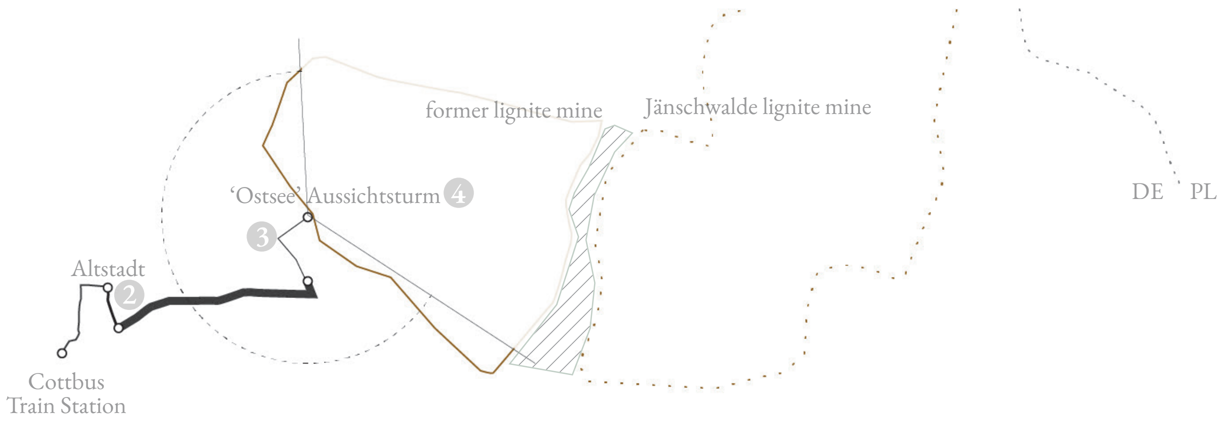
CZ


former lignite mine
Jänschwalde lignite mine
'Ostsee' Aussichtsturm 4
3
Altstadt
2
Cottbus
Train Station
DE
PL

The aim of the field trip was for me to visit the area that I would later design and grasp the conditions on site, gather material and perhaps interact with locals. Following my thesis's progress, it was postponed until after the p3 stage, for me to have a clearer idea and intentions for the sites. Due to specific conditions (budget, time) the trip to Cottbus was conducted in one day, thus the limited and targeted material. The main objective of the field trip was to document forests and the lignite mines. Unfortunately, the only accessible mine was the former Cottbus-Nord mine, which currently undergoes the transformation into an artificial lake, the biggest in the area. The operating mine Jänschwalde was 60km far from the farthest point that I was able to reach, and was inaccessible with the transportation means that I had at my disposal. As I am genuinely interested in this topic, I hope that in the future I will be able to visit an operating lignite mine.

Starting from Delft, Netherlands I traveled to Berlin and from there to Cottbus. The documentation starts from the train as the route from Berlin to Cottbus passes through an area rich in pine forests. I made videos from inside the train, and later extracted frames that show the rich and diverse landscape that I encountered. Some of the forest patches showed signs of forestry however the optical impact of this was to the minimum.

In Cottbus, the first stop I made was the town center, from where transportation to the former mine starts. After consulting the operating company of the two mines, LEAG, I decided to visit the *"Ostsee" Aussichtsturm Merzdorf*, an observation tower on the edge of the former mine that would allow me to observe the overall area and take photographs. As the mine and the tower are outside the town, I was able to pass through some suburbs and the industrial part of the town, and later to also have a stop at one small, fragmented pine forest nearby the tower. From the closest bus stop in the area, the tower was 30min walk, parallel to a regional road. It was of course not a pedestrian-friendly route but was manageable by walking practically through private properties without fences. After a while, the route made a turn, and at this point, I walked through a patch of pine forest, that had signs of a privately owned plantation (trees were marked with paint, different colors probably highlighting trees for harvesting and others for thinning purposes). The tree cover was not dense, with an approximate height of 6-7 meters. Continuing along the regional road, I found myself in a road ring, where the national road passes through, defining small fragments of pine forests. The former mine was not accessible and there were signs instructing people to stay away and pay attention as the area is being gradually flooded. Underneath the observation tower, there was a large container where visitors could take a rest and cover from the wind(!) and go through the hung panels and posters with historical data and plans, materials that was provided by the company that operates the mine and is responsible for its reclamation.

Given the site conditions on the day of my visit (extreme wind, temperature around -1o C, and light rain) there were still some visitors, that would arrive either by car, bikes, or on foot. A family of four with a car, an elderly couple with e-bikes, and three elderly ladies on foot, climbed up the tower and then left, without entering the information kiosk (container). All three groups were speaking German and from what I overheard the three ladies were living nearby and were doing this frequently as an outdoor activity. On the top of the tower, I was able to take photographs but unfortunately, the operating mine was not visible, as a thick patch of vegetation was in the in-between and the mine operations are below the tree line. The point from which the water from Spree enters the mine was visible, as well as the nearby coal-fired power plant *LEAG Lausitz Energie Kraftwerke AG - Kraftwerk Jänschwalde*. They were also many wind turbines extruding from the forest patches. A pool of water is already forming in the former mine and at some points covers tree seedlings (pines).

I followed the exact same route back to the Cottbus town center. While walking to the bus stop that could take me to the city center, I saw more people on foot walking (recreation). It was hard to define the boundaries of the settlements, as they were giving the impression of a continuous fabric that was interrupted only by patches of forests and industrial entities. However, the absence of commercial activities suggests that these settlements depend highly on the Cottbus town. Before my departure back to Berlin, I spent some time walking again in the town center. It was a working day (Monday) between 14.00 and 16.00 local time and in combination with a small tour I did in the morning upon arrival (12.00-13.00) I observed the following: the town center was quiet, especially in the morning, when the people I encountered were mostly elderly, and were either heading from/to a market. Having a small coffee break in a local cafeteria, one of the few open places I found, I noticed again that the clients were mostly groups of elderly women. The afternoon tour was a little bit more vibrant, as school kids were walking around the center.

The town still brings up elements from its socialist past (DDR – or German Democratic Republic), and this is evident in architectural and urban scales. The mural by Heinz Sieger with the title *'Aus dem Spreewald'* made in 1969 is a representation of life in the area during these times. Nowadays is a reminder of the cultural, historic, and collective memory of the area, where people were firmly linked to the countryside. Another interesting observation/finding that I made even from the train journey to Cottbus is that all signs and notifications were made in two languages, German and Sorbian. This can be attributed to the remaining Sorbian populations in the area and it is a fact that was unnoticed before my field trip. In conclusion, the trip helped me understand the scales and characteristics of the area and better understand the social aspects of my research.

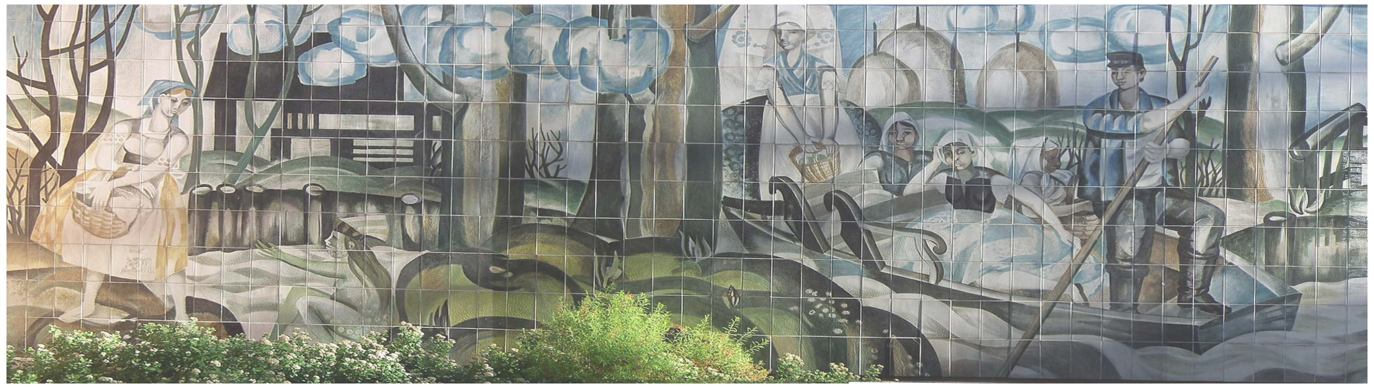


Fig 40. Mural "Aus dem Spreewald" by Heinz Sieger

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Fig 41. Forests between Berlin and Cottbus | Video stills

Fig 42. Cottbus 01|02

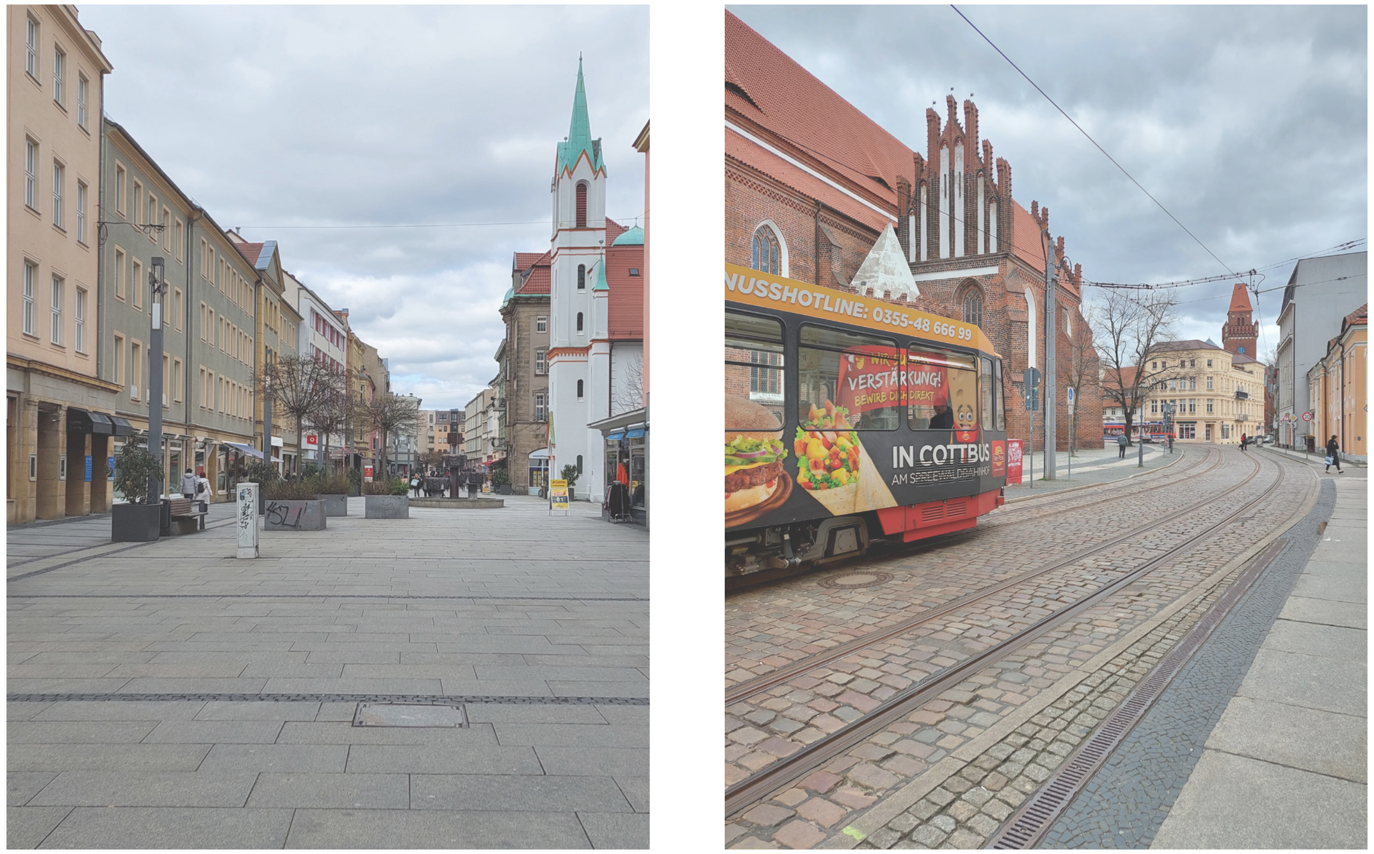


Fig 43. Cottbus 03|04

Fig 44. Settlements and forests 01

Fig 45. Forest fragmentation 01


Fig 46. Mono-culture pine forest 01


Fig 47. Mono-culture pine forest 02

Fig 48. Harvesting timber

Fig 49. Thinning and Harvesting

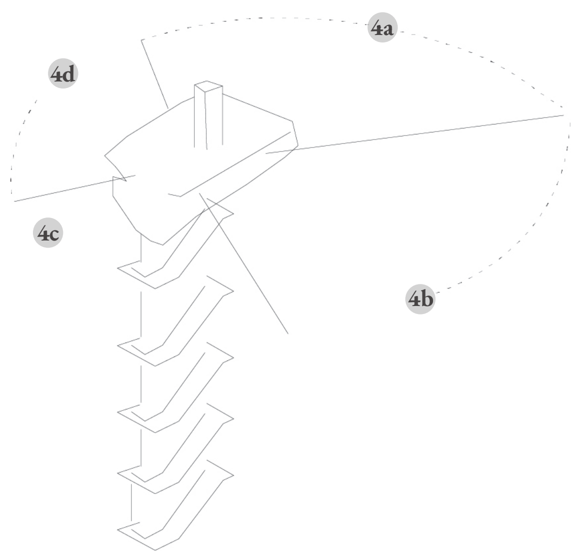


Fig 50. Observation tower - picture diagram

Fig 51. Artificial lake vs pine forest

Fig 52. Coal power plant LEAG Lausitz Energie Kraftwerke AG - Kraftwerk Jänschwalde

Fig 53. Energy transition

4b

Fig 54. Pine Plantations

Fig 55. Work on progress

Fig 56. LEAG Lausitz Energie Kraftwerke AG - Kraftwerk Schwarze Pumpe

Fig 57. Forest fragmentation 02

Fig 58. Settlements and forests 02

Fig 59. Forest fragmentation 03

Fig 60. Forest health

Fig 61. “Coal shores”

Fig 62. Memorabilia

"A dialectic of devaluation and renewal today produces profound and varied transformations in both built and unbuilt environments. ***Global economic restructuring has led to the decline and abandonment of urban environments in shrinking cities but has also engendered new forms of social relations and new models of self-organizations.*** *In other locations, vacant, underused, or foreclosed properties emerge as loci of tension in processes of transformation, as activism and insurrection rise in opposition to speculative capitalism. The programmed obsolescence of buildings produces erasures in built environments that rack communities with cultural loss, while also offering the possibility for more progressive forms of social and ecological relations. Areas of industrial decline may become sites of effervescent biological productivity [...] We find, for instance, that land abandoned by large-scale logging and agriculture has become a key focal point in an expanded project of biodiversity protection that emphasizes industrial hinterlands rather than pristine natural areas. [...]* ***this highlights the contemporary interplay between proliferating contexts of decline and corresponding efforts to recapture neglected and marginal spaces to restore social, ecological or economic capacity****.*
[...] seeks to open a conversation exploring this set of issues and in particular, the tension central to this dialectic: ***the hinge between devaluation and revaluation. This hinge is both process and condition. As a process, forces of transformation unfurl at different scales and across diverse geographies, producing variegated social and ecological relations. As a condition, the moment of pause – of fallowness – is replete with potential to forge new social and ecological relations.".***

Chieffalo, M., & Smachylo, J. (2019). New geographies 10 Fallow. Harvard University Graduate School Of Design.

To this point the thesis has documented through different scales and sites, the current status of the coal regions and has already established the need for a transition, one that reinvents carbon economies building upon the wood economy. It bases this approach on the fact that the wood economy is not only more sustainable but can drive us further away from fossil fuels and the continuation of exhausting our planet's resources. Apart from the obvious role of forests in the wood economy, acting as the resource fields, this thesis draws away from a purely operationalizing interpretation of forests and acts on behalf of forest and biodiversity corridors. For that, in this project forest growth does not mean maximizing wood production and profit, but aims to balance supply/demand and the protection and sustainable growth of forests.

At the same time, forestry is a driver for rural development and growth (Borges et al., 2014), and that can counteract the depopulation and shrinkage that the coal regions are witnessing, which will be further discussed in this chapter. So, looking at a greater context, coal regions, forests, and shrinking, are the three prerequisite elements that can foster a new perspective into the carbon economies and more specifically the wood economy. Based on that understanding, the thesis will explore in this chapter this dual challenge: forest growth and the retreat of the built environment, which forms the base for the wood economy to start.

To unpack this dual challenge, I zoom in on the scale of the transboundary area and then even more on the scale of the German cluster of mines. The material presented in this chapter shows the history of the area through the lens of the chapter and present current conditions so that we can build upon them in the following chapter through the strategy and design.

Fig 63. "Cottbus, von der Westseite", Robert Geissler, Lithography, 1875

Fig 64. "Cottbus, Gesamtansicht von Südosten", Henning (gez.), Hans Finke (gest.), Lithography, 1841

FORESTS

[Reservoirs]
A component or components of the climate system where a greenhouse gas or a precursor of a greenhouse gas is stored. Trees are "reservoirs" for carbon dioxide.

[Sink]
Any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere. Forests and other vegetation are considered sinks because they remove carbon dioxide through photosynthesis.

[Carbon Sequestration]
The process of removing carbon from the atmosphere and depositing it in a reservoir.

[Planted forests, forest plantations or industrial forest plantations]
The cultivation of trees that result in the satisfaction (direct or indirect) of human consumption needs.

[Afforestation]
The establishment of a tree crop on an area from which it has always, or for a very long time, been absent.

[Reforestation]
The establishment of a tree crop on forest land.

Glossary from Borges et al. (2014) and Evans (2008)

In this subchapter, forests will be seen as a source of raw material, an economic agent that fosters growth, employment, and human development, on top of their role as mechanisms that promote environmental restoration and services, while mitigating climate change.

In the bibliography, industrial forests as often mentioned (plantations meant for forestry), are characterized as efficient and sustainable industrial developments. According to Borges et al. (2014) plantations produce highly demanding products with minimal negative collateral impacts, based on the principle that trees synthesize carbon fueled by sunlight, while on a greater scale, forests can reduce the impact of other natural recourses and especially fossil fuels. With this in mind, planting trees responsibly means that we not only care for nature but also humans, as they provide sources of raw materials for a plethora of uses, from wood fuels to forest products such as resins, food, sawn wood for building, etc. Historically forests have always been drivers for economic growth, but how can this be integrated into the context of the coal regions where the coal phase-out will trigger unemployment and depopulation? We should consider the aspect of forest growth as an agent of socio-economic development, because even from the early stage plantations boost local employment, from nursery production to plantation tending. Another important element to consider in favor of the establishment of wood economies in the former coal regions is the demand for forest products and specifically for industrial products for the built environment. Sustainable forestry could contribute to less CO2 emissions derived from current practices linked to the construction sector. It is projected that the wood demand might even be quadrable by 2050. In that matter, sustainable forestry could not only balance this demand but also protect forests from illegal/uncontrolled logging. Overall, it is anticipated that this new establishment will have immediate advantages in the socio-economic status of the regions explored.

When compared to naturally-regenerated forests, plantations are relatively simple biological systems with fewer species and most probably even-aged stands, characteristics that simplify and facilitate the harvesting and management techniques (Borges et al., 2014). However, as this thesis aims for balanced, sustainable growth it looks at ways to boost and protect existing forests, that due to anthropogenic disturbances experience biodiversity loss, thus it also suggests the establishment of biodiversity corridors as referenced literature draws connections between vegetation and animal diversity. The biodiversity corridors pose a solution to the forest fragmentation that can be traced all over Europe but also in the regions studied in this thesis.

Another important aspect to mention is that as forests and wooded lands cover around one-third of the planet, they are a significant component of the C stored in the terrestrial biosphere and thus play a significant role in the global cycling of C and the carbon storage in soils. Thus, forest management has the potential to conserve and sequestrate C and could assist in stabilizing greenhouse gases, by reducing C emissions from soil and increasing C sequestration in soil, and the introduction of agro-forestry and alternative land-use systems on degraded and marginal lands could also have significant results (Evans, 2008).

For all these reasons, forests, biodiversity corridors, and new plantations pose an important element in the regeneration of the coal regions. They act not only as a way to regenerate ecosystems and bring back balance, but they have a great impact on climate mitigation through carbon cycles, by reducing emissions in the construction sector, and by offering alternative fuels like biomass. At the same time, forest management and the wood economy revitalize rural regions by boosting employment and economic growth.

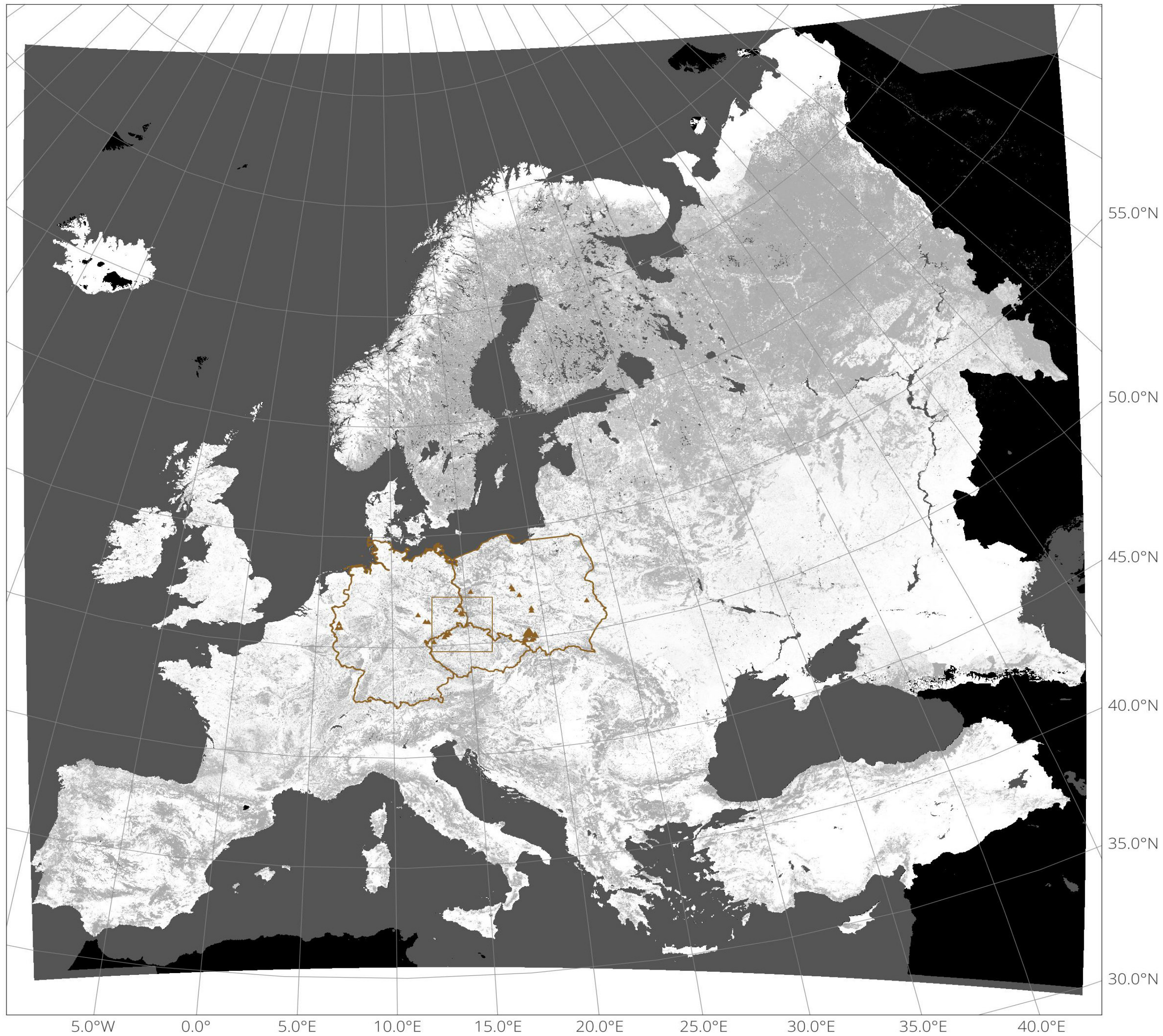


Fig 65.The Forest Map of Europe (2011) courtesy of European Forest Institute edited by author
Source found in Datasets chapter

Before diving in the current conditions in the area, we should have a look at its rich history, especially as it has a long history linked to environmental crisis. The **Black Triangle** area could pose as a transboundary example of pollution that resulted in severe environmental degradation. Also known as *"Schwarzes Dreieck"*, it is a mountainous area shared by the three countries that this project investigates.

Lignite extraction can be reported back in the 19th century, and it developed rapidly along with heavy and chemical industries after World War II. The *"brown coal belt"* as it is referred to, lies in the center of this area, from **Lower Silesia** (Poland) to **South Saxony** (Germany) and **North Bohemia** (The Czech Republic). As heavy industrial activities intensified during the socialist era, they generated high levels of Sulphur dioxide (SO_2) and nitrogen dioxide (NO_2). These pollutants were trapped for long periods under a layer, created by the temperature inversion that traps ashes and gases under layers of warm air. The result – acid rain – led to water and soil acidification and human health problems. Emission sources could be dated back to industrial areas such as Most, Chomutov, and Ústí nad Labem in the Czech Republic and Zwickau, Chemnitz, Dresden, Plauen, and Elsterber in Germany.

The top parts of the mountains faced the worst forest damage. Between 1972-1989 50% of coniferous forests in the Ore Mountains disappeared. The most affected areas were south and south-east. The deforestation rate started from 26.7km2/year to 7.8km2/year in 1989 and unfortunately, only 26% of Bohemian forest, 45% of Saxonian forest, and 22% of Silesia forests remain undamaged, as the needed clearcutting that occurred cut down 30.000 hectares of forest.

Mentioning this to highlight the history of environmental degradation that occurred in the area and continues to exist, with less evident results. As ecosystems are already altered, they are vulnerable and while coal extraction continues, the threat is even higher. The forest damage was significant and scars are open, thus the post-mining landscape and the ongoing and future actions to reclaim these sites should bear in mind this (European Environment Agency, 1999) and (Strub, 2002).

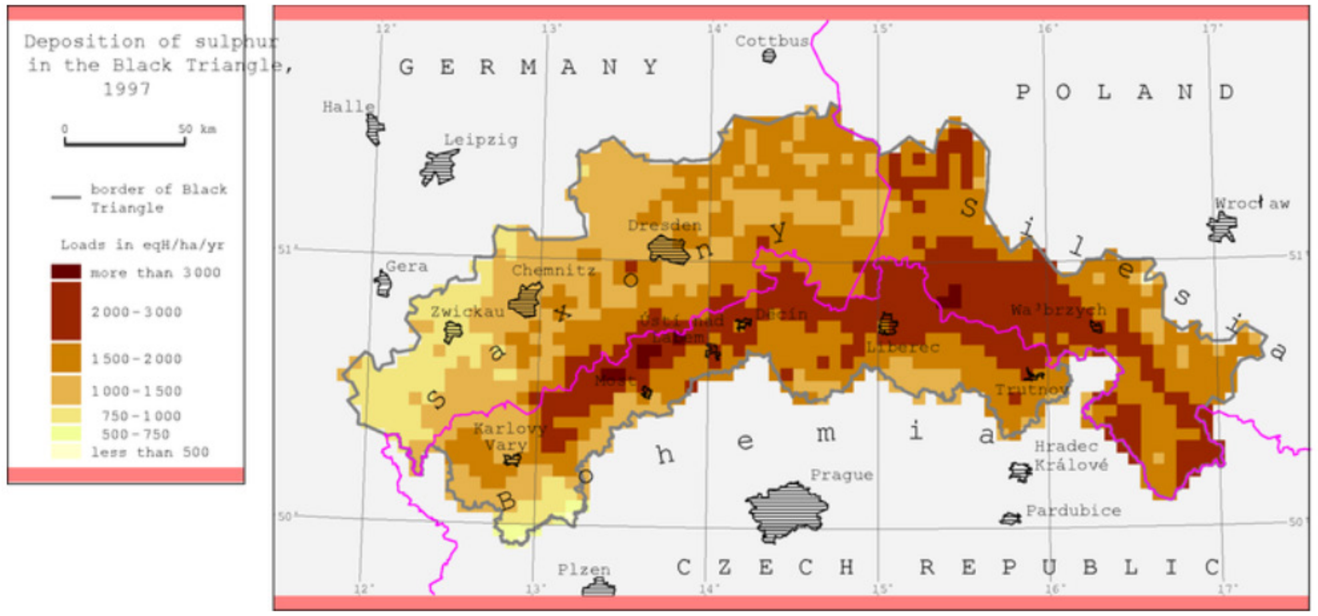


Fig 66. Black Triangle area

The reclaiming process of a post-mining landscape usually falls under the responsibility of the operating company, however specific national and European laws must be followed. In most cases, other specialists are outsourced to bring in innovative ideas and take care of the reclaiming stage. In the case of Lusatia (scale 3: cluster of the four German mines), where one company (LEAG) has the responsibility to take care of four mines, the stakes are high.

According to LEAG, open-cast mining areas can offer a new habitat for species. Given the poor nutrient soils, only specific species can exist there. First birds and then insects like spiders, butterflies, and beetles, gradually come back, with efforts being concentrated on bee colonies. It is reported that more than 200 bird species have been claiming the recultivated areas in Lusatia (Hertzer, 2021).

But what is the future for these recultivated areas? In the Lusatia region, of the 28.839 hectares of mining land, now 13.727 hectares have been recultivated and 3.632 hectares are devoted to agricultural use. With the current management system, farmers from the region can work on the land on behalf of the mining operator, and in the future, the land will be available for lease. An interesting crop used in the first test sites around Reichwald mine is hemp, a plant that seems to adapt well to Lusatia. Near Nochten mine different lavender varieties and Szechuan pepper have been planted and other plant experiments include apple trees, vineyards, and chestnuts. However, one major factor that seems to impede these testing sites is the winter frost (Schirmer, 2020).

Moreover in the heart of the Jänschwalde mine protected species have found a new habitat. This effort however happened with the anthropogenic factor involved. As mentioned in the article, after Germany's reunification all mines had to be restored – however the initial approach to be left untouched didn't succeed, thus human action was needed to create nature conservation areas in the dumps. According to legislation, the mining companies are obliged to re-cultivate the areas after the end of extraction. Through renaturization, a colorful meadow with rare plants is now emerging. To accomplish this, a method called *"Mahdgutübertragung"* is used where cuttings from other species-rich meadows, strictly in the areas around the mines are put on top of the bare earth dump sites, and over time seeds sprout. In the case of the Jänschwalde mine, mowing material is arriving from a nearby vineyard in Guben (Graetz, 2015).

Fig 67. Ready to be harvested hemp

Another site around Reichwalde mine tests the cultivation of Miscanthus (also known as giant Chinese reed grass). This test site is under the EU project MISCOMAR+, an initiative that explores the role of Miscanthus as a bioenergy plant in Marginal, Contaminated, and industrially damaged land (MaCL). The research claims that it is a robust plant with biomass use, but also favored for its high rate of carbon absorption compared to other cultivated plants. In addition, while processing the plant, several ingredients can be extracted that can be used in the paper and packaging industries (Schirmer, 2021b).

Concerning the afforestation that is taking place in the Lusatia region on behalf of LEAG, specialists are ensuring that the forests to be, must have species resilient to the local conditions. Let's take the case of the Cottbus Nord mine, where mining operations were concluded in 2015. Operations to transform the mine into the lake "Cottbuser Ostsee" are already happening, and required 20mil cubic meters of earth to be placed on site for the bottom of the lake. At the same time, a forest is planted. The first seedlings came from a nearby forest nursery in Liebenwerda and they will be translated into 190.000 trees and bushes located at the lake banks and more trees to come to create a 70-hectare forest. In the overall afforestation, tree species like pine, birch, and aspen are favored for the given soil conditions whereas for parts with more nutrient soils Sessile, pedunculate and red oaks could be planted. At the peripheries and edges of the new forests, shrubs will be planted, like hornbeam or lime tree (Schirmer, 2021).

Also, the afforestation process taking place in Cottbus-Nord involves three machines that work with the soil and six workers (two workers per machine) and the outcome is half a hectare (around 3000 trees) per day. Specialists hope that 80% of the planted seedlings will make it to trees. In total, the mining company aims for a total of 141 hectares of forest, with 30 he in Cottbus Nord, 12 hectares in Jänschwalde, 20 hectares in Nochten, 49 hectares in Reichwalde, and 30 hectares in Welzow-Süd. The company claims to have a total of 7.500 he of forest in the area of Brandenburg and Saxony. (Schirmer, 2021).

The above gives the hope that the post-mining landscapes are being treated, hopefully with care. If the mine operator turns to come true to the objectives that have been set, then mixed, robust forests will emerge helping biodiversity growth, while fostering agricultural and forestry activities (wood and non-wood). Nearby societies could benefit from these activities they could pose as an economic driver in a depopulating and shrinking rural region.

Fig 68. Reclaiming land for agriculture

Reclaiming the post-mining landscape
How to grow a pine tree?

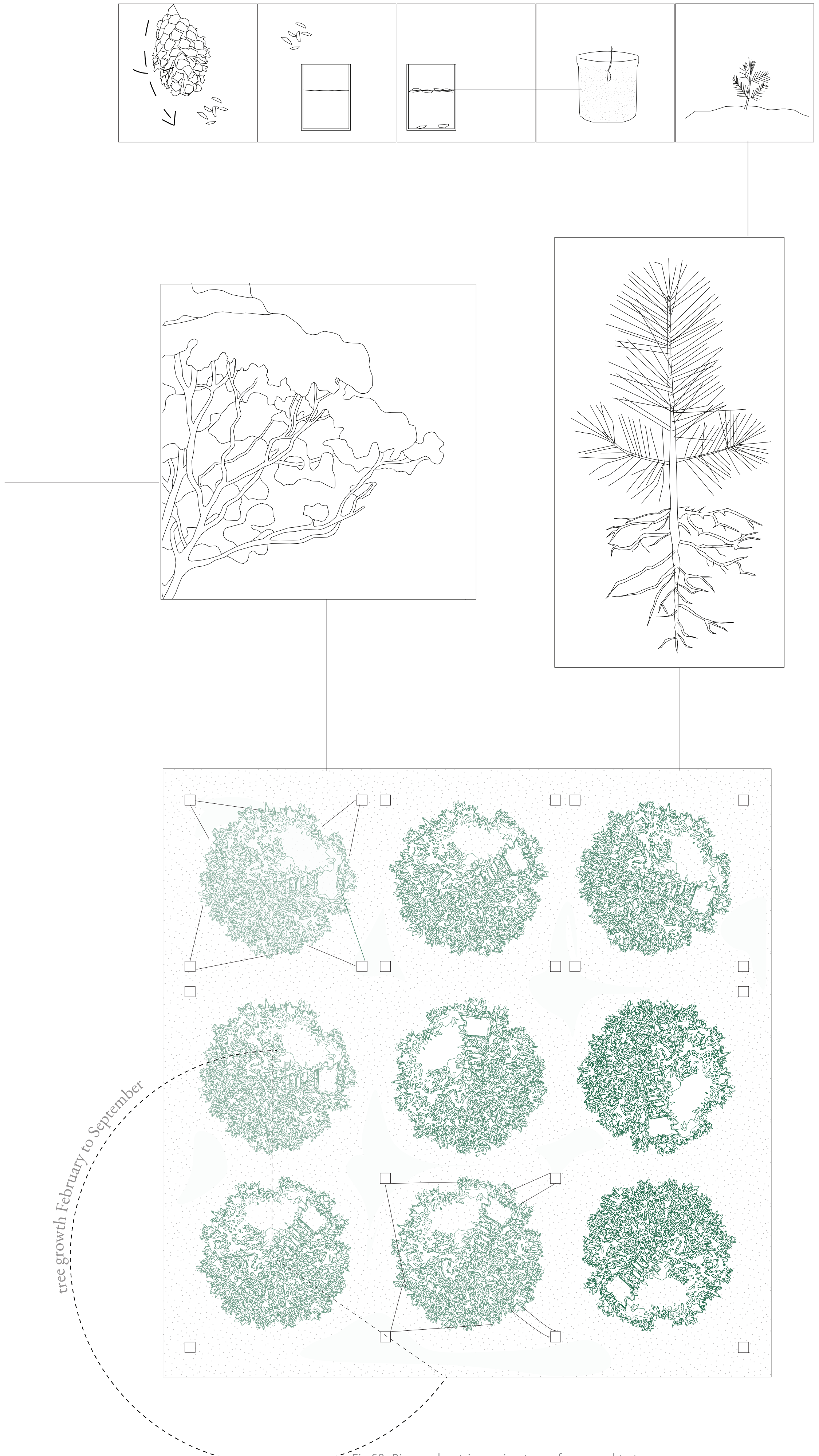
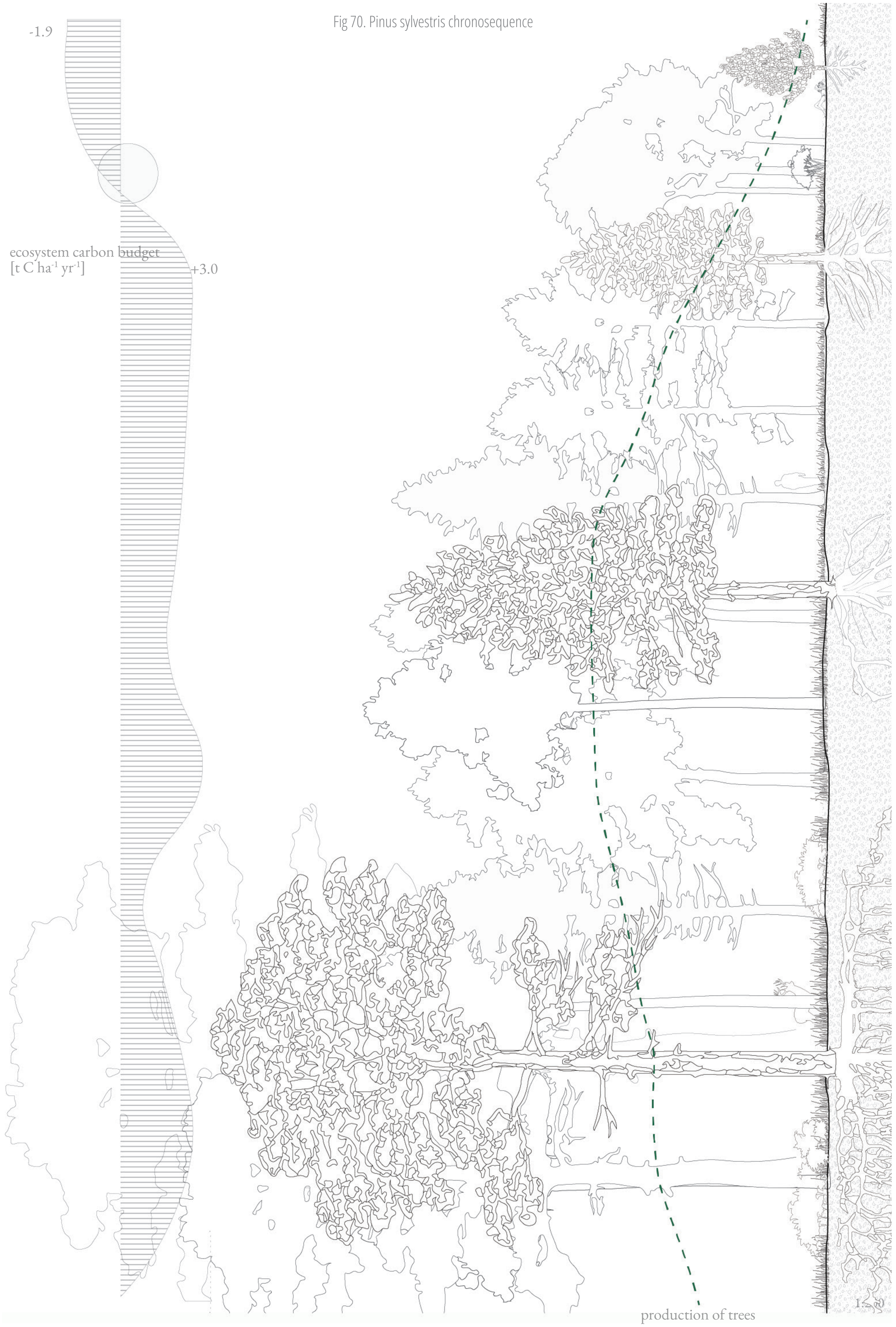


Fig 69. Pinus sylvestris or pine tree - from seed to tree

Fig 70. Pinus sylvestris chronosequence



Reclaiming the post-mining landscape

Carbon storage, fluxes and plant growth
in in scotch pine chronosequence

According to FAO (2022) “increasing sustainable forest use, and building green value chains, would help meet future demand for materials and support sustainable economies”. Current trends suggest that the annual global consumption of natural recourses (biomass, fossil fuels, metals, and minerals) is expected to more than double by 2060, putting at great risk natural resource systems including forests. From another report (FAO - Forestry Economics and Policy Division, 2009)the main drivers for this global demand specifically for wood were demographic changes, economic growth, regional shift, environmental policies and regulations, and energy policies. Another important element in this demand is the decline in harvesting from natural forests and the emergence of plantation forests as the major recourse field for wood products. A more recent report from FAO (2022) highlights further the demand for forest-based biomass driven by the construction sector - wood products are linked to lower greenhouse gas emissions over their lifecycle - which is expected to triple and for the packaging industry which will double. To sustainably meet these demands requires actions that will continue to increase forest areas and manage sustainable forests in ways that could support a green recovery and a transition to carbon-neutral economies.

According to FAO (2022):

> *“Forest Pathway: A development approach involving forests, of which the following three are identified in SOFO 2022: (1) halting deforestation and forest degradation as a crucial element for reversing the drivers of climate change, biodiversity loss, land degradation, desertification and the emergence of zoonotic diseases (2) restoring degraded forests and landscapes and putting more trees into agricultural settings as cost-effective means for improving natural assets and generating economic, social and environmental benefits and (3) increasing sustainable forest use and building green value chains to help meet future demand for materials and ecosystem services and support greener and circular economies, particularly at the local level.”*

To conclude, given the growing global and European demand for materials coming from forests, it is very important to sustainable approach to the matter, by increasing forest areas, restoring degraded land and further developing economies based on these forest products. To contextualize this to this thesis, the coal regions will undergo significant changes, especially in land use. The future of the former mines depends on their location, their condition, and the operators is different and they can be transformed into lakes, forests even agricultural land but it is important to consider these new fragments of land that we will inherit from the coal phase-out as an opportunity to meet global demands and societal needs, but in a more sustainable and a circular way, that promotes the importance of the natural ecosystems. ***For that, this thesis supports that the gradual planting of the mines with the aim to create forests is far from an aesthetic approach and a contemporary post-mining reclamation project, but thinks of ways to meet current and future demands and support rural development while in the long term supports actions mitigating climate change (net zero future).***

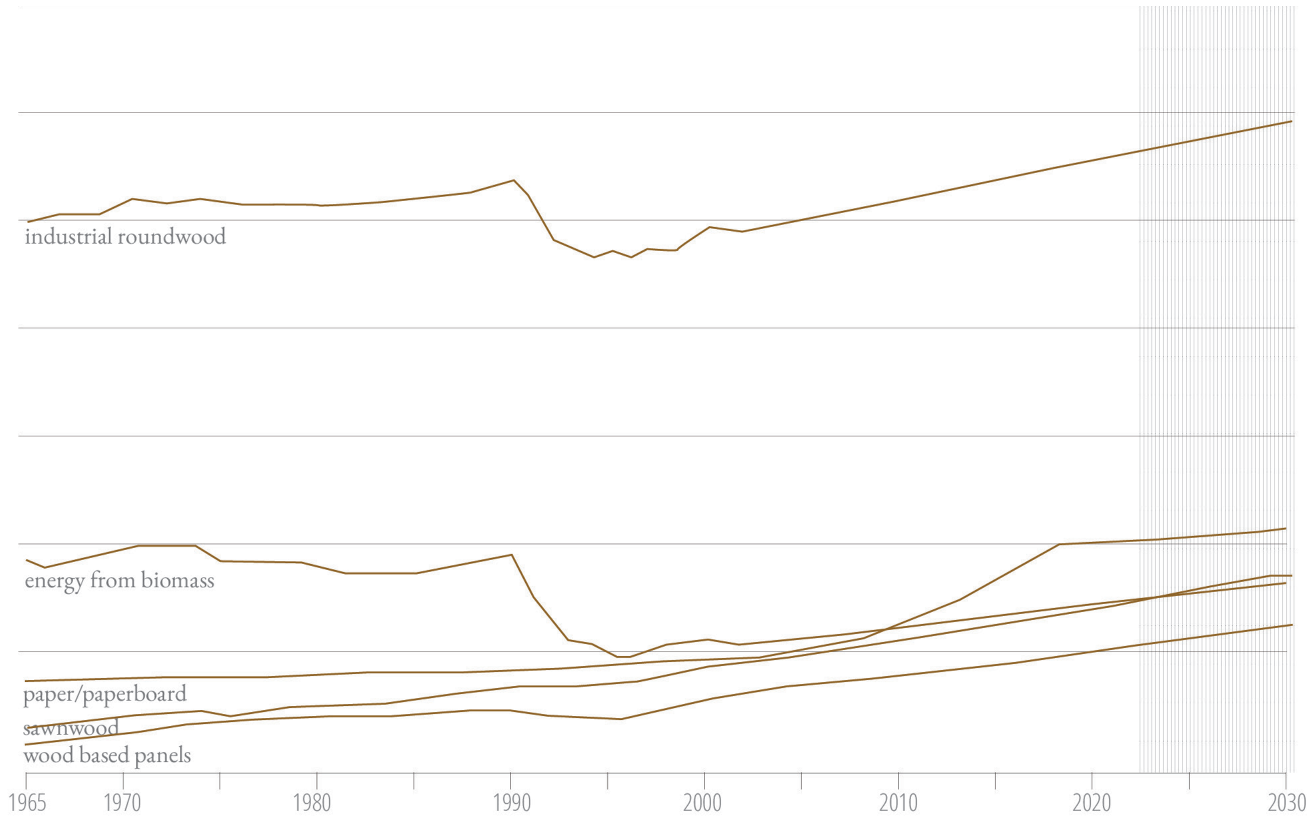


Fig 71. Europe’s demand for wood products (production trends)

RETREAT

"The term "fallow" as a metaphor to examine this critical juncture in cycles of devaluing and revaluing built and unbuilt environments. In agriculture, fallowing is understood as a process of restoring latent ecological capacity through periodic idleness. NG10 proposes to extend this concept to a much broader spectrum of conditions, including many that are not immediately associated with crop rotation, but which are inscribed in diverse forms of devalorization and revalorization associated with geographies of industrial capitalism. *Lack of productivity in urban contexts, for instance, is often described in such negative terms as abandonment, marginality or wasteland, circumstances often produced through industrial exploitation. What insights might be gleaned from viewing the dynamics that shape sociospatial and socioecological relations in this and other contexts by instead using fallow as a lens?* .

Chieffalo, M., & Smachylo, J. (2019). New geographies 10 Fallow. Harvard University Graduate School Of Design.

Conclusions from the URBACT, a project by the European Union: ***"Cities must learn to conceive of sustainable urban development as an ongoing cyclical process of change, rather than pretend that socio-economic development is a linear and predictable progression from the status quo to a better future".***

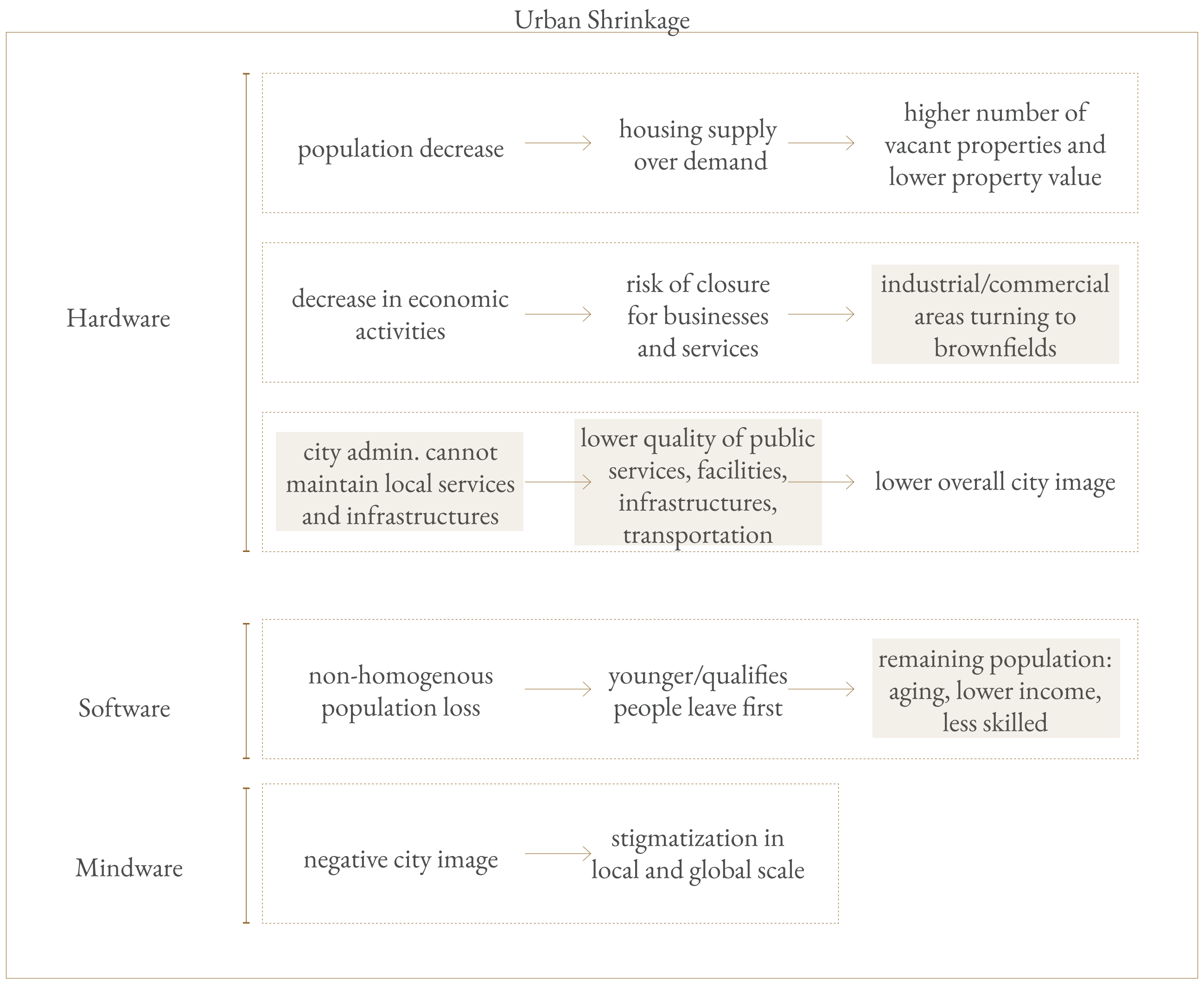
Cutieru, A. (2021, July 12). Shrinking Cities: The Rise and Fall of Urban Environments. ArchDaily.

According to a publication by European Commission (Aurambout et al., 2022) in the next 30 years demographic change will result in a higher number of shrinking cities, a challenge affecting almost every European country. But this is not something new. Over the years, cycles of growth and decline affected many cities, triggered by various reasons, such as historical, social, economic, demographic even political factors. Often, driven by the fact that globally the population is rising, an impression that all cities can grow too is created, however, that is false.

Looking at Europe, between 2001 and 2011, more than a quarter of the FUA (Functional Urban Areas) shrank, mostly affecting Eastern Europe, Balkan, and South Italy. For the years 2011-2018, the shrinkage continued to grow leading to a 23% decrease in population in the affected areas. The report states among others that by 2050 Germany might face a significant decrease. In that context, it is important to anticipate such conditions in the design area of this project (Aurambout et al., 2022).

Shrinking cities in Europe have been greatly linked to deindustrialization (also aging and population outmigration) however it is of paramount importance to comprehend this urban shrinkage as a result of many different factors happening at many scales, from local to global. A possible combination of these factors could potentially reinforce the effect, causing even greater shrinkage. The effects of shrinkage can be visible in the built environment -*Hardware* (infrastructures, buildings), in the socio-economic and demographic fabric – *Software* but also in others – *Mindware,* showed also in the graph next (Aurambout et al., 2022).

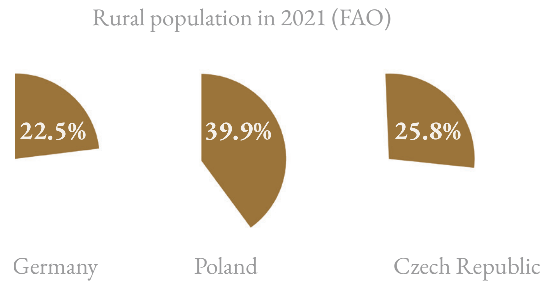
There are many ways and measures that are suggested to counteract this urban shrinkage, however in this project, one is looked in depth; ***Economic diversification, or the re-orientation of the current economic activities.***



Another similar approach begins the conversation on urban shrinkage and urban decline by breaking the misconception that urban planning is based on continuous demographic and economic growth and attempts to showcase cities that recover or try to based on top-down or bottom-up approaches. Again, in that context, the urban decline is caused by deindustrialization, migration, and population change but also following the depletion of natural resources and thus the extractive activities. It recognizes this phenomenon as a global challenge and identifies two distinct pathways, ***re-imbracing the de-urbanization through methods like deliberate rightsizing and shrinkage***, or re-inventing the city under new premises mostly through arts, culture, or tourism. The first direction, embracing re-urbanization, ***calls for drastic measures that revolve around downsizing the city to its real, current needs, be demolishing properties that are abandoned or derelict with the aim adapt to the new condition and the current population needs.*** However, these drastic measures can bring up issues of social justice, sustainability, and equity. An interesting example is located in Leipzig, where in 2004 an agreement was reached by architects, planners, and residents to stop paying rent with the obligation to protect the properties from vandalism and carry out minor reparations. The second direction, cultural re-invention, has a more bottom-up approach and resorts to art and culture to regenerate parts by bringing awareness and starting a conversation. This brings up cases like Bilbao or Manchester where signature architectural pieces were placed to boost the market and attract growth. Concluding, it is imperative to look closely at this phenomenon but keep in mind that its case requires a different approach to match the local conditions. (Cutieru, 2021).

The European Commission has also tackled the issue of shrinking rural areas. In the report (European Commission, Directorate-General for Agriculture and Rural Development, 2021) they acknowledge that rural areas are home to 30% Europeans, however life there is constantly challenged by globalization and urbanization leading to population decline and aging populations. Concerns are made among others for ***declining rural infrastructures and services and lower employment opportunities***. Nowadays, rural areas pose as less attractive areas to live and work in. Whereas in the past the main drivers were agriculture, forestry, and fishery, they are currently declining (12% loss of all jobs) while tourism increases. The report underlines ***the role of natural resources as a key element in a sustainable and prosperous future that involves forestry and farming as drivers for growth*** as well as the deployment of renewables. *"Rural areas should build on sustainable farming, forestry, agri-food economic activities and a diversified range of greener economic activities promoting carbon-farming and local, community-based high-quality production"*. Once again, the importance of diversifying economic activities based on local strategies is noted.

Following the above, I explored socio-economic conditions on-site. The map showing the GDP per inhabitant for the year 2020 clearly depicts the different economic conditions in the three countries, but what I would like to stress is the differences inside Germany as we move from the west to the east, but also the similarities while looking at the chosen transboundary site, where the three countries seem to have a more similar or at least more comparable status. The depopulation argument is supported by population change data and projections published by the European Union, which I use to create the charts.



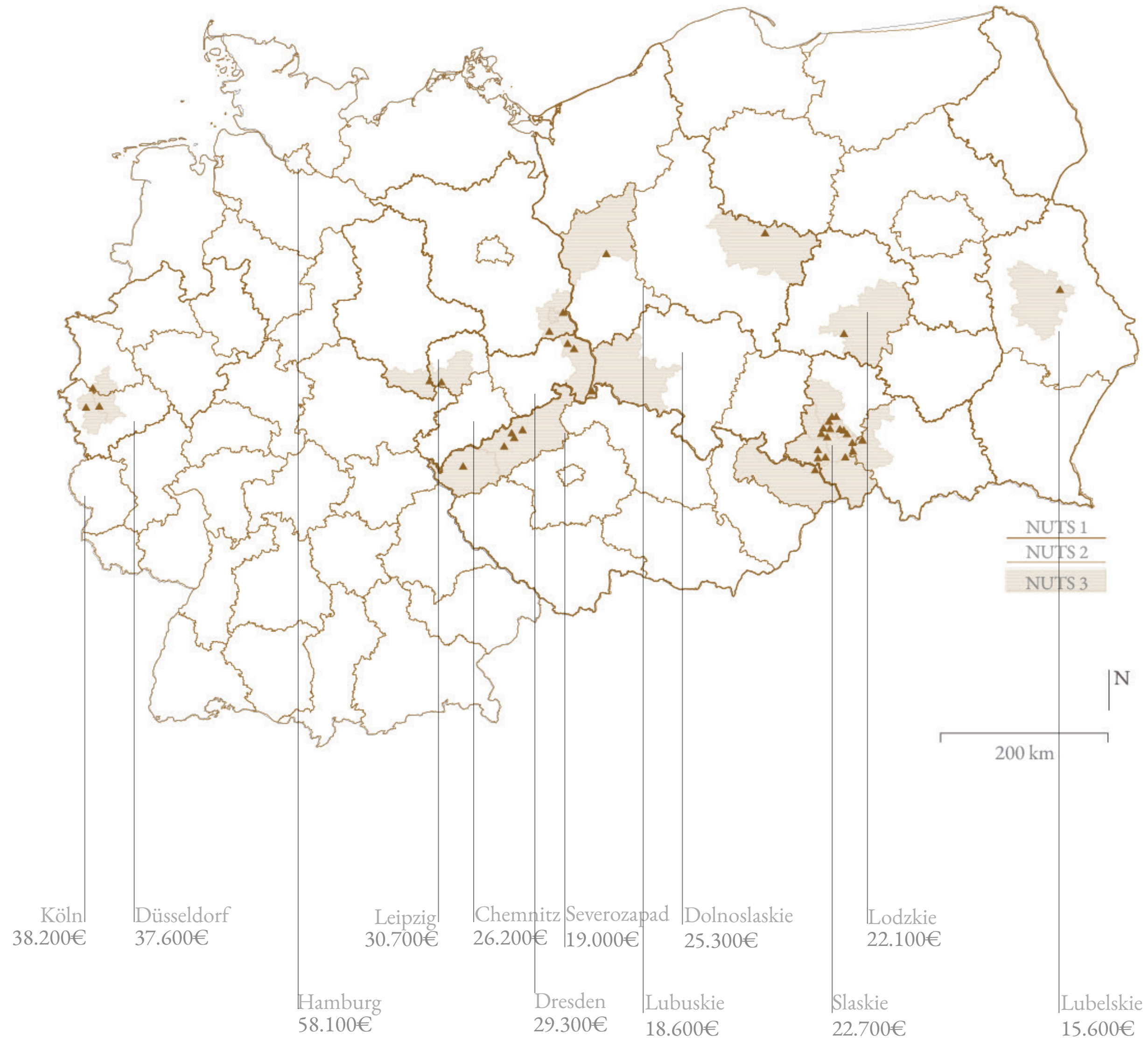


Fig 72. NUTS 2 and GDP per inhabitant 2020

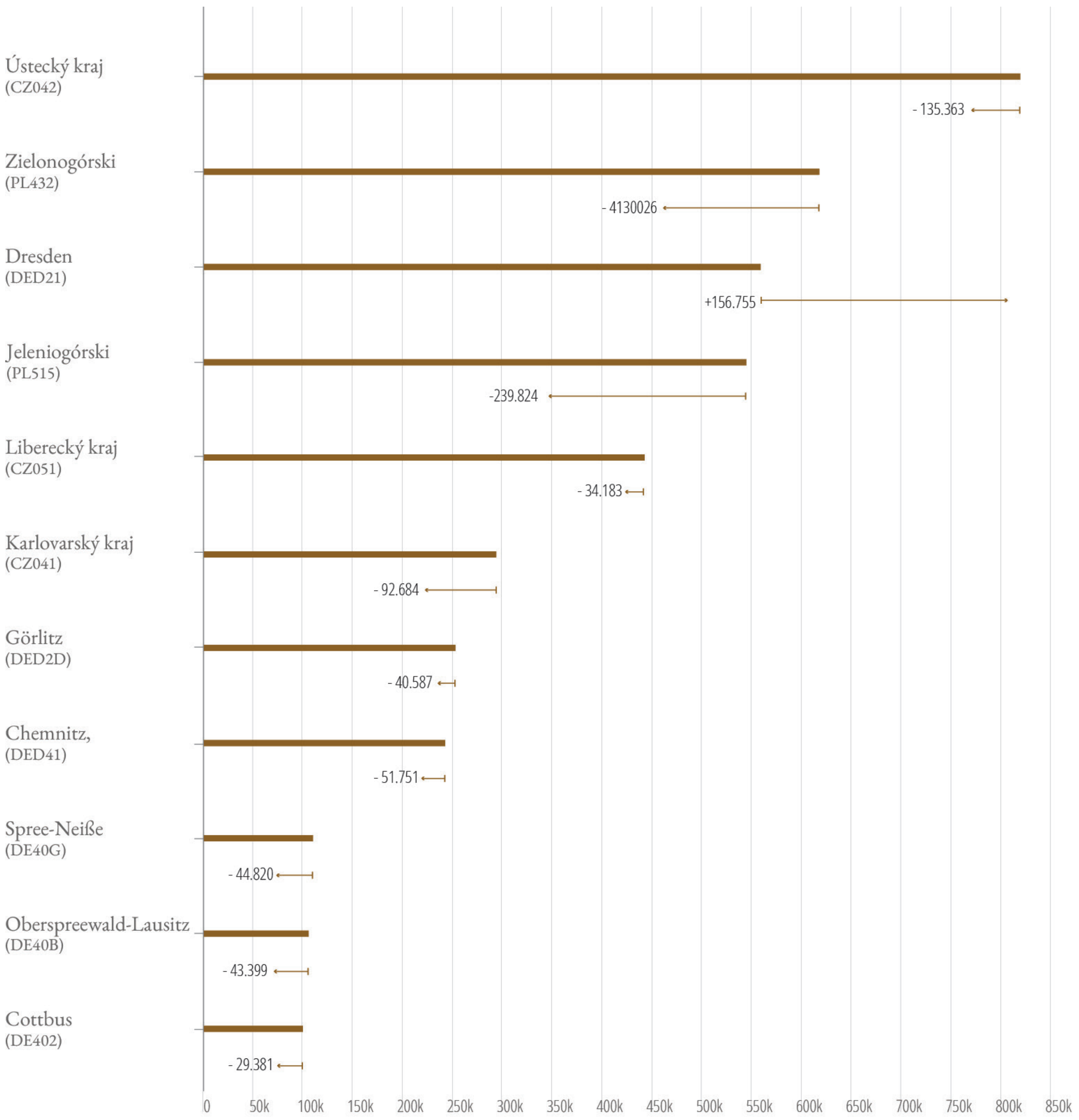


Fig 73. Population change 2020 to 2090

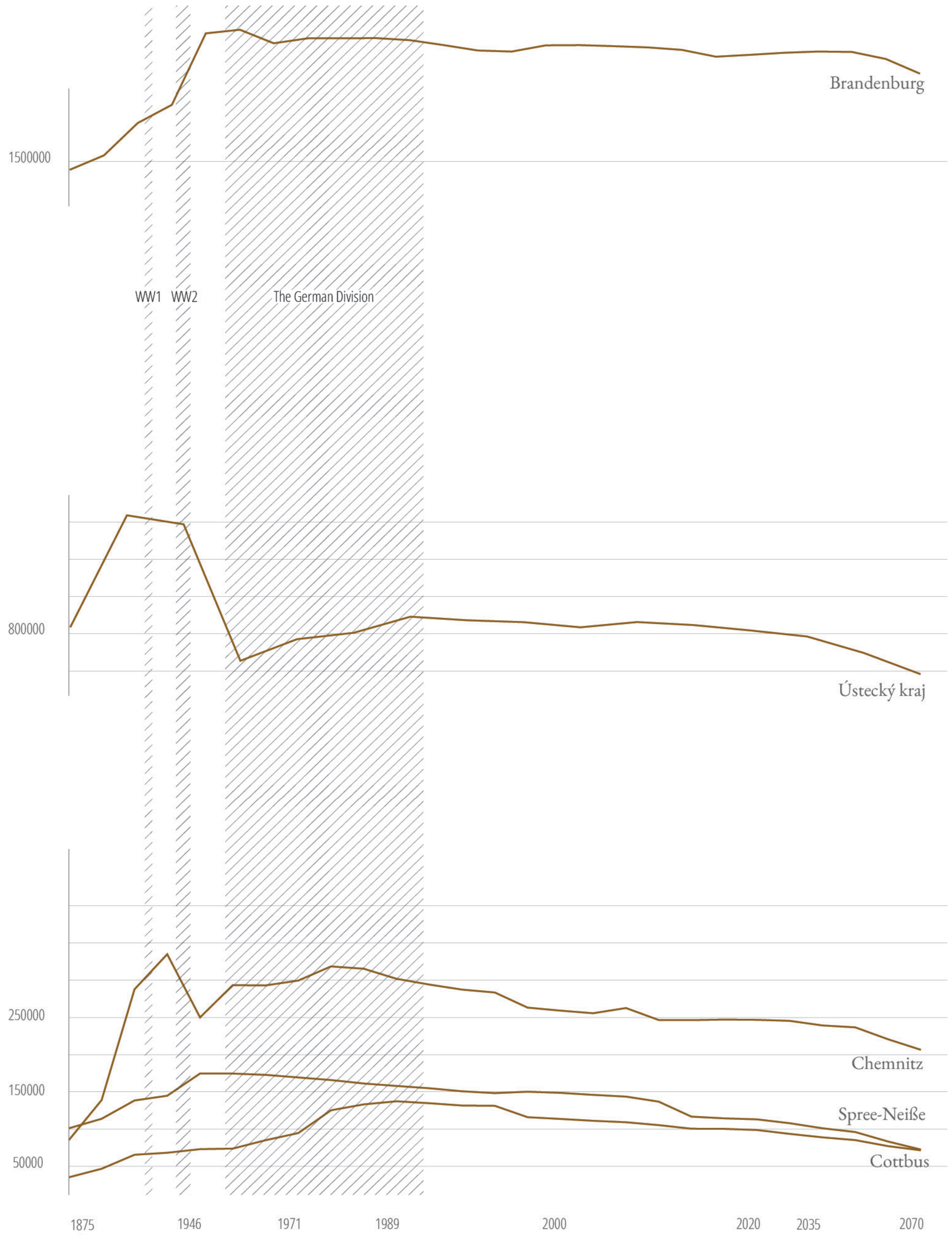


Fig 74. Population chart 1875-2070

DUAL CHALLENGE

The above investigations, Forests, and Retreat pictured a vivid image of the overall area through time and highlighted challenges and threats, but also opportunities that can stimulate growth in times of a great transition and the coal phase-out.

But how does this dual challenge become part of this project and the design proposal? As argued before, in an area where depopulation and shrinkage unravel in combination with the ongoing coal phase-out and the deployment of renewables, the land is under extreme pressure. On the one hand, reclaiming the post-mining landscape offers opportunities for forest and biodiversity growth and on the other hand, shrinkage is translated to less infrastructure needed, unregulated retrieval, and an overall abandonment and at some it is expected that it will be hard for administrators and locals to maintain the land and whatever lies on top of it.

For that this thesis builds upon this duality, offering narratives that propose downsizing and a deliberate retreat for settlements and towns while targeted afforestation and plantation patches increase forest and biodiversity growth. Fostering the forestry and the wood industry boosts and diversifies the local economy, offering that way an alternative carbon economy scenario in the coal regions. Retreat and Forests become elements of design, which starts by eradicating (or sometimes targeted repurposing) infrastructures that belong to the coal sector, and shrinking settlements opening up space for forests. Mines are reclaimed with the target to host agro-forestry activities while supporting substantially the deployment of renewables. As mentioned before, growth and decline in urban environments is a cyclical process and that applies to forests too and the design comes at the intersection of these two cycles.

The front end of Jänschwalde open pit mine, Brandenburg, Germany, Dec 2008

Slide at Mondsee, restored part of Profen mine, Saxony-Anhalt, Germany, Dec 2007

Heuersdorf in demolition because of Schleenhain mine, Saxony, Germany, Feb 2009

Tourists in Welzow, Brandenburg, Germany, April 2008

Fig 75. Pictures from Atlas of Places by René Zieger "Retired Soil" (2007–2010)

"In our expanded field, fallowing (v.) is a concomitant phase in the process of both producing and demolishing built and unbuilt environments. Fallowness (adj) as a condition within the production process – a state of pause – becomes a field of potential, a moment or site in which human and non-human actors have the opportunity to rework those relations that structure their environments. Here new strategies emerge, countering many models of dispossession with new organizational capacities and biological richness".

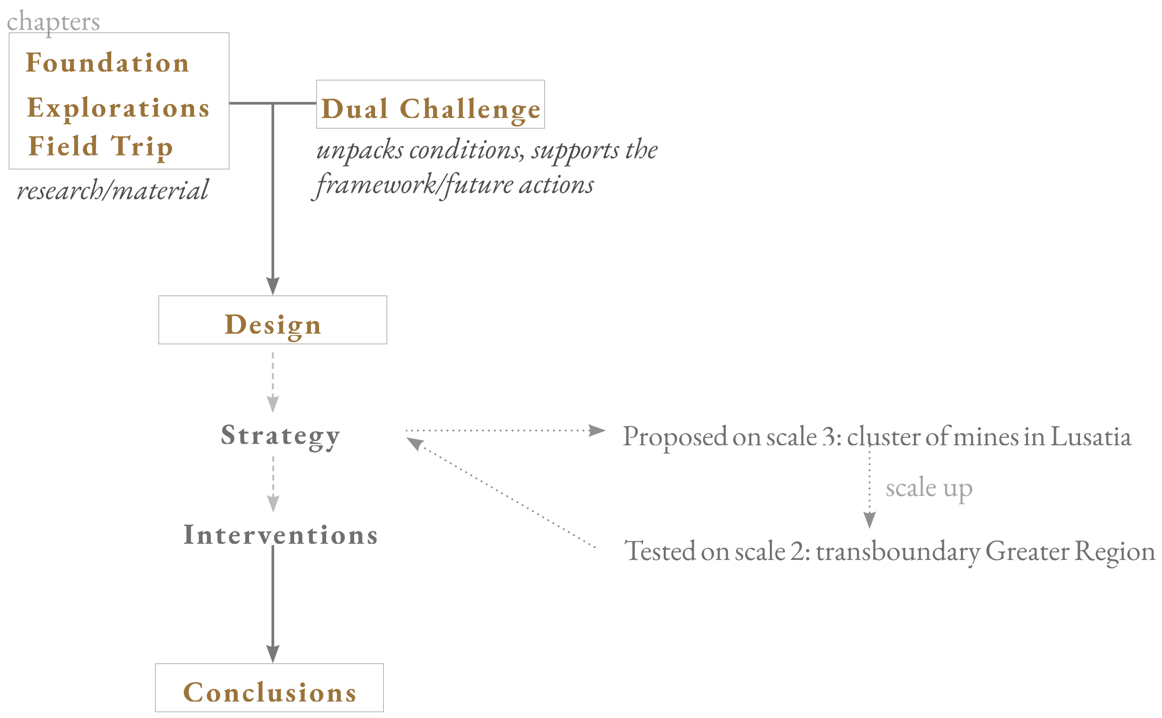
Chieffalo, M., & Smachylo, J. (2019). New geographies 10 Fallow. Harvard University Graduate School Of Design.

"The built environment is a complex composite of complex composites of complex composites... of elements that wear out and depreciate according to varying rhythms. The built environment becomes waste according to varying, simultaneous rhythms determined by the modes of circulation of fixed capital and fluid capital.".

Labban , M. (2019). Rhythms of Wasting/Unbuilding the Built Environment . In New Geographies 10: Fallow. Harvard University Graduate School of Design.

At this point, it is very clear what this thesis proposes, a reinvention of carbon economies in coal regions. The design phase of the thesis has two elements, the strategy, and the design interventions. The strategy identifies once again the pillars of the thesis and translates them in a spatial vision, first in the cluster of German mines in Lusatia and then following the same approach, scaling it up to the transboundary Greater Region. Choosing to work with a cluster, enables the exploration of synergies between the mines, but also tests the codependency between different spatial elements such as energy production sites (power plants, renewable parks), nature elements, and urban centers. From the strategy certain spatial interventions are highlighted which will be visualized in the second part of the chapter. Concerning the design interventions, I would like to state my motives and objectives beforehand to make clear the way the thesis takes shape. The interventions aim to visualize how the new carbon economies and coal regions take shape, meaning that I speculate on the way the suggested strategies will impact the area and thus the design is not focused on "solving" specific buildings or settlements. The main outcome of this thesis is how the introduction of a forest economy can reshape the coal regions; each time based on local conditions. Even though the strategy and interventions stem from the area of Lusatia the overall approach is that they could be reapplied in other parts of the systemic zone. Thus, designing, for example, a sawnwood processing unit is not the target of this thesis, but rather depicting the synergies that would allow the wood economy to take place.

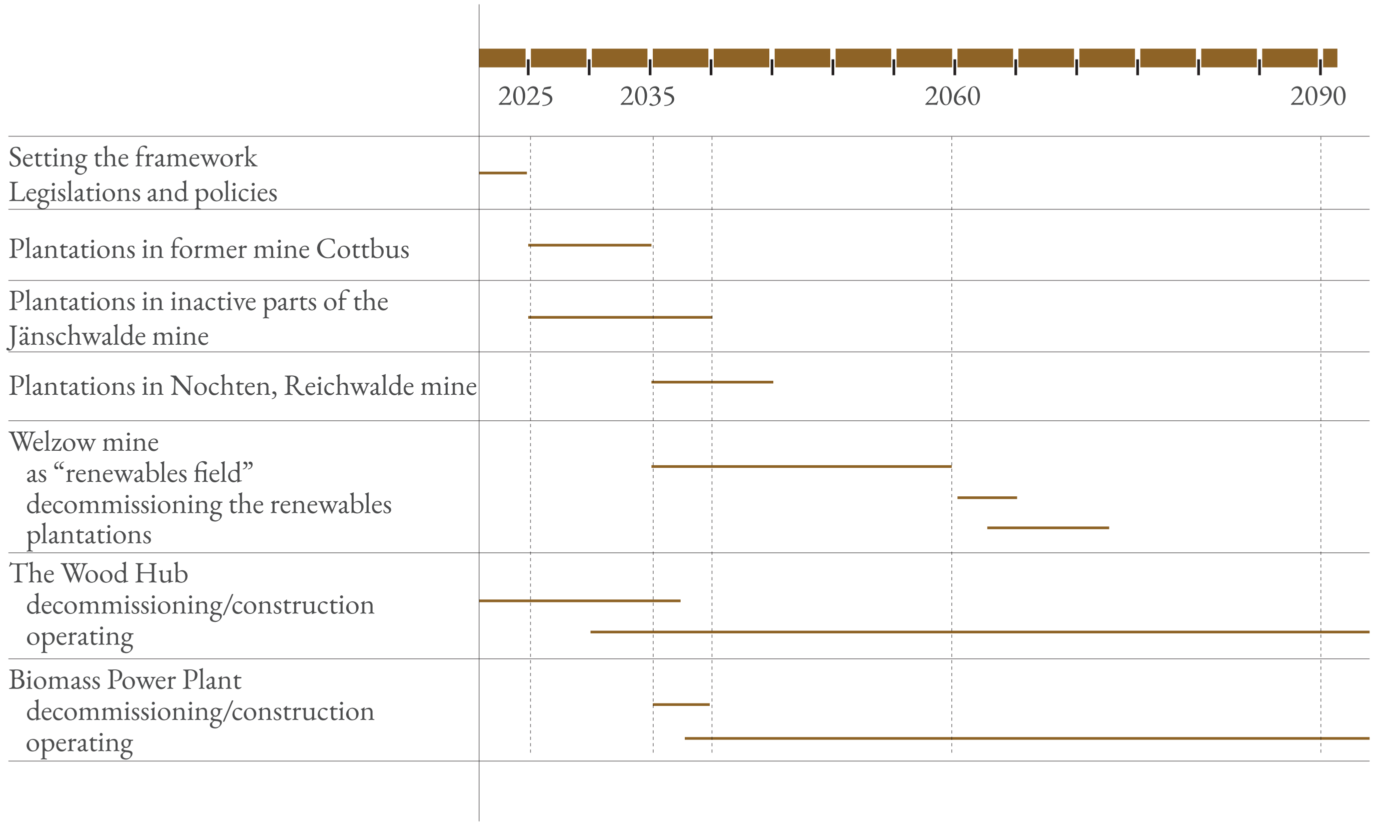
The strategy builds upon the dual challenge as presented in the previous chapter, and works with these duo, forests, and retreat, while structuring the basis for the proposed wood economy. For that, the strategy has three basic elements: shrinkage/retreat, forest growth, which includes the new plantations and biodiversity corridors, and the elements of the wood economy. Combined they create an alternative view of the carbon economies, one that is more sustainable, that builds on local dynamics, and that through local challenges strives to foster growth and progress. The strategy is based on gis data and calculations in the qgis environment, that draw on an overview of the design intentions.



The strategy is structured based on a timeline starting from 2025 until 2090. The timelines takes into the consideration the coal phase-out (Germany exits coal between 2030-2035) and uses this to prioritize actions.

In combination with the timeline different stakeholders can be identified such as:

Governmental agencies, Municipalities and regional agencies
Locals, inhabitants on a regional/national scale (people who live near forests, tourists)
Mines' operating companies
Coal community (people with direct and indirect connections to the coal sector)
Forestry community (people with direct and indirect connection to the forestry sector)
Small, medium scale entrepreneurs locally and regionally
Managers of forests (applying to private forests)
Environmentalists (institutions, agencies)
Forest officials
Consumers of timber products



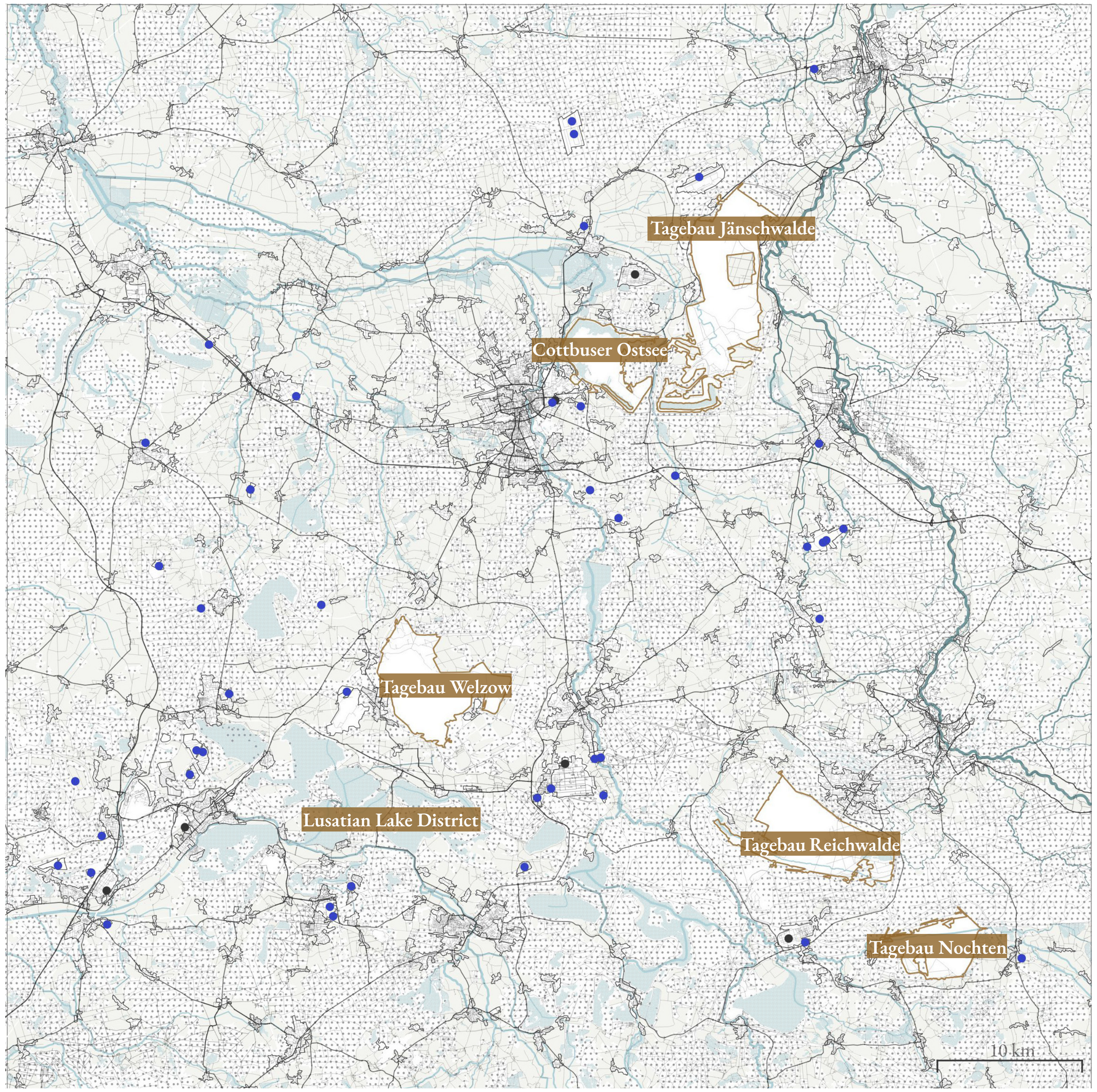
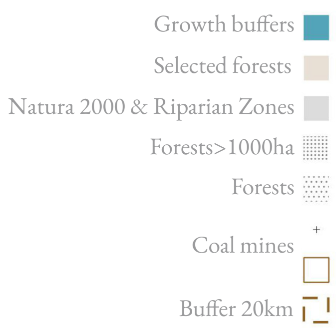


Fig 76. Cluster of mines in Lusatia, Germany

The first pillar of the thesis is forest growth. It aims at increasing the forest areas while defining areas that are protected and should be conserved, and suggesting locations where biodiversity corridors could connect fragmented forest patches.

At the beginning the forest layer is filtered for forest polygons greater than 1000 ha, considering this as the minimum forest area to sustain a "core". The forests are selected from a radius of 20km from a coal mine, based on the average commuting distance in Germany, as the mines to be forest would require intensive human labor that should live and work nearby. In this selection, only forests that were at least by half inside the 20km radius were chosen. Next, the polygons are buffered externally for 100 meters. These buffer zones were later intersected by the union layers of Natura 2000 and riparian zones. This happens to make sure that the protected areas remain untouched and to minimize anthropogenic interventions that would potentially damage the ecosystem (for example by introducing alienated species). The light blue zones are the new areas where forest would grow, taking up space mostly from agricultural land or meadows.



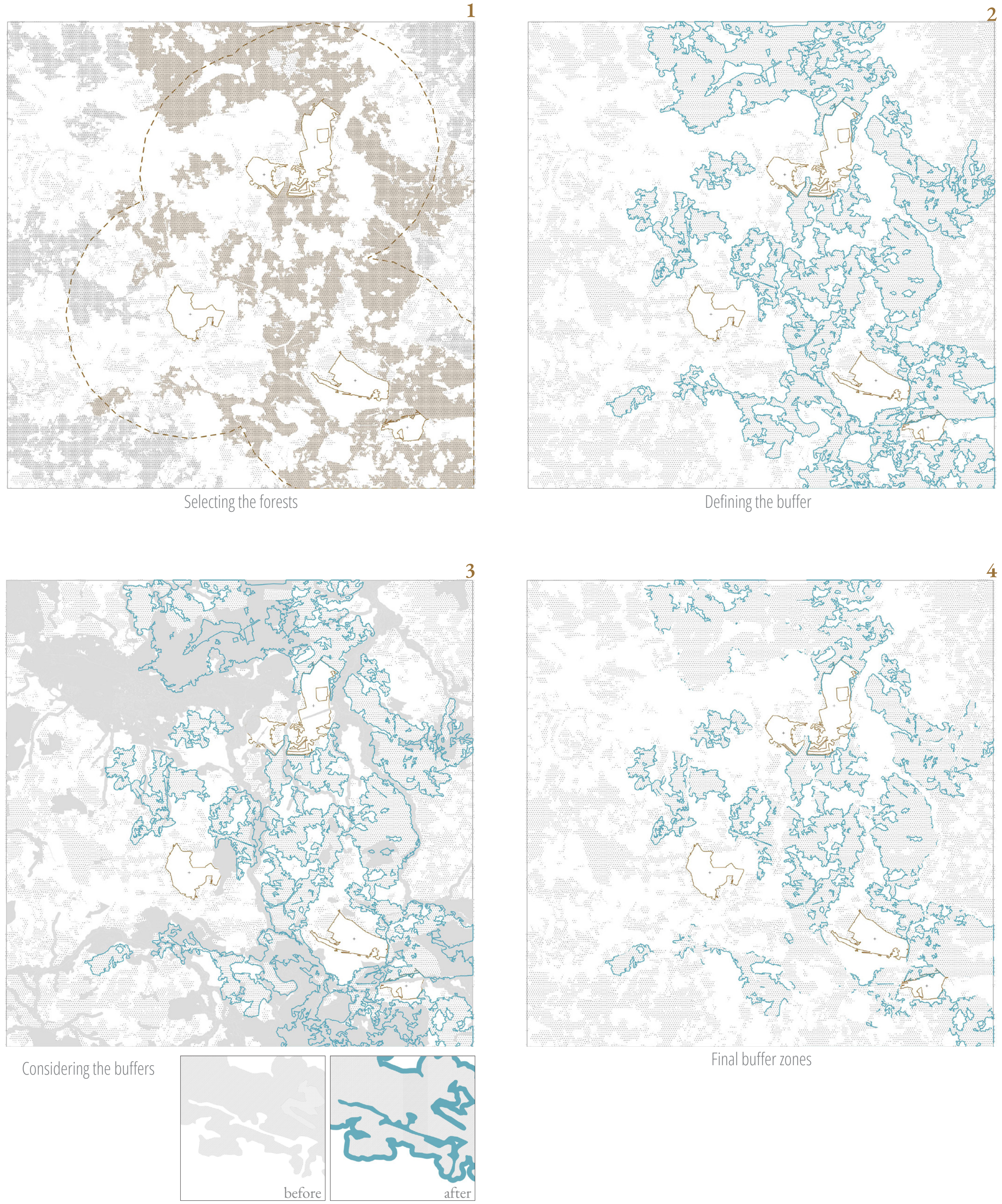
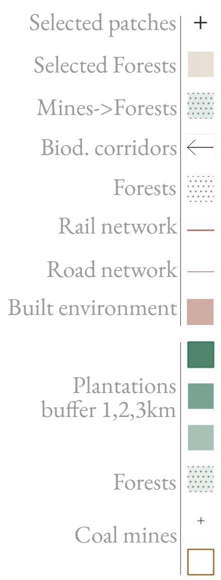
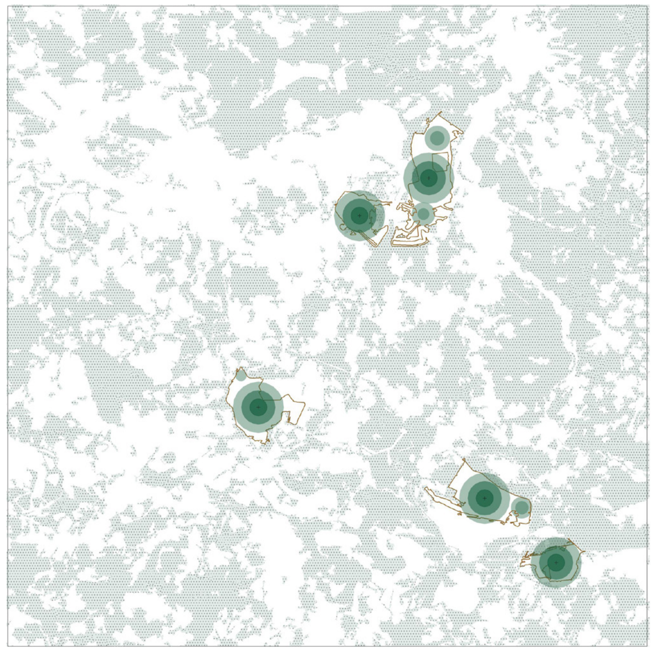
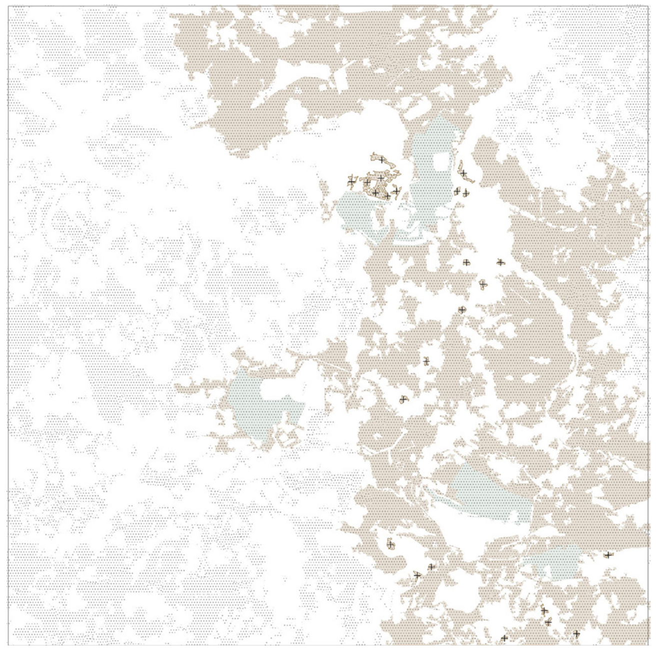


Fig 77. Strategy for Forests, biodiversity and plantations -01

Next, the mines are to be planted by species native in the area. Plantations will imitate the creation of a forest, meaning that they should start at the center of the mine (buffers of 1,2,3 km over time) towards its periphery. That way, the very first plantations over time will be the core of the forest. The fragmented patches of forests are being highlighted and connections are drawn to connect them to the closest forest patch.




New Plantations


Selecting fragmented patches

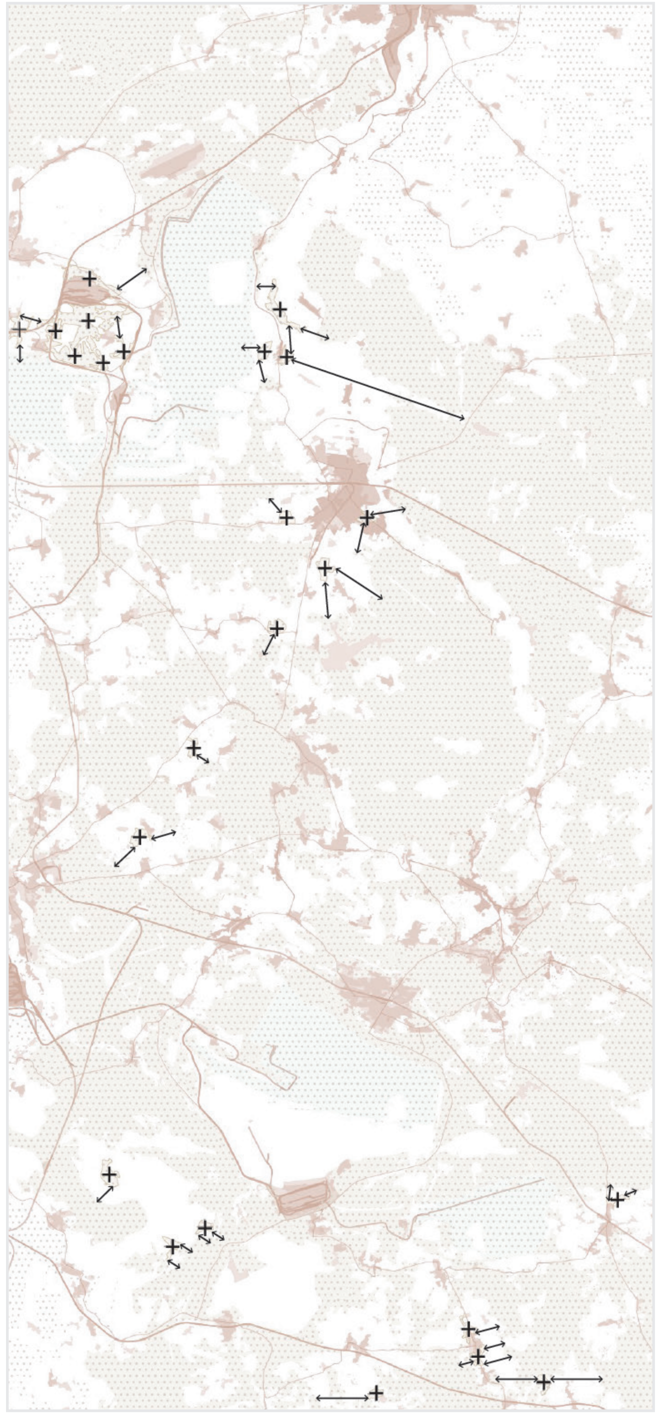
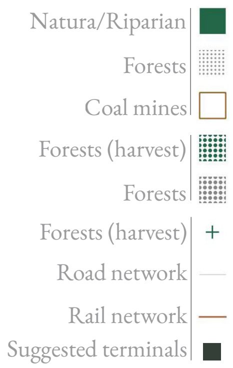
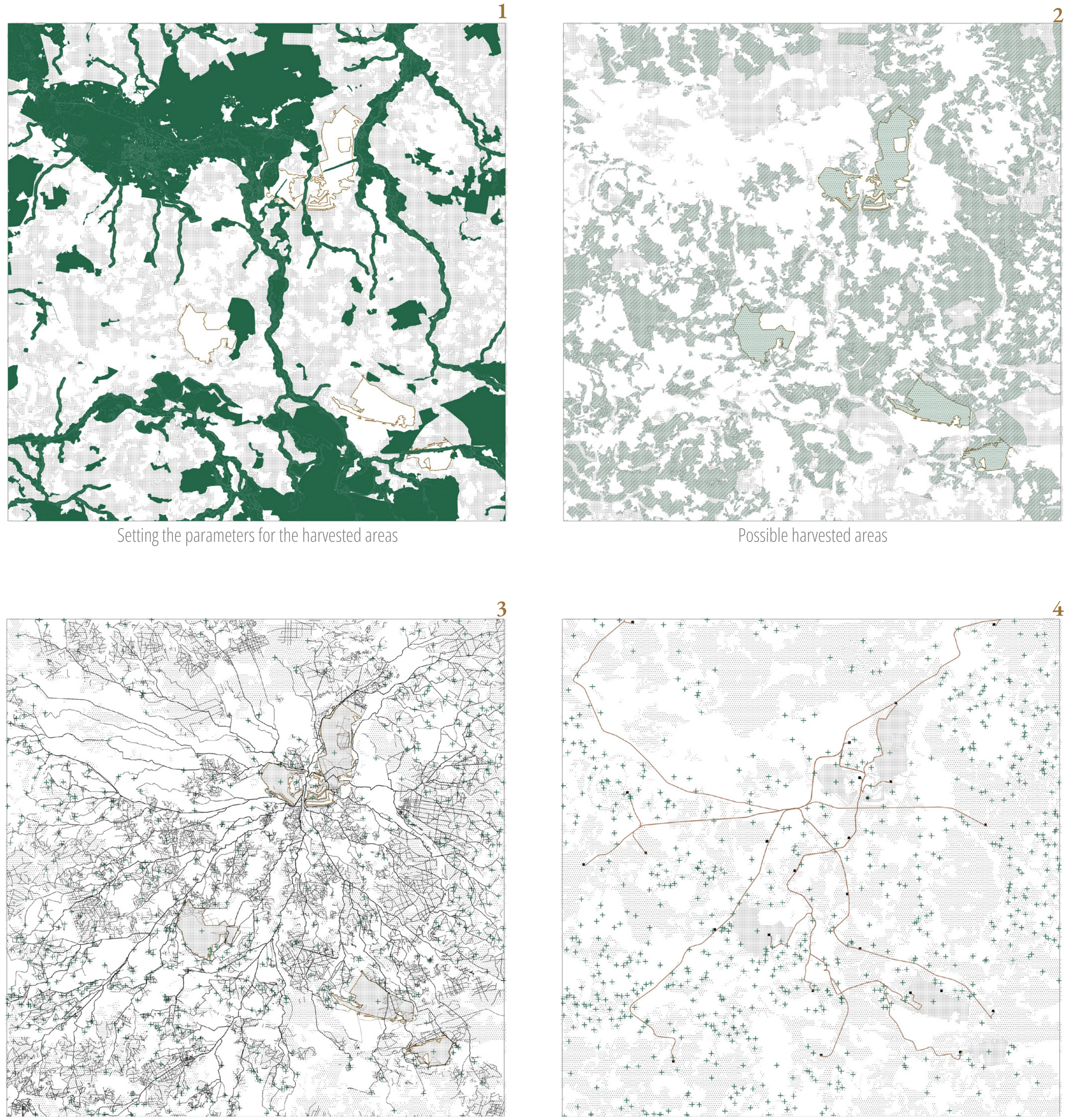

Drawing biodiversity corridors

Fig 78. Strategy for Forests, biodiversity and plantations - 02

Another important element is to identify the areas that could be harvested and those that should not. Using again the layer of Natura 2000 and riparian zones, it intersected with the forest layer to identify patches that become the drivers for the wood economy. For this to happen a transportation network for the commodities is needed. As the strategy builds upon the existing coal sector infrastructures, it proposes a hybrid network of rail and roads that are in place already minimizing costs, and emissions and altering the nature ecosystems as less as possible. Network layers (road: filtered and selected as primary, secondary and trucks and rail) from OSM are processed by the embedded algorithm in qgis "Shortest path (point to layer)", which uses the location of the suggested wood hub as the starting point. The network layer that is being produced is the minimum requirement to reach the forests and will be used later in addition to service paths for visualizing the footprint of the suggested wood economy in the area.





Setting the parameters for the harvested areas

Possible harvested areas

Road network for the wood economy

Rail network for the wood economy

Fig 79. Strategy for Forests, biodiversity and plantations - 03

Here the strategy explores the growth/retreat concept. For that, it suggests areas that will be deliberately eradicated and areas that should attract population or remain the same. It starts by identifying built areas (OSM: residential, retail, commercial, and industrial and Copernicus data codes:1.1, 1.2). First, we need to identify areas that would support the wood economy, based on their proximity to the mines as the future highly-intensive-labor forest areas. The 20km buffer from the mines is brought up again, as a filter to choose built areas inside it. Outside this buffer, there are many other built areas, from which towns and cities are chosen to be added in the previous selection as well as settlements that have services (bakery, supermarket, schools) to support people's needs. We end up having identified areas that have fewer possibilities of depopulation and shrinking as they would attract people from the shrinking areas but also people interested in working with the wood economy. By inverting the selection, the shrinking built areas have been identified. The areas that remain are being supported by a network as processed by the algorithm from qgis Shortest path (point to layer), which takes into consideration the minimum requirements for connecting living areas, the forests, and agricultural uses. By comparing the first the last step, we can see that the retreating effect gives space for forests to grow.

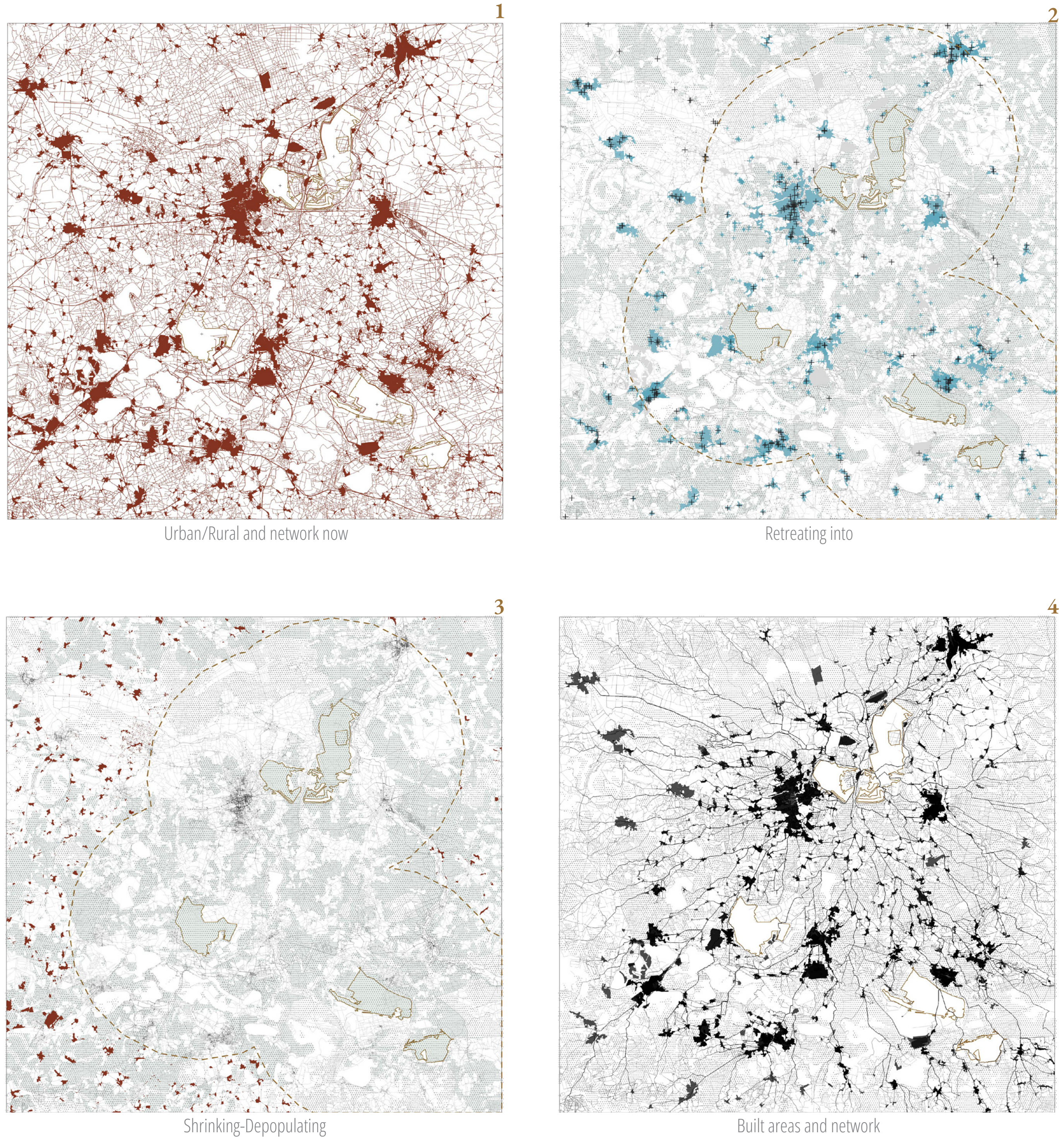


Fig 80. Strategy for retreat

But the wood economy cannot operate without a center or hub, where wood products and forest materials will be gathered, processed, and then shipped. Also, a biomass power plant could also provide energy and in combination with the deployment of renewables, it can act as a more sustainable source. These two elements, the biomass power plant and wood hub, can benefit from the remains of the "coal economies". For the mines to operate, auxiliary services, infrastructures, and buildings are needed to support extraction. In every case, the end of extraction means that all these components are no longer needed, thus they could be eradicated or repurposed. In the strategy, we already saw that the rail network that transports coal can be used for timber. Applying the same logic in the built environment, could not minimize the costs of the new activities but also the need for new constructions.

Having said that and based on the above strategy we need to identify the ideal locations for these two elements, the wood hub and the biomass power plant. As can be seen on the next page, the wood hub could be located in the in-between of the two mines around Cottbus, repurposing existing industrial buildings and a very well-articulated infrastructural network. Looking closely at the current arrangements we can identify two parts, the upper one as a direct part of the coal extraction (LEAG operating offices) and the lower part which comprises industrial uses, storage, and processing facilities. Although repurposing the existing buildings could stand as a project itself, the thesis suggests that an evaluation of the constructions could identify which buildings could be decommissioned/eradicated and which buildings could be repurposed.

Since the coal will be phased out, the existing coal-fired power plant will have to be decommissioned as well, meaning that it could be repurposed as a biomass power plant, once again profiting from the network and the facilities. Additionally, the strategy proposes the deployment of renewables (pv panels and wind turbines) in one former mine, more specifically the Welzow mine, bridging the energy gap that will be created from the coal phase out. This mine is strategically chosen based on its proximity to an energy power plant (that could be repurpose for energy storage) and the Lusatian Lake District, a complex of lakes where a lot of renewable energy fields emerge, thus having a better connection to the energy grid.

Fig 81. Existing infrastructure of the coal economy

Last, the strategy explores the spatial components needed for the wood economy to function in the cluster of mines. From the previous steps forests that can be harvested, the network, and the living areas have already been identified. Combining these layers with a layer of supporting network inside forests is needed too (OSM layer road network, selection of track3-5 and service areas inside forests). While building the strategy, we can identify the rest of the spatial components that are needed for the wood industry to operate, which is a wood hub, a processing hub where materials will gather But the wood economy cannot operate without a center or hub, where wood products and forests materials will be gathered, processed and then shipped. Also, a biomass power plant could also provide energy and in combination with the deployment of renewables, it can act as a more sustainable source. These two elements, the biomass power plant and wood hub, can benefit from the remains of the "coal economies". For the mines to operate, auxiliary services, infrastructures, and buildings are needed to support extraction. In every case, the end of extraction means that all these components are no longer needed, thus they could be eradicated or repurposed. In the strategy, we already saw that the rail network that transports coal can be used for timber. Applying the same logic in the built environment, could not minimize the costs of the new activities but also the need for new constructions.

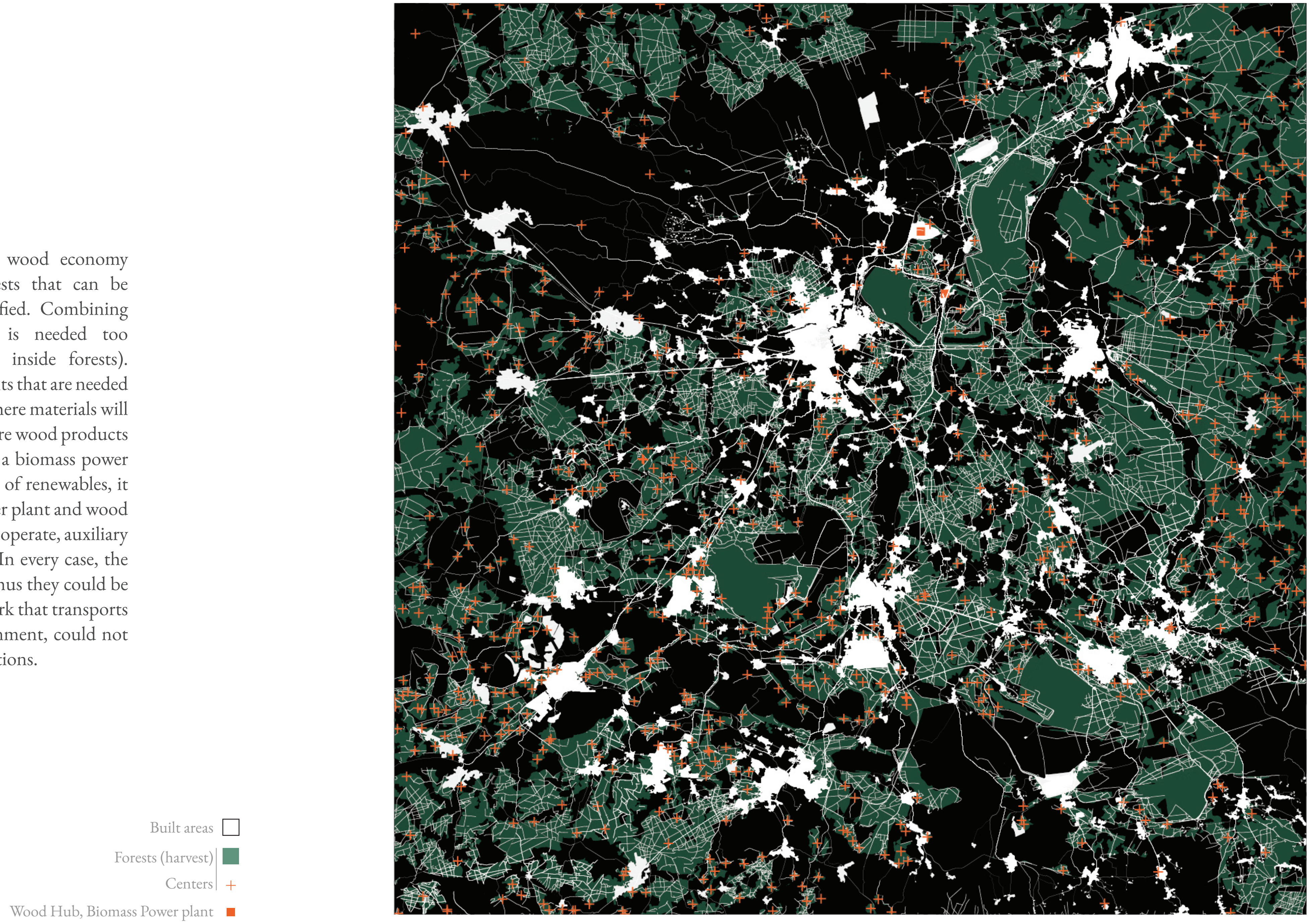


Fig 82. The wood economy

Strategy
Scale up to the Transboundary Greater Region

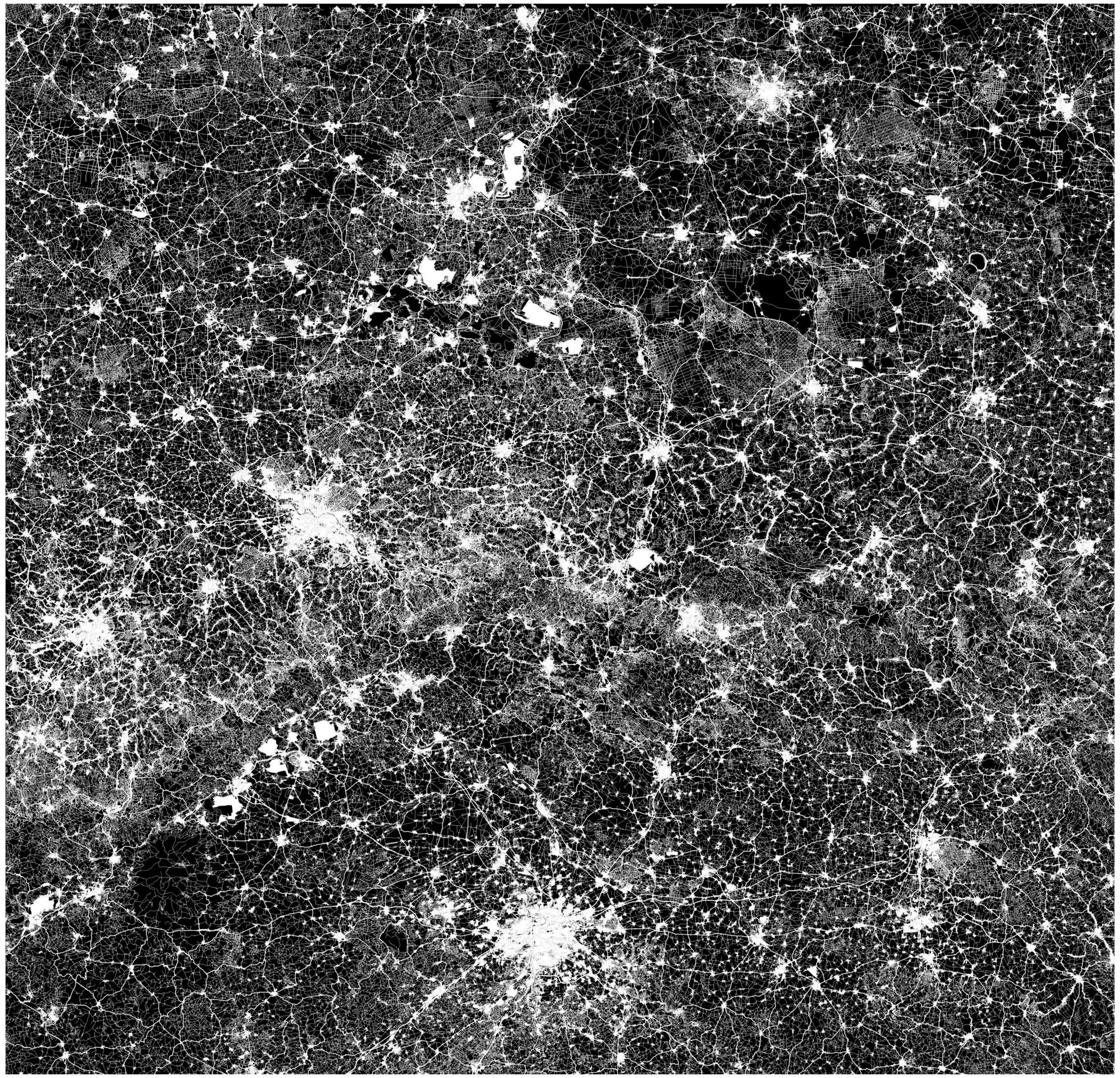


Fig 83. Spatial footprint of the coal economy

Built environment/network ○

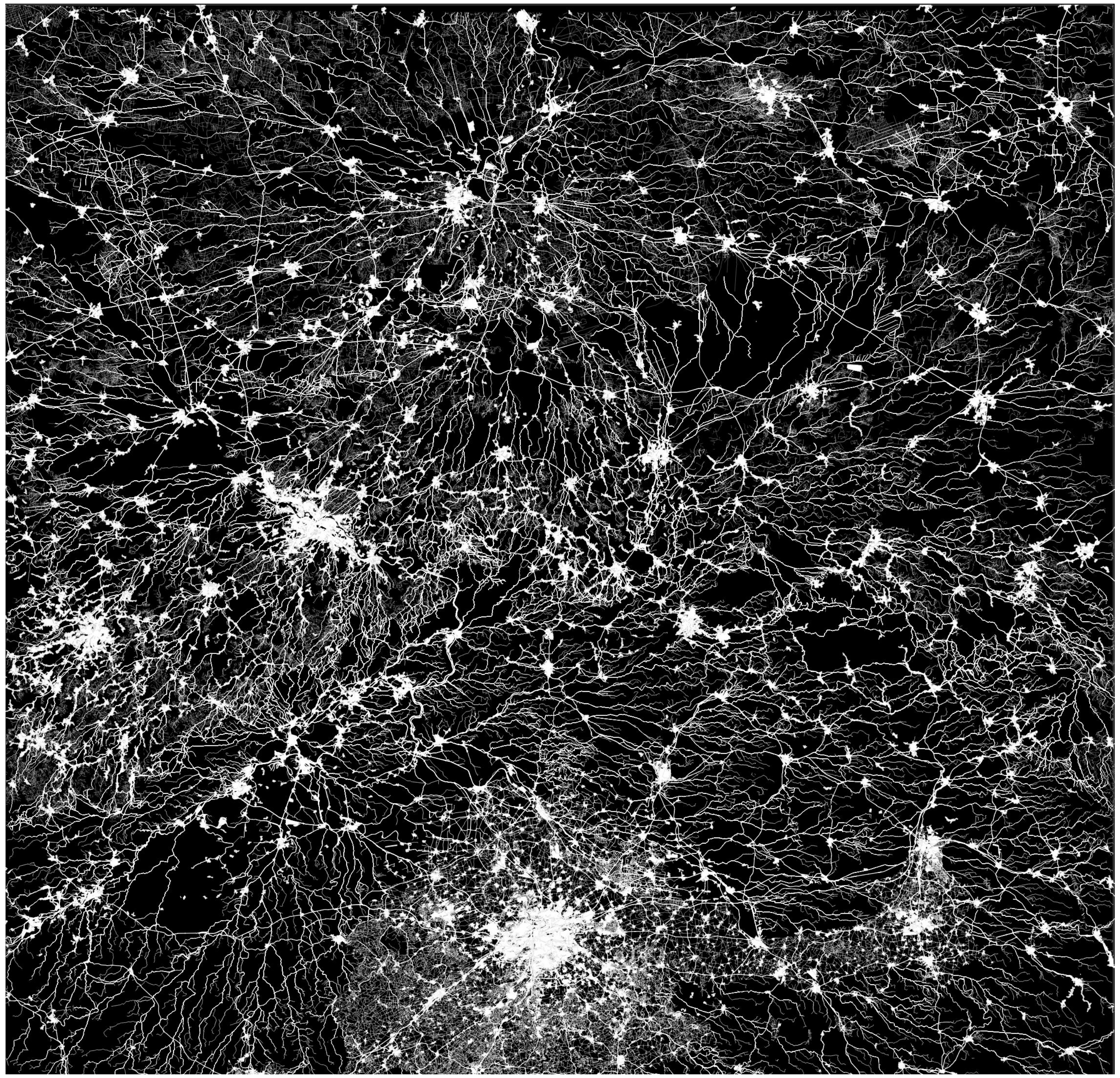


Fig 84. Spatial footprint of the post-coal economy

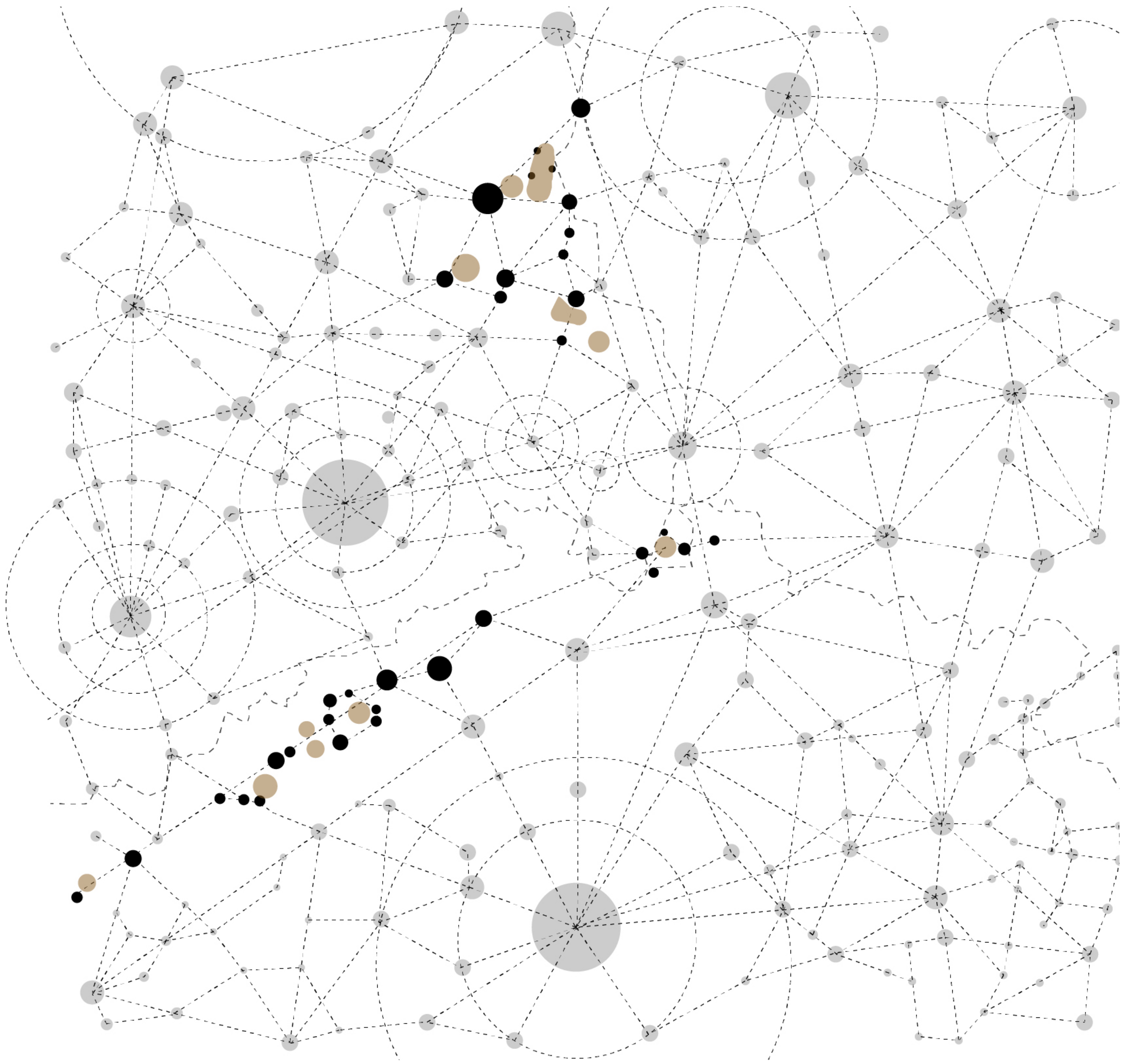


Fig 85. Territorial diagram of the coal economy

Extractive system | Coal mines ● Coal cities ●

Settlement system | Centers ●

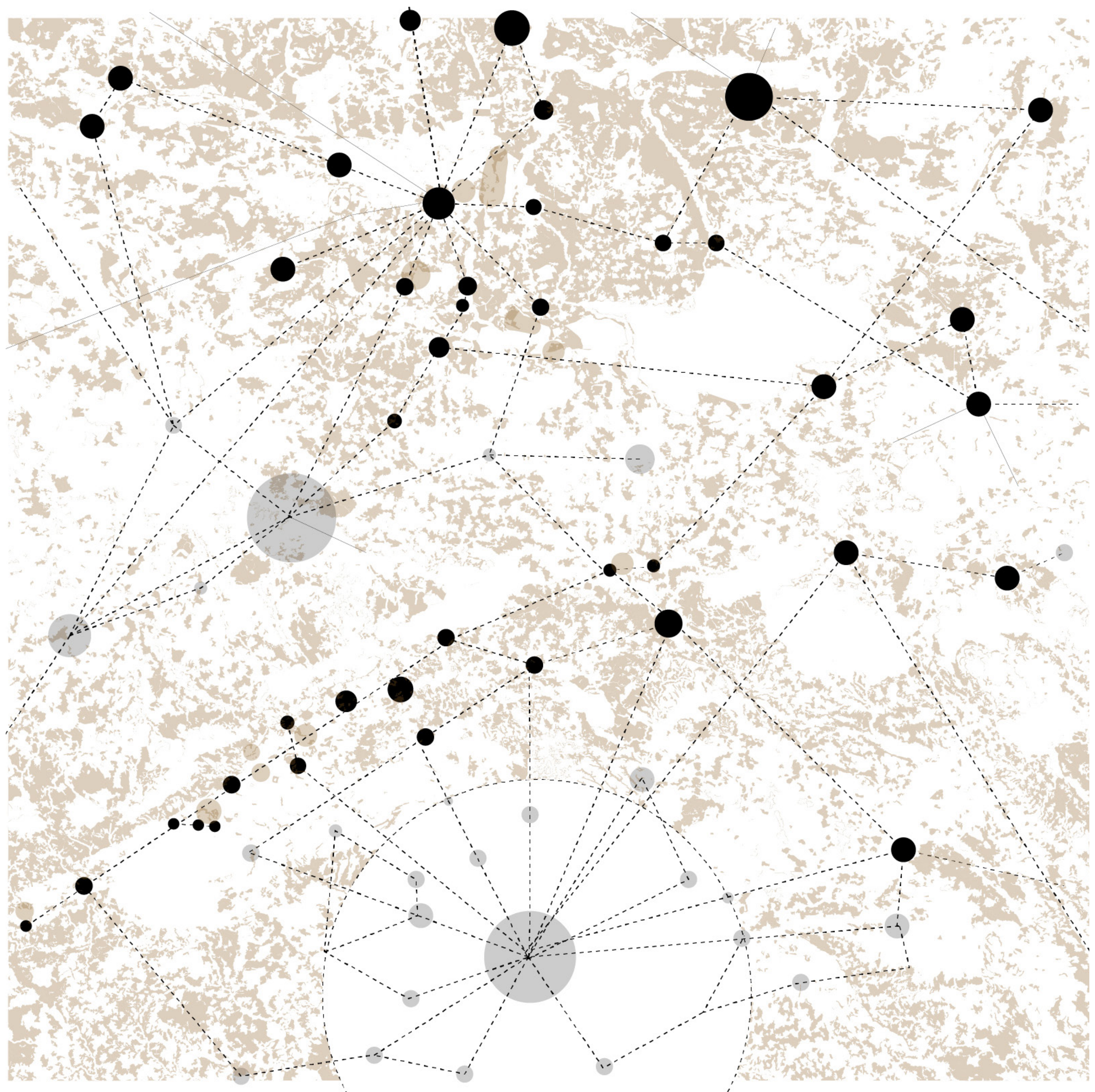


Fig 86. Territorial diagram of the post-coal economy (forestry)

● Forests (harvest) ● Centers | Extractive system

● Centers | Settlement system

As a final step, the strategy explores its applicability on the scale of the systemic zone. For these to happen we must identify if the two major elements, decline/retreat/shrinking and forest cover are dominant as well. In the next map, 5 samples from the systemic zone of three countries are taken to look closer at the conditions on different sites.

First, the coal and the mine type are of paramount importance for determining the exact post-mining landscape, the impact of the extraction, and the remediation steps that are to happen. For example, in Poland the mines are mostly underground, meaning that they would have a different approach than the rest which are lignite open-cast surface mines. Next, we must identify the current demographic and economic trends in order to understand the socio-economic conditions that manifest in each site. At that moment, we ask "Do we anticipate an urban decline, shrinking cities, labor flows, or depopulation?". Secondly, we must look at the forest cover. In the strategy that the thesis proposes forests act as the recourse field for the wood economy while fostering forest/biodiversity growth. For instance, in the case of sites A and B, we can see that forests occupy only a small area, meaning that the strategy that builds upon the wood economy, might not be that feasible. Also, site A and its proximity to Düsseldorf and Köln, major urban centers in the Rhine-Ruhr metropolitan region, makes it quite a unique site, due to its socio-economic conditions, most probably not suitable for the strategy. At the same time, sites C and D, which are also part of the transboundary greater region (scale 2), are surrounded by lush forests, making the implementation of the strategy more relevant. Site E, is also unique, as it is comprised of many underground mines, surrounded however by forests.

The important takeout from this scaling up is to check the applicability of the strategy on other components – coal regions of the systemic zone. The five sample sites highlighted that the different sites even though they share similar characteristics, threats, and conditions, are also unique, meaning that in any attempt to implement the aforementioned strategy, we must review each site to evaluate all micro-conditions. Finally, the outcome of this strategy is to start the conversation on the post-coal times, of the transition and its impact on the post-mining landscape that will affect the coal regions and their communities. All the steps of the strategy can be negotiated with the interested parties, however, the notion behind the steps leads to a creation of an alternative carbon economy as part of rural development, targeting the shrinking/depopulation trends, and fostering forest growth while diversifying and boosting economic activities.

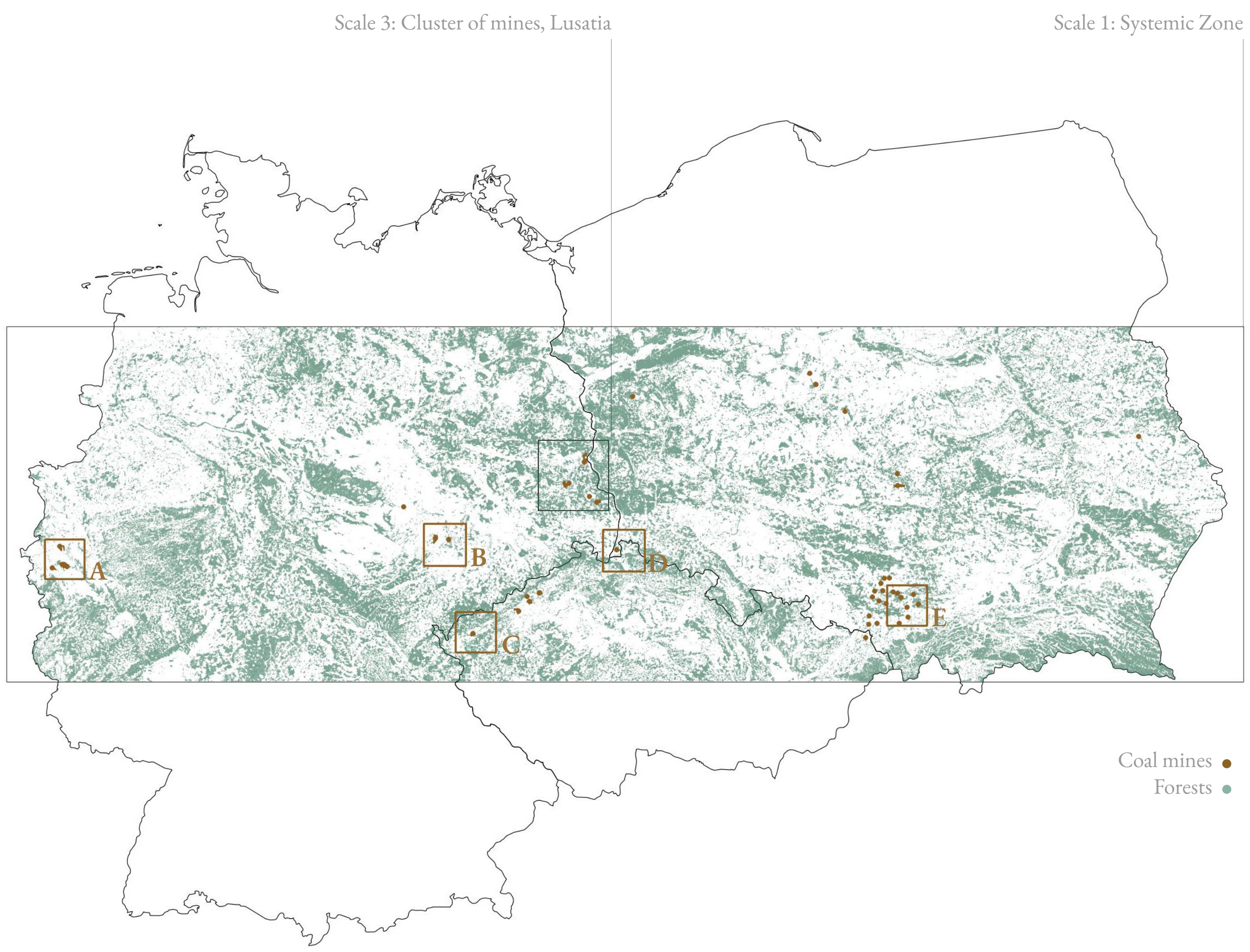


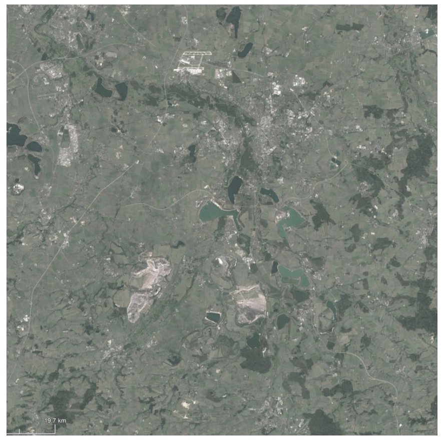
Fig 87. Systemic zone and strategy applicability

Strategy
Scale up to the Systemic Zone

A 50°55'9.45"N, 6°33'9.11"E

Hambach mine (surface, lignite)
Garzweiler mine (surface, lignite)
Inden mine (surface, lignite)

B 51°10'1.16"N, 12°25'14.62"E

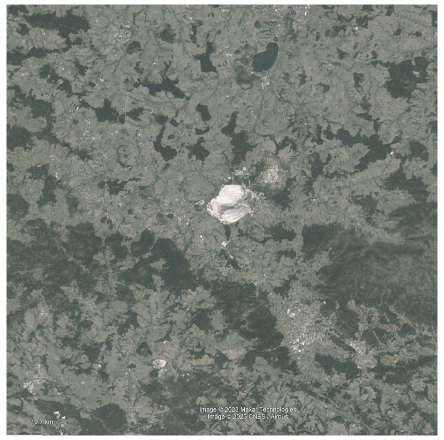


Profen mine (surface, lignite)
Vereinigtes Schleenhein mine (surface, lignite)

C 50°11'3.74"N, 12°46'28.65"E

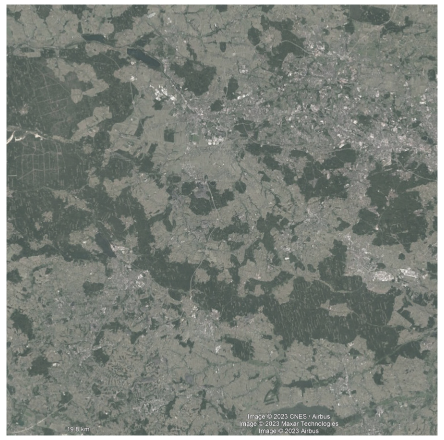
Jiří mine (surface, lignite)

D 50°53'19.56"N, 14°57'3.70"E



Turow mine (surface, lignite)

E 50° 9'38.15"N, 18°50'50.10"E



Bobrek-Piekary mine (underground, bituminous)
Eko-Plus mine (underground, bituminous)
Budryk mine (underground, bituminous)
Knurów-Szczygłowice mine (underground, bituminous)
Borynia-Zofiówka mine (underground, bituminous)
Sośnica mine (underground, bituminous)
Siltech mine (surface, bituminous)
Ruda mine (underground, sub-bituminous)
Staszic-Wujek mine (underground, sub-bituminous)
Mysłowice-Wesoła mine (underground, bituminous)
Row mine (underground, sub-bituminous)
Piast-Ziemowit mine (underground, bituminous)
Bolesław Śmiały mine (underground, bituminous)

Fig 88. Sites and strategy applicability

Fig 89. Synthesis

As mentioned before, the strategy is first being applied to a cluster of mines in Germany, where also design interventions are inspired from. By choosing the specific site and scale, the strategy is being tested to be able to be reapplied in different clusters of mines, not only in the German context but in Czechia and Poland as well. Choosing to work with a cluster, enables synergies between the mines, but also tests the codependency between different spatial elements such as energy production sites (power plants, renewable parks), nature elements, and urban centers.

The strategy builds upon the dual challenge as presented in the previous chapter, and works with these duo, forests, and retreat, while structuring the basis for the proposed wood economy. For that, the strategy has three basic elements: shrinkage/retreat, forest growth, which includes the new plantations and biodiversity corridors, and the elements of the wood economy. Combined they create an alternative view of the carbon economies, one that is more sustainable, that build on local dynamics, and that through local challenges strives to foster growth and progress.

The contents of this chapter are the design products of the thesis, starting from the strategy, the timeline and gradually introducing local interventions. The strategy is based on gis data and calculations in the qgis environment, that draw on an overview of the design intentions. The timeline presents how the actions are being spread through time, and the cluster maximizes synergies. Last local interventions visualize the reinvented carbon economy that the thesis proposes.

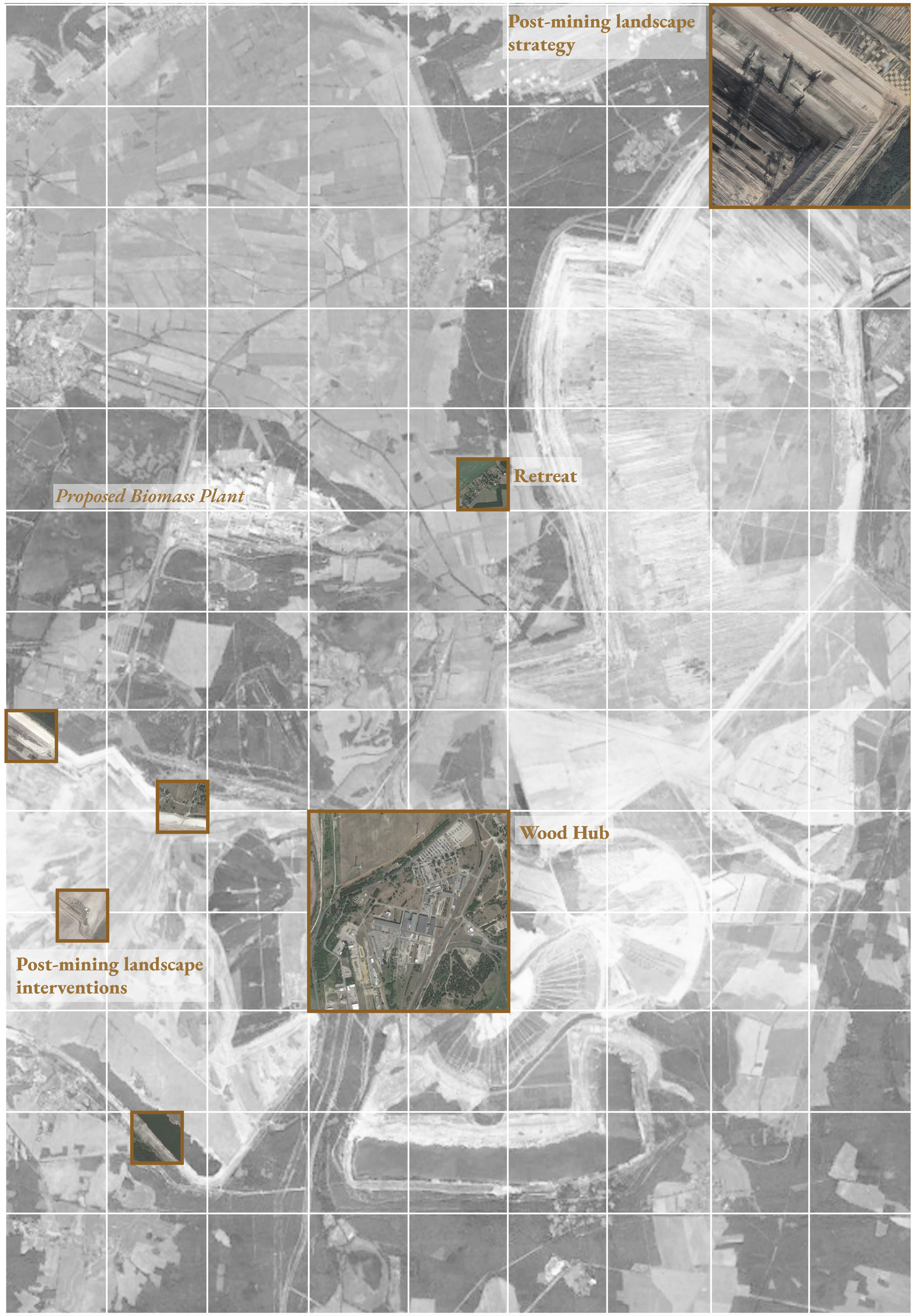


Fig 90. Overview

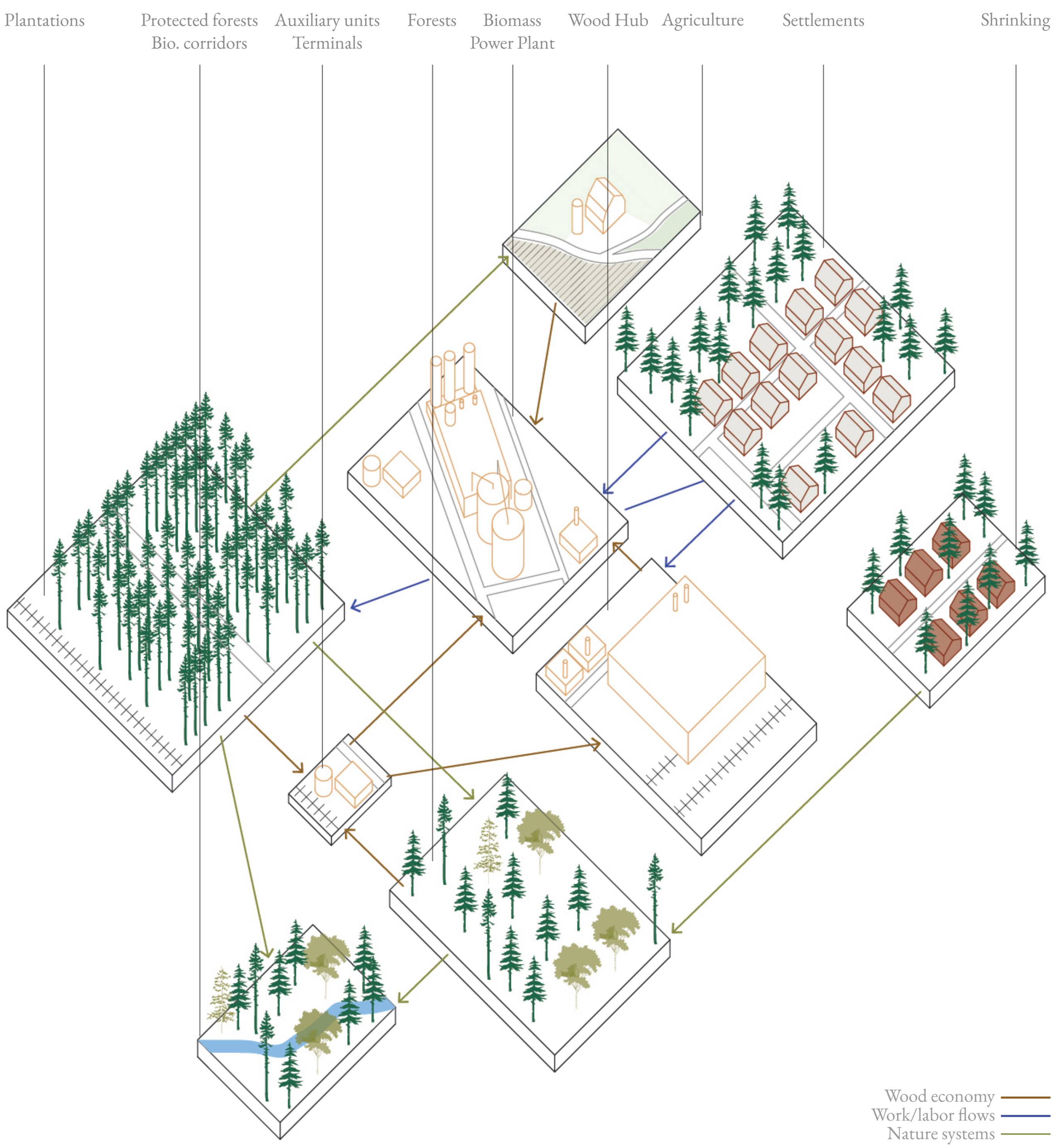


Fig 91. Spatial components for the wood economy and synergies

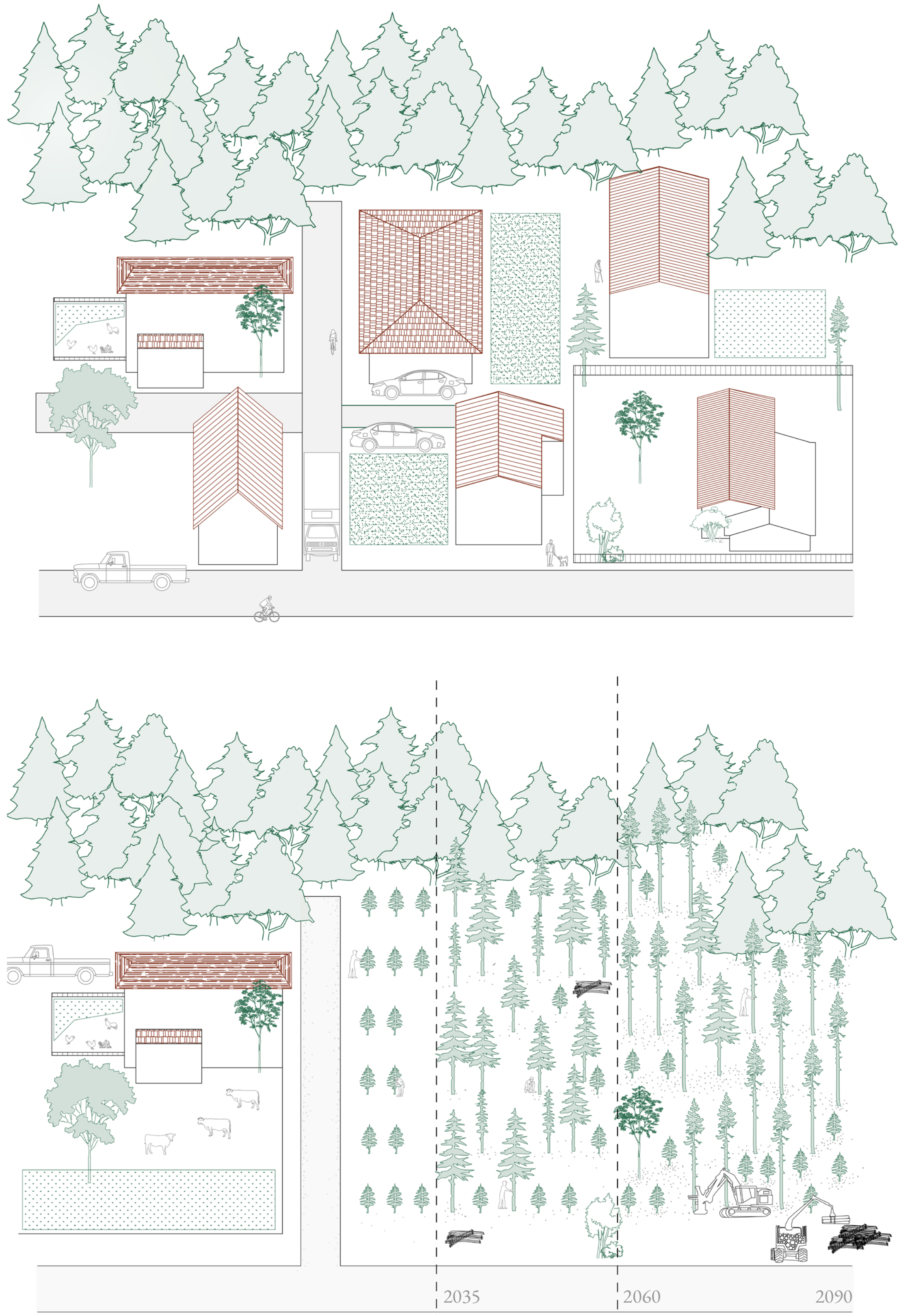


Fig 92. Settlement in coal era - Retreat and forest takeover in post coal era

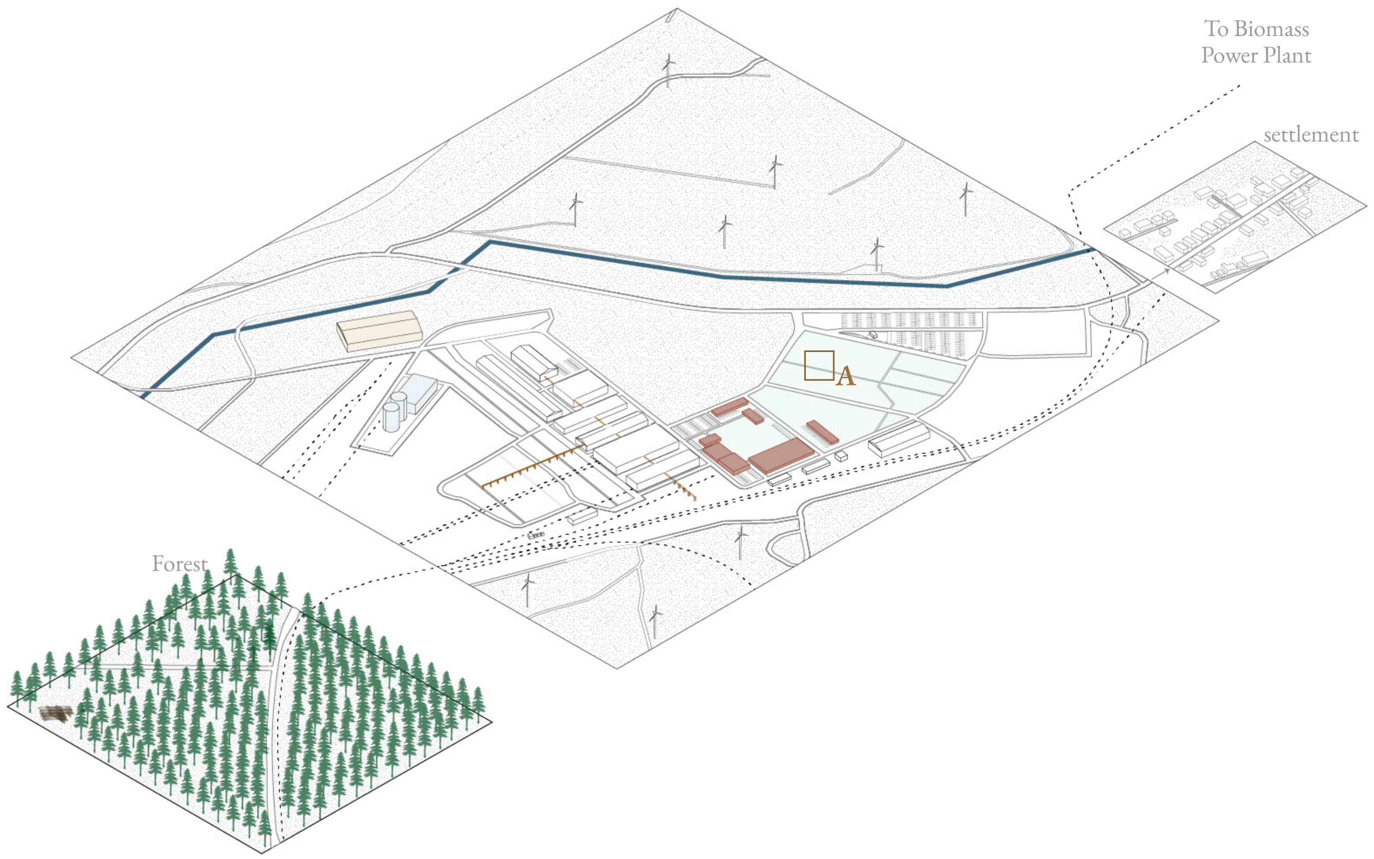


Fig 93. The wood hub

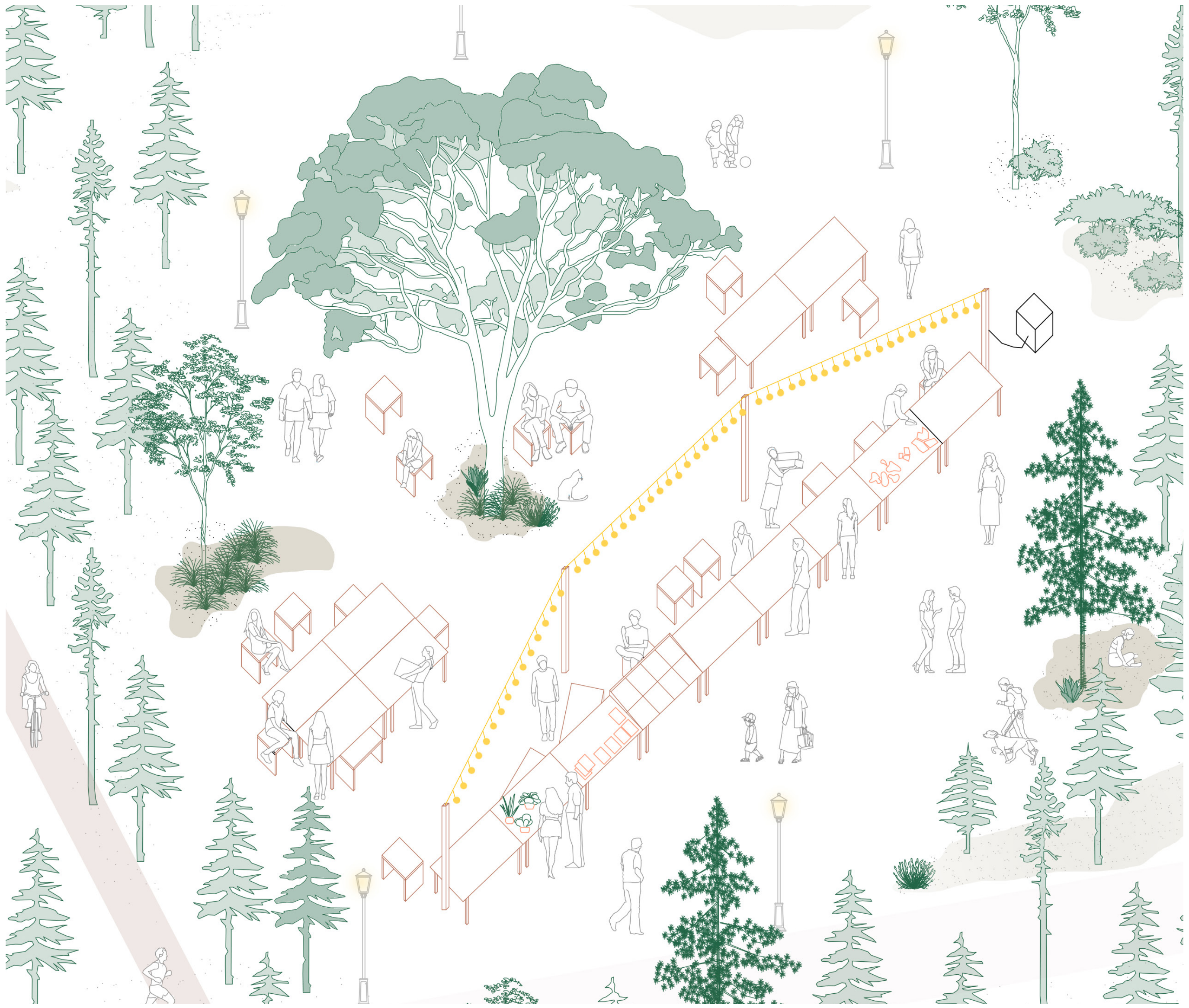


Fig 94. Public space: market

Retail
Makers space
Rail

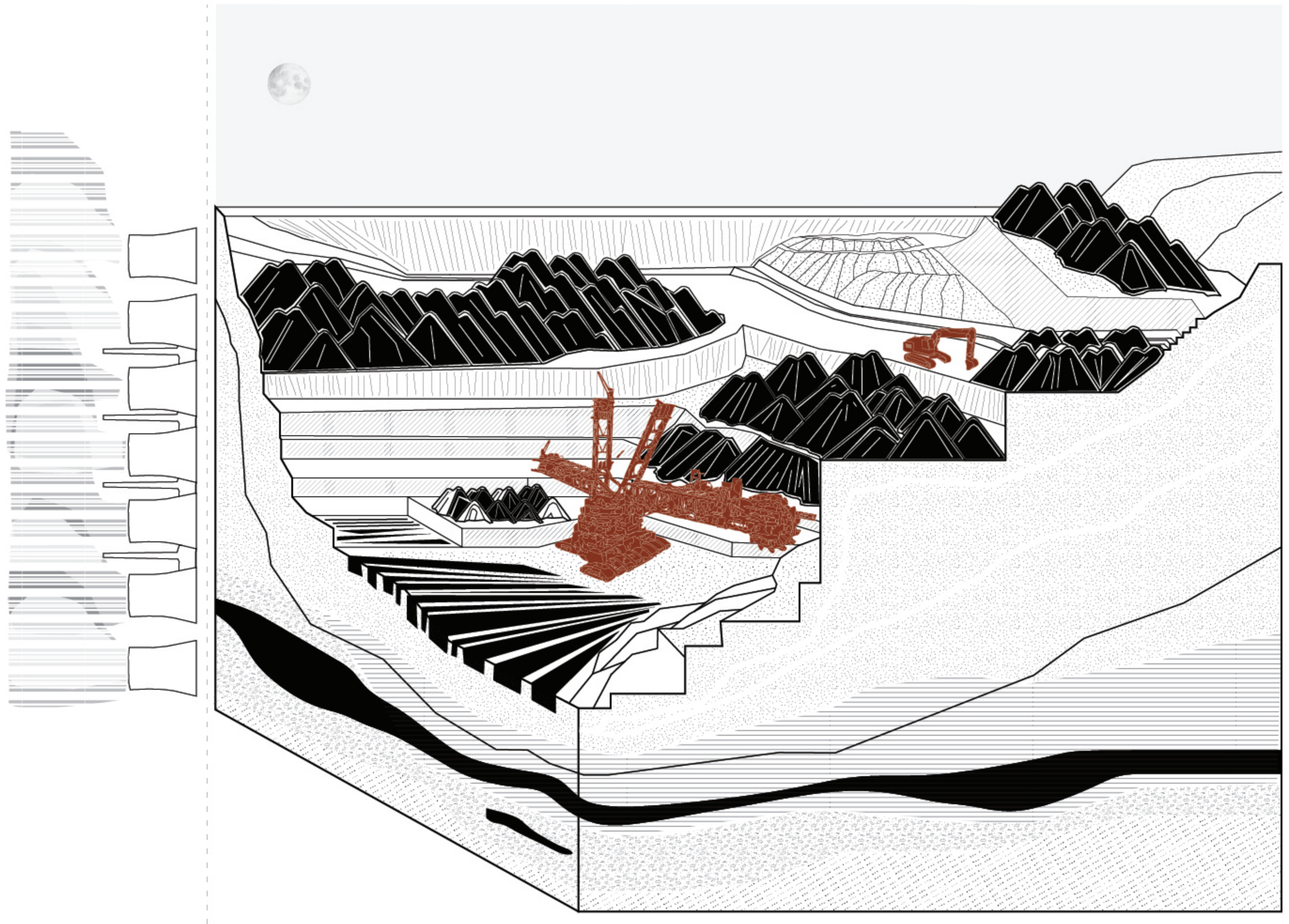


Fig 95. Coal Economy

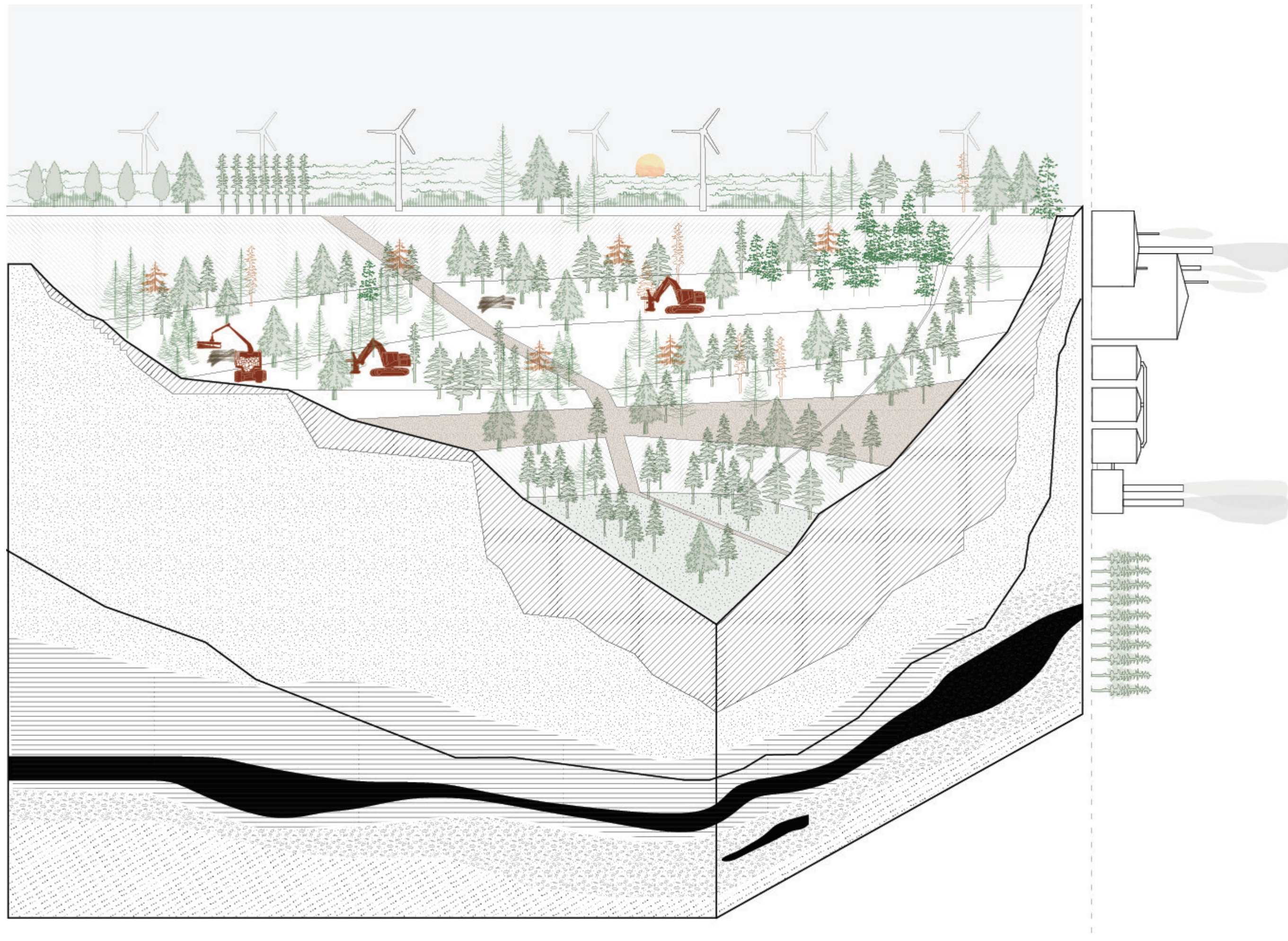


Fig 96. Wood Economy

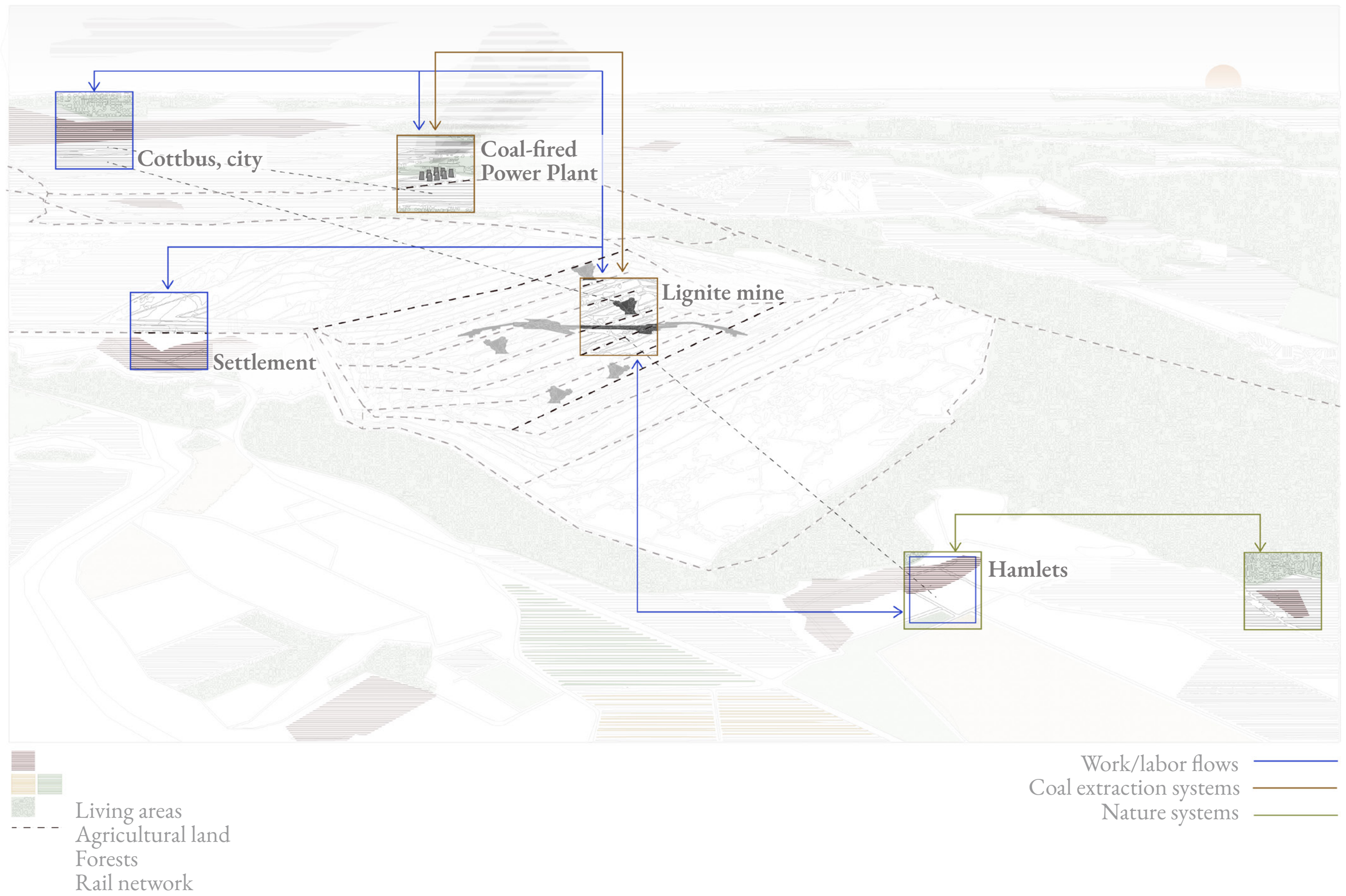


Fig 97. Coal Economy and its spatial components and flows at the north of the Jänschwalde mine

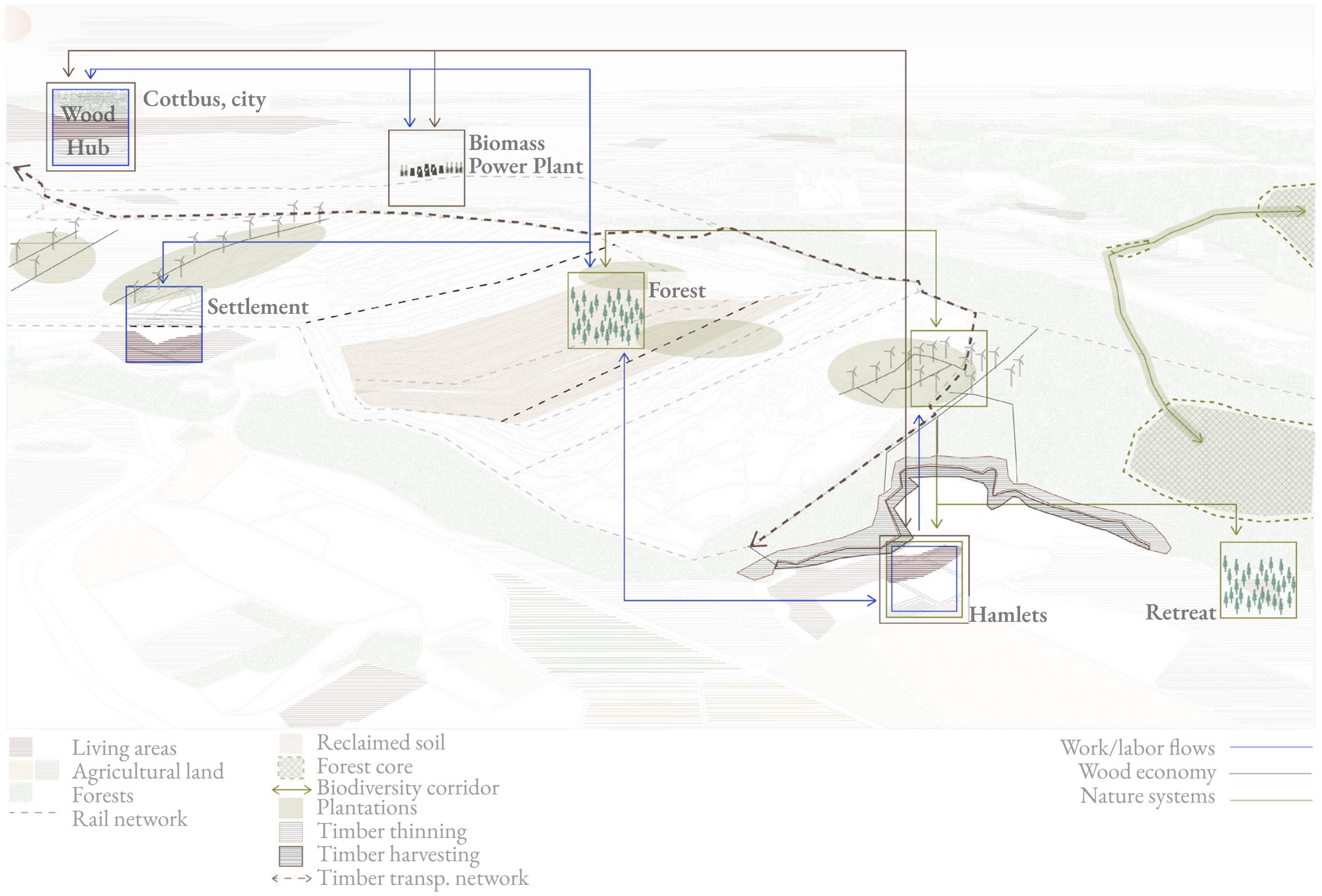


Fig 98. Wood economy and its spatial components and flows at the north of the Jänschwalde mine

Fig 99. The interventions inspired from the strategy for forests, biodiversity and plantations

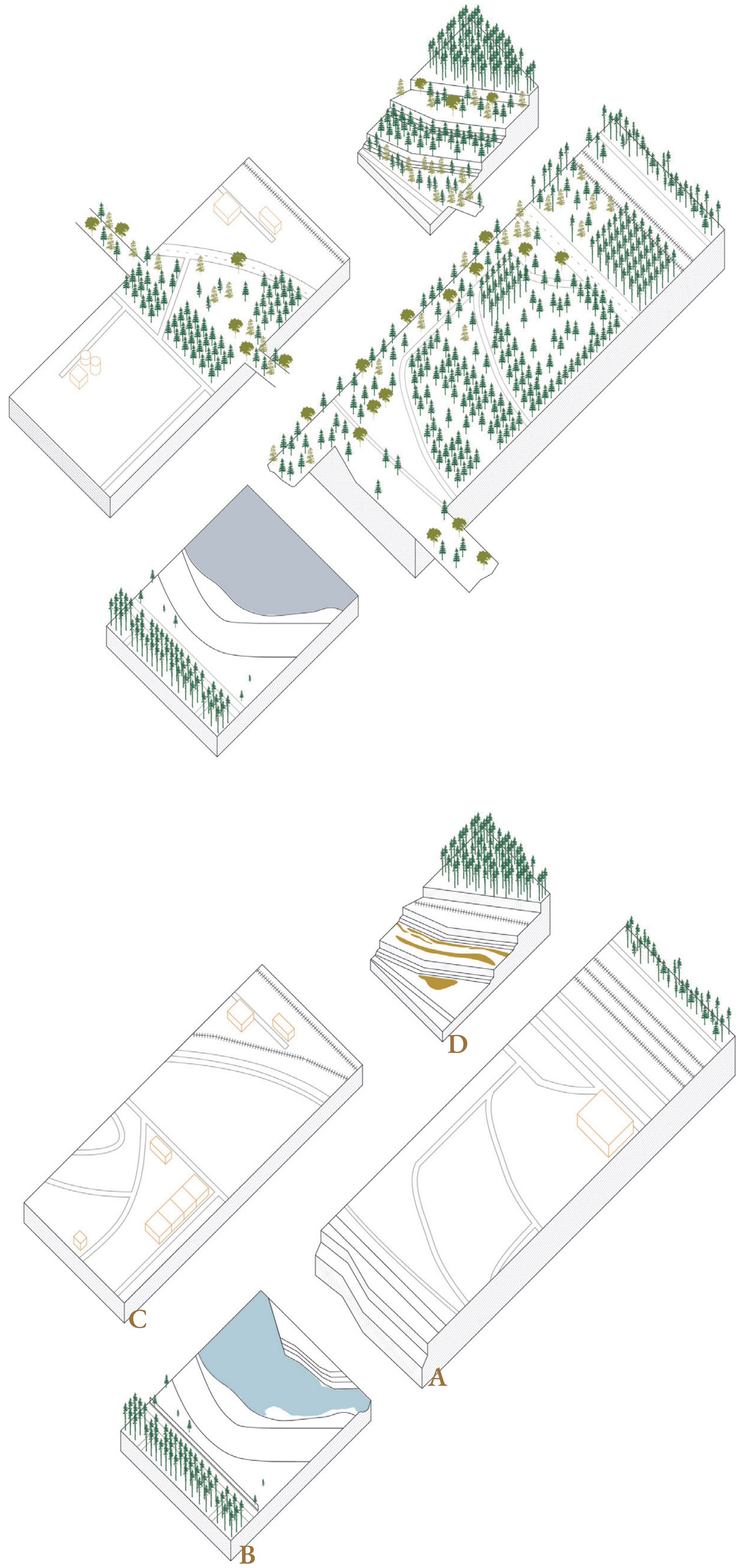


Fig 100. The spatial components for the post-mining landscape

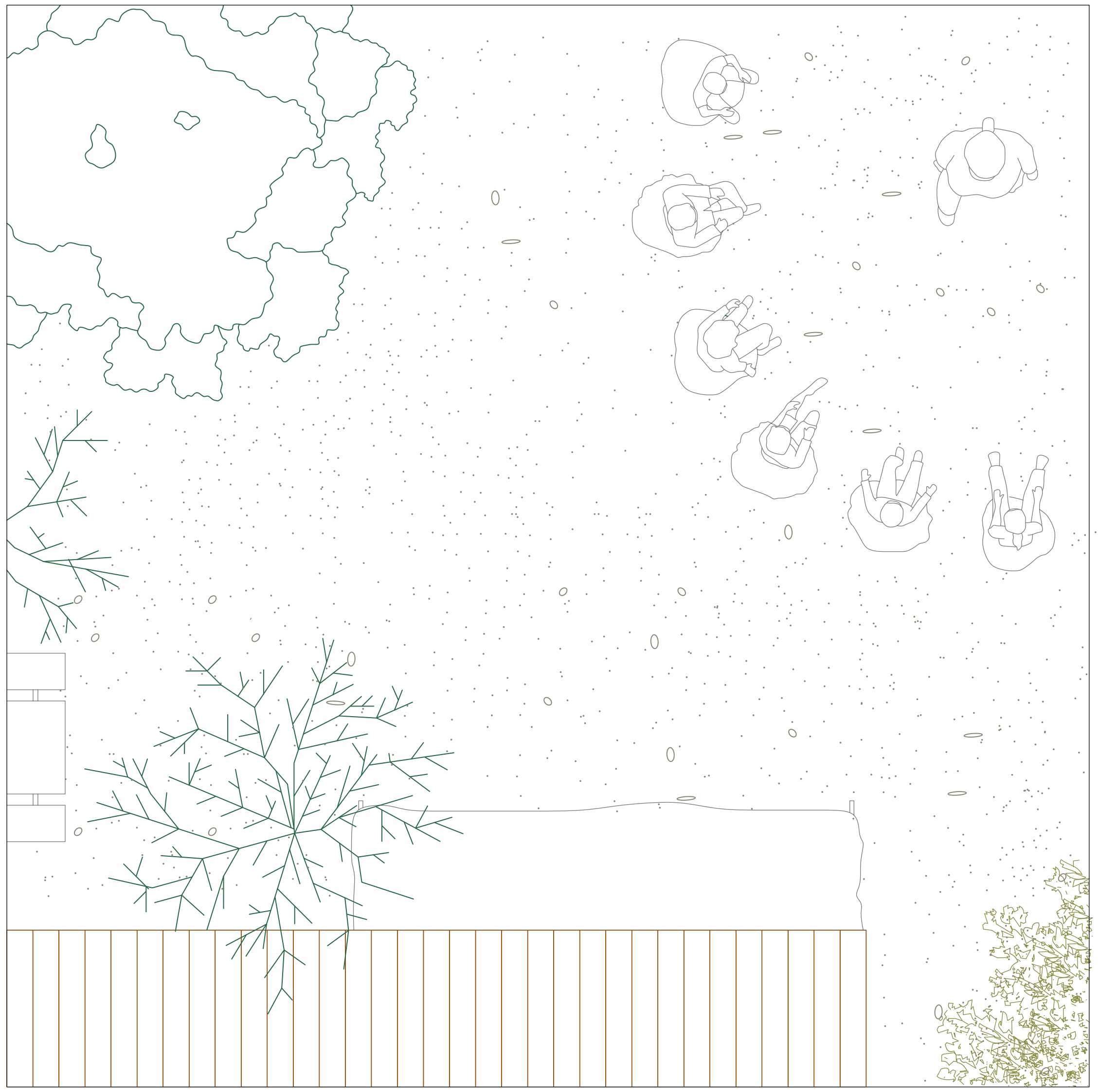
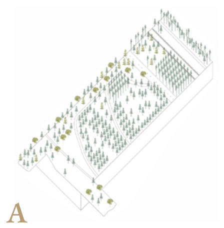
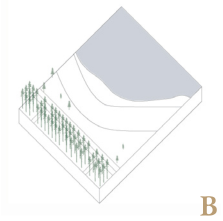


Fig 101. Waldkindergarten in Cottbuser Ostsee

Fig 102. Recreational activities in the Cottbuser Ostsee



A



B

Fig 103. Agro-forestry activities in the Cottbuser Ostsee

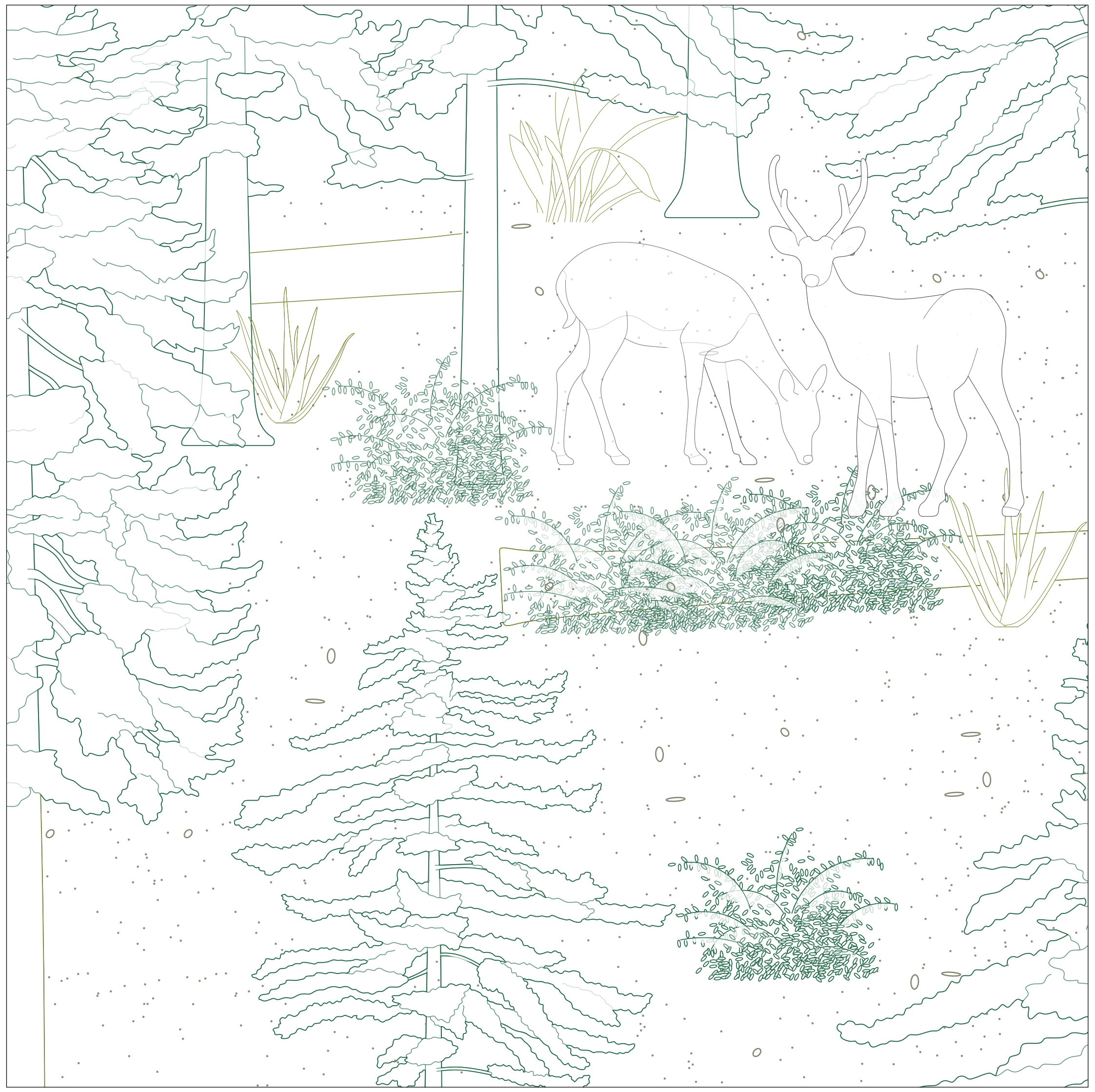
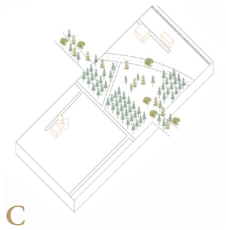


Fig 104. Biodiversity corridors in Cottbuser Ostsee



C

D

The thesis sets to explore a narrative for the post-coal era in "Europe's coal heartland", the coal regions that can be found in Germany, Poland, and the Czech Republic. After investigating current conditions and externalities, geo-dependencies, and current synergies, limits, threats, and opportunities, it proposes the re-invention of a carbon economy model (wood economy), that has great potential to foster growth, in areas that are prone to depopulate, decline and shrink following the ceasing of their current socio-economic driver (coal). In that context, it visualizes the coal regions as parts of one systemic zone that runs from the west to the east, encompassing different parameters, scales, and local conditions. Due to the systemic approach of this and the scale, it introduces four different scales that the project uses to create a strategic vision based on which examples of interventions are being explored.

The strategy that builds on one cluster of mines (Lusatia) is being tested on the scale of the transboundary region proving to work and providing similar spatial results. However, it is anticipated that the strategy would have different spatial effects in other parts of the systemic zone, for example in the western part of it, at another cluster of German mines Hambach, Garzweiler, and Inden, in the Rhine-Westphalia region. In that case, the degree of urbanization, the local conditions (suburbanization, available markets, and labor force), and also the available recourse (forests) result in an alternative carbon economic model that will have less impact than in other parts of the systemic zone.

The outcome of this thesis is to start a dialogue for the post-coal era, by problematizing, posing questions, and calling for awareness for the coal communities. The inheritance and the remains of the coal era in combination with depleted, over-exhausted landscapes and fragmented communities call for a biophysical and economic strategy that aims to regenerate the land and provide alternatives for the coal regions. The design outcome supports this effort by providing a territorial vision and design interventions that explore an alternative carbon economy, one based on forestry in the coal regions. Growth and retreat, the two main elements that the thesis uses to investigate and later design, can be seen as a lens through which we can look at different regions that are being characterized by intense operationalization linked to energy commodities. In that context, the approach, the methodology, and the strategy in this thesis could lead the way to other similar phase-out projects (ex. Gas, oil terminals).

Fig 105. Lignite mine in 2090

Process

While following the studio presentations at the beginning of the year, I was intrigued by the two terms that TT studio brought up – *accumulation and clearance*. At that moment, I could only speculate what this will be about, however, it was enough to convince me to work within this studio. After all, I was already considering joining it, since it is an interdisciplinary studio that works with dynamic territories at risk, a spatial condition that over the years has been manifesting rapidly throughout the world and is a topic of great significance for me. Coming from a country like Greece, I was raised within a context of fearing my surroundings, of being intimidated by the landscape and what it can potentially unleash, the harshness of the steep topography, the deep-sea waters, the challenging winter in the islands, the strong sun, all these elements, typical for my land, are elements of unpredictability, signs of potential scarcity, segregations, and indeterminacy. Choosing TT was a mean for me, to learn how to work with these elements rather than designing against them.

While exploring a potential site in Greece, a coastal region from Galaxidi to Porto Germeno, where among the hard beauty of the landscape, bauxite mines and an aluminum profile processing unit stands, I stumbled upon the absence of adequate data/material that would enable me to continue and support my thesis. I had to abandon my initial site and figure out another one.

Fortunately, that was quite easy. Being determined to work again with a mining/extraction site, continuing an investigation that started years ago with my diploma thesis (Lavrio's underground ore mines and remaining material hills) on the past-mining landscape, I shifted to central Europe, starting to investigate the current mining situation, gradually leading me to the study the coal mines. Although the site I chose, was not significantly influenced by water elements, I still believe that TT Studio was the right option for me. At this moment, my journey in the 'coal regions' began.

The thesis set out to investigate the coal phase-out, that is taking place in central Europe and more specifically in Germany, the Czech Republic, and Poland. It aimed to critically approach a dynamic region that was marked by years of exhausting extraction, knowing that with the demise of coal it will be conquered by wind turbines and solar panels. Instead, my thesis claimed to reclaim the sites, while working with their surroundings and all agents involved, not only humans, while attempting to foster growth in a depopulating and shrinking region.

One of my very first questions was whether or not this could be an urbanist project. I strongly believe that it is. In the epoch of the Anthropocene, that we have been altering Earth with unprecedented speed and sometimes beyond control, we should not rule out from our conversations natural systems. Also, the dichotomy between *city* and *non-city* must be further investigated. Such questions are emerging, noted by Brenner and Katsikis (2020) as "*What role do spaces beyond the city play in urbanization and how are they transformed through this process?"* In the current thesis, the role of the Urbanist is to further explore the role of these territories of extraction in the age of planetary urbanization, attempting to visualize spatial-socio-economic entanglements and give shape to sustainable synergetic narratives between *human* and *non-human*, *city* and *non-city*.

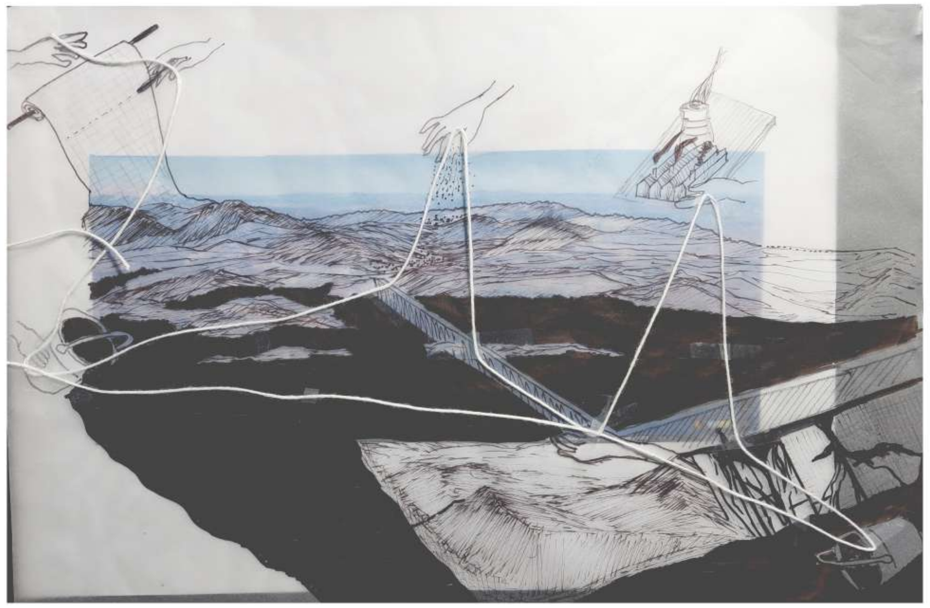


Fig 106. Collage from terra-forming in Itea, Greece

Research and Design

The graduation project is based on *research by design* approach, as part of a collective graduation studio. That means that research in the early stages combined with a critical collection of data, yielded a pile of materials to work with, and that were analyzed and processed and later enabled me to start mapping the territories I wanted to engage with. Cartographic exercises mapping early concepts of *accumulation* and *clearance*, *transposition,* and other factors helped me frame the problem statement and the research question. It also allowed me to highlight areas that are undefined or undervalued and would probably require extra research. In addition to that, as part of the studio's approach, the thesis incorporates a series of drawings 'Lines of Inquiry' that look at the chosen topic through four thematic lines, *Matter, Topos, Habitat, and Geopolitics*, urging us to be critical at all levels and look at things that perhaps could have been ignored.

The design approach comes naturally, following the studio work. Design is the tool for us to express our future intentions/narratives and by putting things on paper we automatically initiate a dialogue that could foster progress. For this to succeed a multiscalar approach is required, to bridge differences of scale, in this particular case, from the seed of a pine tree to the energy grid of a country. This method can efficiently bridge the gap between different domains but also create representations that can visualize complexities, opportunities threats, and indeterminacies. The overall method of the studio helps to construct a strong and coherent narrative that can later develop in a design proposal.

Limitations | Future Research

Framing the 'coal regions'

As explained later in the ethical considerations, a great deal of thinking and researching was put in defining the coal regions, by identifying coal mines and their boundaries. The data offered by Global Energy Monitor were cross-checked with European Environmental Agency for more reliable results.

Framing the research site for the 'Lines of Inquiry

While doing the Lines of Inquiry the focus was mainly given to Germany. The reason behind this decision is based on the availability/accessibility of data for the time being. In future research, the perspectives that are being examined could be represented also for Poland and the Czech Republic.

Framing the focus of the mining areas

This thesis is based, spatially but also theoretically around coal mines, and it creates a narrative for another carbon economy, less polluting and more sustainable. For this to happen, it claims the mines and re-organizes them in a systemic zone that revalues them and assigns new activities. However, before any new activity could take place reclamation projects have to occur to deal with the environmental degradation and pollution and many other impacts that decades of exploitation have created. This step is not investigated in this discourse, although it is a prerequisite for any future developments.

Framing the scale and sites of the project

Working through different scales was an important methodological element of this project. From the scale of the three countries and the '*coal regions*' to the design interventions, the gradual zooming-in and then zooming-out, works by considering multiple factors and how they can be unraveled throughout the systemic zone. Of all the clusters of mines scattered in the three counties, those around the borders seemed to have the biggest significance, as they would foster a conversation and future actions among the countries (trans-boundary cooperation). But it was also due to similarities found in that particular region that go back to the industrial era of the 20th century (Black Triangle). When determining the design scale (for the strategy) I decided to focus on the cluster of four mines in Germany, based on the close proximity of these mines and the magnitude of the impact triggered there from the coal phase-out. Also, due to an already developing system (and infrastructures) towards the deployment of renewables. However, alternatively, future research in that field could focus on the remaining mines, forming a line parallel to the CZ-DE borders towards the stand-alone Polish mine. It is an area of great interest, as it is not only in the center of the Black Triangle region but also includes the very forest areas that suffered the most from this industrial past.

Framing the narratives

The design of this thesis focuses on assisting the energy transition while introducing another carbon economy in the area and fostering biodiversity growth. Due to the limited time for the completion of the project, I chose specific components of the coal economy and designed how these change in the new carbon era. The thesis focuses on the spatial impact of the strategies, thus is shifts away from designing buildings or specific site locations, and focuses more on components that can be reproduced in other parts of the systemic zone.

Reflection

The relation between the project, the graduation studio, master track (Urbanism), and the master programme (MSc AUBS)?

Transitional Territories is an interdisciplinary studio that follows a three-year cycle, the current year with the theme "*Inland-Seaward*". It focuses on fragile territories, with the hypothesis that territory is a project - and through a research and design approach aims to unravel complexities and indeterminacies. As a collective studio, we are working closely with the notions of *Accumulation* and *Clearance* and we use a collection of drawing "*Lens of Inquiry*' to explore and narrate our sites of choice, by highlighting conditions and relationships under four themes, *Matter, Topos, Habitat, and Geopolitics*.

The project '***Coal regions in transition: reinventing the carbon economy***', focuses on the spatial reconfigurations that are happening and will occur due to the energy transition and more specifically the coal phase-out and how this land re-evaluation can be aligned with biodiversity and economic growth through sustainable forestry. The topic falls within the research interests of the studio as it investigates the transition of a greater operationalized landscape (Brenner & Katsikis, 2020)– an intensive coal mining one - that shaped economically and socially three countries in central Europe. In the Transitional Territories Studio, we choose to look into these territorial transitions as complex processes by unraveling the tangled existent situation and then weaving narratives that involve multiple perspectives, while maintaining a caring approach for all. Regarding the MSc track (Urbanism) the project expresses concern about the rapidly happening shift in the region that affects large groups of people, existing urban fabrics, and European economies, that rely on these extractive-productive zones. These highly systematized productive zones are turning gradually into "wastescapes" and as how the literature mentions, re-purposing and revaluing them would pose a paradigm shift towards a new era – a post-fossil fuel era – that envisions a different state for *human* and *non-human*, *city* and *non-city*. Here the role of an Urbanist is highlighted, anticipating the ongoing changes in the current economic and productive system that results in alternative urban and peri-urban environments. The spatial implications and the geopolitical maneuverings are reflected in nature but also in society, thus it is important to put this project in a greater context, in the crossing of AUBS.

Societal, scientific and professional relevance

In times of great instability and uncertainty, we often forget to see through the eyes of those being affected by our actions. It is only logical to say, that the ongoing coal phase-out will be reflected in those who live, work, and make business with the coal industry; almost half a million people in Europe. The transition should be planned in a way that addresses their concerns and is fair for all, taking into account the different dynamics of each country involved. The project aims to contribute to the re-integration of the 'coal community' in the post-fossil fuel-free era through a design that fosters economic growth (forestry) and offers opportunities for people to remain in their hometowns and work, instead of abandoning rural areas.

Our studio challenges us to think not the conventional ways; we stand critically towards decades of intensive accumulation and urges us to make action of clearance. In my project, this comes by finalizing decades of exhausting mining process, identifying its impact, and weaving a narrative that involves a sustainable future for this region based on carbon economy again, tackling not only unemployment but also the anticipated shrinking that will occur based on projections about the rural areas. The role of an Urbanist is to mediate between different stakeholders and encourage the dialogue between those involved, be able to foresee problems and anticipate threats, but most importantly to raise issues by thinking unconventionally, and unbiasedly, challenging the status quo and caring for all beings.

Reflection

Transferability of the project

Decarbonizing the energy sector is a difficult task and it will keep us busy for the years to come. Intensive anthropogenic activities aligned to the production of energy have left behind scars; our mining actions have a footprint that even when concealed through reclamation processes, continues to exist. This thesis looks closely at the coal footprint, the spatial implications that will be triggered from the coal phase-out, and the deployment of the renewables; to propose actions that should restore the balance after years of land exploitation.

The thesis starts with a 'phase-out' concept and a transition or to paraphrase it the closing of a certain lifecycle. Through research, analytical and experimental mapping, and visualization it highlights conditions/factors and elements that later shape design decisions and spatial interventions. The above process can be systematized into a coherent method and re-applied to other similar topics involving the extraction/production of energy commodities (like gas phase out) or in the future the decommissioning of wind turbines/solar panels, and potentially could tackle the decommission of similar infrastructures (like dams, offshore drilling platforms). It could also be reapplied in other parts of the world where similar systems take place as the approach/method affords this transferability.

This transferability characteristic is very important and it is tackled in the thesis. It is part of the thesis itself if we consider that from a proposed systemic zone that includes all the coal mines in Germany, the Czech Republic, and Poland, it scales down to a region in the borders, then to a cluster of mines in Germany and last zooms in to one mine. The transfer between the scales is a crucial element for approaching such decommission/phasing out projects.

Ethical considerations

I started this thesis knowing that I will have to tackle terms and practices way outside my knowledge field and academic expertise as an architect, for example, carbon cycles and economies, forests ecosystem services, etc. I tried to read and expand my horizons as much as possible and back up every action/design on research. For that, when it comes to my design proposal, I tried to avoid definitive suggestions and I worked in the intersection of design elements, scales, and materials that I am more familiar with while incorporating new ones.

Regarding the material/data that was used for the implementation of this thesis, I tried hard to cross-reference it with different sources to determine its credibility. More specifically the number of active coal mines and coal power plants in the three countries, which is the basis of this thesis, was very difficult to determine, and for that, data from Global Energy Monitor were cross-checked with European Environmental Agency for more reliable results. To that moment the exact depth of all mines or the exact number of workers remain undetermined. Additionally, coal mines and coal power plants are privately owned multinational companies and material that was obtained through them should be used with a critical set of eyes. Also, regarding the energy transition and the sustainable forestry policies, policy reports from the European Union and German ministries were used as a base for the quantitative data hoping for maximal credibility. Concerning the design phase, several interventions and decisions were made, for how the new proposed carbon economy should work, and of course, final results could be debated for their implementation and feasibility as they require the involvement/willingness of locals to abandon practices and everyday life that they are familiar with and adopt a new one in the forestry sector.

Last, this thesis calls us to rethink the relationship between energy, space, humans, and nature and aims to bring awareness and establish a new way of understanding carbon economies at a regional and transboundary level. Energy is of course a necessity for us to continue to live in the "world" that we have shaped around us. However, we should be more critical of this consumeristic point of view that takes energy for granted. The most important output of this thesis is to challenge the current practices that seem to dominate every single piece of land on this planet, stemming from a misunderstanding or even a narcissistic/selfish point of view that humans are superior to other forms of life. Instead, we should be exploring alternatives that foster synergetic relationships between all.

Reflection

ITHAKA

Σὰ βγεῖς στὸν πηγαιμὸ γιὰ τὴν Ἰθάκη,
νὰ εὔχεσαι νἆναι μακρὺς ὁ δρόμος,
γεμάτος περιπέτειες, γεμάτος γνώσεις.

Τοὺς Λαιστρυγόνας καὶ τοὺς Κύκλωπας,τὸν
θυμωμένο Ποσειδῶνα μὴ φοβᾶσαι,
τέτοια στὸν δρόμο σου ποτέ σου δὲν θὰ βρεῖς,
ἂν μέν᾽ ἡ σκέψις σου ὑψηλή, ἂν ἐκλεκτὴ
συγκίνησις τὸ πνεῦμα καὶ τὸ σῶμα σου ἀγγίζει.

Τοὺς Λαιστρυγόνας καὶ τοὺς Κύκλωπας,
τὸν ἄγριο Ποσειδώνα δὲν θὰ συναντήσεις,
ἂν δὲν τοὺς κουβανεῖς μὲς στὴν ψυχή σου,
ἂν ἡ ψυχή σου δὲν τοὺς στήνει ἐμπρός σου.

.Νὰ εὔχεσαι νά ῾ναι μακρὺς ὁ δρόμος.
Πολλὰ τὰ καλοκαιρινὰ πρωϊὰ νὰ εἶναι
ποὺ μὲ τί εὐχαρίστηση, μὲ τί χαρὰ
θὰ μπαίνεις σὲ λιμένας πρωτοειδωμένους·

Νὰ σταματήσεις σ᾽ ἐμπορεῖα Φοινικικά,
καὶ τὲς καλὲς πραγμάτειες ν᾽ ἀποκτήσεις,
σεντέφια καὶ κοράλλια, κεχριμπάρια κ᾽ ἔβενους,
καὶ ἡδονικὰ μυρωδικὰ κάθε λογῆς,
ὅσο μπορεῖς πιὸ ἄφθονα ἡδονικὰ μυρωδικά.

Σὲ πόλεις Αἰγυπτιακὲς πολλὲς νὰ πᾷς,
νὰ μάθεις καὶ νὰ μάθεις ἀπ᾽ τοὺς σπουδασμένους.
Πάντα στὸ νοῦ σου νἄχῃς τὴν Ἰθάκη.
Τὸ φθάσιμον ἐκεῖ εἶν᾽ ὁ προορισμός σου.

Ἀλλὰ μὴ βιάζῃς τὸ ταξείδι διόλου.
Καλλίτερα χρόνια πολλὰ νὰ διαρκέσει.
Καὶ γέρος πιὰ ν᾽ ἀράξῃς στὸ νησί,
πλούσιος μὲ ὅσα κέρδισες στὸν δρόμο,
μὴ προσδοκώντας πλούτη νὰ σὲ δώσῃ ἡ Ἰθάκη.

Ἡ Ἰθάκη σ᾽ ἔδωσε τ᾽ ὡραῖο ταξίδι.
Χωρὶς αὐτὴν δὲν θἄβγαινες στὸν δρόμο.
Ἄλλα δὲν ἔχει νὰ σὲ δώσει πιά.

Κι ἂν πτωχικὴ τὴν βρῇς, ἡ Ἰθάκη δὲν σὲ γέλασε.
Ἔτσι σοφὸς ποὺ ἔγινες, μὲ τόση πείρα,
ἤδη θὰ τὸ κατάλαβες ᾑ Ἰθάκες τί σημαίνουν.

As you set out for Ithaka
hope your road is a long one,
full of adventure, full of discovery.

Laistrygonians, Cyclops,
angry Poseidon—don't be afraid of them:
you'll never find things like that on your way
as long as you keep your thoughts raised high,
as long as a rare excitement
stirs your spirit and your body.

Laistrygonians, Cyclops,
wild Poseidon—you won't encounter them
unless you bring them along inside your soul,
unless your soul sets them up in front of you.

Hope your road is a long one.
May there be many summer mornings when,
with what pleasure, what joy,
you enter harbors you're seeing for the first time;

may you stop at Phoenician trading stations
to buy fine things,
mother of pearl and coral, amber and ebony,
sensual perfume of every kind—
as many sensual perfumes as you can;

and may you visit many Egyptian cities
to learn and go on learning from their scholars.
Keep Ithaka always in your mind.
Arriving there is what you're destined for.

But don't hurry the journey at all.
Better if it lasts for years,
so you're old by the time you reach the island,
wealthy with all you've gained on the way,
not expecting Ithaka to make you rich.

Ithaka gave you the marvelous journey.
Without her you wouldn't have set out.
She has nothing left to give you now.

And if you find her poor, Ithaka won't have fooled you.
Wise as you will have become, so full of experience,
you'll have understood by then what these Ithakas mean.

C. P. Cavafy, "The City" from C.P. Cavafy: Collected Poems. Translated by Edmund Keeley and Philip Sherrard
Greek Source: http://users.uoa.gr/~nektar/arts/poetry/constantin_cavafy_poems.htm

I would like to conclude this report with the poem "Ithaka" by *Kavafis*. In the realm of coal regions in transition, the poem finds profound resonance, as a metaphor. Like the journey described in the poem, these regions are embarking on a transformative path, navigating the challenges of economic diversification and ecological restoration. "Ithaka" speaks of the importance of the journey itself, emphasizing the lessons learned and experiences gained along the way. The coal transition to come will be a journey in which sooner or later we will all be involved, each of us with a different starting point, with a different purpose and motivation. No matter how much we try to predict 2035 or 2060, there is always the possibility that our predictions will fail, which is why this thesis proposes the creation of a systematic zone composed of coal mines and related facilities to be decommissioned, as a new territory that can be redefined and reconfigured to meet the future needs of society, beyond the extraction of fossil fuels.

In "Ithaka", the poet Cavafy, inspired by the Homer epics and Odysseus' long return journey from Troy to Ithaca, forms an allegory for each traveler beginning a journey in life. He wishes the journey to be a long one, full of experiences and discoveries so that when one finally arrives, one is richer."Ithaka", then, was nothing more than an incentive for someone to embark on a journey, to be able to dare. The same allegory can be seen in our journey to decarbonize the energy sector. It is a journey that will surely be long and just as in the story of Odysseus there will be many stops, delays, difficulties, and unforeseen situations. But the goal must remain the same and we must always redefine our path towards it. In the end, we will not only have accomplished one particular goal, but we will have learned to travel together to any other destination we are destined to. 'Ithaka' reminds us that it is the journey, with all its hardships and discoveries, that shapes our character and offers the most valuable insights.

Literature

Alves Dias, P., Conte, A., Kanellopoulos, K., Kapetaki, Z., Mandras, G., Medarac, H., Nijs, W., Ruiz Castello, P., Somers, J., & Tarvydas, D. (2021, March 15). Recent trends in EU coal, peat and oil shale regions. JRC Publications Repository. https://publications.jrc.ec.europa.eu/repository/handle/JRC123508

American Mine Services. (2019, March 7). 5 Major Types of Surface Mining. AMS. https://americanmineservices.com/types-of-surface-mining/

Aurambout, J. P., Schiavina, M., Melchiori, M., Fioretti, C., Guzzo, F., Vandecasteele, I., Proietti, P., Kavalov, B., Panella, F., & Koukoufikis, G. (2022). Shrinking Cities. In JRC Publications Repository. European Commission. https://publications.jrc.ec.europa.eu/repository/handle/JRC126011

Azau, S., & Treadwell, K. (2021). EUROPE'S COAL REGIONS: Boosting employment, environment, economy through "just transition" 2 BOOSTING EMPLOYMENT, ENVIRONMENT, ECONOMY THROUGH ' JUST TRANSITION' (WWF European Policy Office, Ed.). https://www.wwf.eu/?3223816/Europes-coal-regions-boosting-employment-environment-economy-through-just-transition

Baker, G., Chen, R., Fenaughty, L., Li, C., Liu, S., Read, S., & You, N. (2021). Kerb 29: Wild. In Idea Books. Uro Publications.

Belanger, P. (2016). Landscape as Infrastructure. Taylor And Francis.

Berger, A. (2007). Drosscape : wasting land in urban America. Princeton Architectural.

Biodiversity Information System for Europe. (n.d.). EU Biodiversity strategy. Biodiversity.europa.eu. Retrieved May 25, 2023, from https://biodiversity.europa.eu/countries/germany/eu-biodiversity-strategy

Borges, J. G., Diaz-Balteiro, L., McDill, M. E., & Rodriguez, L. C. E. (Eds.). (2014). The Management of Industrial Forest Plantations: Theoretical Foundations and Applications (Vol. 33). Springer. https://doi.org/10.1007/978-94-017-8899-1

Branzi, A., & Cattaneo, E. C. (2020). Andrea Branzi : E=mc2 : The Project in the Age of Relativity. Actar Publishers.

Bratton, B. H. (2019). The terraforming. Strelka Press.

Brenner, N., & Katsikis, N. (2020). Operational Landscapes: Hinterlands of the Capitalocene. Architectural Design, 90(1), 22–31. https://doi.org/10.1002/ad.2521

Bridge, G. (2009). The Hole World: scales and spaces of extraction. New Geographies 2: Landscapes of Energy, 43–48.

Chieffalo, M., & Smachylo, J. (2019). New geographies 10 Fallow. Harvard University Graduate School Of Design.

Climate action and the Green Deal. (n.d.). Commission.europa.eu. Retrieved December 23, 2022, from https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/climate-action-and-green-deal_en

Coal production and consumption statistics. (2022). Ec.europa.eu. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Coal_production_and_consumption_statistics#Consumption_and_production_of_brown_coal

Coal regions in transition. (2022). Energy.ec.europa.eu. https://energy.ec.europa.eu/topics/oil-gas-and-coal/eu-coal-regions/coal-regions-transition_en

Order of the Vice-President of the Court in Case C-121/21 R: Czech Republic v Poland, (Court of Justice of the European Union September 20, 2021). https://curia.europa.eu/jcms/upload/docs/application/pdf/2021-05/cp210089en.pdf

Cutieru, A. (2021, July 12). Shrinking Cities: The Rise and Fall of Urban Environments. ArchDaily. https://www.archdaily.com/964908/shrinking-cities-the-rise-and-fall-of-urban-environments

de La Bellacasa, M. P. (2017). Matters of Care: Speculative Ethics in More Than Human Worlds. University of Minnesota Press.

Department of Environmental Protection. (n.d.). Underground Coal Mining. Department of Environmental Protection. Retrieved December 23, 2022, from https://www.dep.pa.gov/Business/Land/Mining/Pages/Underground-Coal-Mining.aspx

Deutsche Welle. (2018, October 27). Germany: Thousands protest to save Hambach Forest | DW | 27.10.2018. DW.COM. https://www.dw.com/en/germany-thousands-protest-to-save-hambach-forest/a-46060826

Deutsche Welle. (2020, June 23). Hambach Forest: Police again tackle anti-coal activists' eight-year blockade | DW | 23.06.2020. DW.COM. https://www.dw.com/en/hambach-forest-police-again-tackle-anti-coal-activists-eight-year-blockade/a-53904915

Esposito, E., & Abramson, S. F. (2021). The European coal curse. Journal of Economic Growth, 26(1), 77–112. https://doi.org/10.1007/s10887-021-09187-w

European Commission. (2020). Biodiversity strategy for 2030. In environment.ec.europa.eu. https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en

European Commission. (2021). New EU Forest Strategy for 2030. In ec.europa.eu. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021DC0572

European Commission. (2023). The impact of demographic change -in a changing environment. https://commission.europa.eu/system/files/2023-01/the_impact_of_demographic_change_in_a_changing_environment_2023.PDF

European Commission, Directorate-General for Agriculture and Rural Development. (2021). A long-term Vision for the EU's Rural Areas - Towards stronger, connected, resilient and prosperous rural areas by 2040. In eur-lex.europa.eu. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2021:345:FIN

European Commission, Joint Research Centre, Barbosa, M., Peteves, E., Vázquez Hernández, C, Aparicio, G., Kanellopoulos, K., Kapetaki, Z., Nijs, W., Shortall, R., Mandras, G., Czako, V., Trombetti, M., Telsnig, T., Medarac, H., Lacal Arántegui, R, Tzimas, E., & Dias, A. (2018). EU coal regions : opportunities and challenges ahead. Publications Office. https://doi.org/doi/10.2760/064809

European Council. (2022a, December 16). EU sanctions against Russia explained. Www.consilium.europa.eu. https://www.consilium.europa.eu/en/policies/sanctions/restrictive-measures-against-russia-over-ukraine/sanctions-against-russia-explained/

European Council. (2022b, December 20). Tackling climate change in the EU - Consilium. Europa.eu; European Council. https://www.consilium.europa.eu/en/policies/climate-change/

European Environment Agency. (1999). Environment in the European Union at the turn of the century. In www.eea.europa.eu (p. 143). https://www.eea.europa.eu/publications/92-9157-202-0/3.4.pdf/view

Evans, J. (2008a). The Forests Handbook, Volume 1: An Overview of Forest Science. In Oclc.org (Vol. 1). Wiley-Blackwell.

Evans, J. (2008b). The Forests Handbook, Volume 2: Applying Forest Science for Sustainable Management. In Oclc.org (Vol. 2). Wiley-Blackwell.

FAO. (2020). Global Forest Resources Assessment 2020: Main Report. FAO. https://www.fao.org/documents/card/en/c/ca9825en

FAO. (2022). The State of the World's Forests 2022: Forest pathways for green recovery and building inclusive, resilient and sustainable economies. FAO. https://www.fao.org/3/cb9360en/cb9360en.pdf

FAO - Forestry Economics and Policy Division. (2009). State of the World's Forests 2009. FAO. https://www.fao.org/documents/card/en/c/0390ae34-5ae6-5d90-b573-e28a15fe3fc0

Federal Ministry of Food and Agricultural. (2021). German Forests - Forests for Nature and People. In www.bmel.de. https://www.bmel.de/SharedDocs/Downloads/EN/Publications/german-forests.pdf?__blob=publicationFile&v=7

Garcia, J. M., & Casero, J. J. D. (2012). Sustainable Forest Management - Current Research. In www.intechopen.com. Intechopen. https://www.intechopen.com/books/617

Ghosn, R. (2010). New Geographies 02: Landscapes of Energy . In New Geographies (Issue 2). Harvard University Graduate School of Design.

Ghosn, R. (2014). Energy Regions: Production Without Representation? Journal of Architectural Education, 68(2), 224–228. https://doi.org/10.1080/10464883.2014.937240

Graetz, C. (2015, July 15). Artenvielfalt auf der Tagebaukippe. Www.leag.de. https://www.leag.de/de/seitenblickblog/artikel/artenvielfalt-auf-der-tagebaukippe/

Hertzer, D. (2021, March 3). Wertvoll für die Artenvielfalt: Offenflächen im Revier. Www.leag.de. https://www.leag.de/de/seitenblickblog/artikel/wertvoll-fuer-die-artenvielfalt-offenflaechen-im-revier/

Ibáñez, D. (2019). Urbanism beyond "Eco-Parts" and "Eco-Bubbles." In D. Ibáñez, J. Hutton, & K. Moe (Eds.), Wood Urbanism: From the Molecular to the Territorial (pp. 306–315). Actar Publishers.

Ibáñez, D., Hutton, J. E., & Moe, K. (2019). Wood urbanism : from the molecular to the territorial. Actar Publishers.

Ibañez, D., & Katsikis , N. (2014). New Geographies 06: Grounding Metabolism. In New Geographies (Issue 2). Harvard University Graduate School of Design.

Ingmar Björn Nolting. (2023, January 24). The eviction of Lützerath: the village being destroyed for a coalmine – a photo essay. The Guardian. https://www.theguardian.com/artanddesign/2023/jan/24/eviction-lutzerath-village-destroyed-coalmine-a-photo-essay

Kleinow, R. (2015). Die Genese von schwer gewinnbaren Tonen und Toneisensteinen im basalen Bereich der Inden-Schichten im Tagebau Hambach [Dissertation]. https://publications.rwth-aachen.de/record/573679/files/573679.pdf

Labban , M. (2019). Rhythms of Wasting/Unbuilding the Built Environment . In New Geographies 10: Fallow. Harvard University Graduate School of Design.

Latour, B. (2018). Down to earth : politics in the new climatic regime (C. Porter, Trans.). Polity Press.

Mehrotra, R., Vera, F., MayoralJ., Sennett, R., & Burdett, R. (2017). Ephemeral urbanism : does permanence matter? (First edition). List Lab.

Mononen, T., Kivinen, S., Kotilainen, J. M., & Leino, J. (2022). Social and environmental impacts of mining activities in the EU. In https://www.europarl.europa.eu/thinktank/en/document/IPOL_STU(2022)729156 (pp. 15–23). Policy Department for Citizens' Rights and Constitutional Affairs - Directorate General for Internal Policies. https://www.europarl.europa.eu/RegData/etudes/STUD/2022/729156/IPOL_STU(2022)729156_EN.pdf

OMA. (2010). Roadmap 2050: A practical Guide to a Prosperous, Low-carbon Europe. OMA. https://www.oma.com/publications/roadmap-2050-a-practical-guide-to-a-prosperous-low-carbon-europe

PGE Mining and Conventional Energy SA. (2017). Belchatow power plant. Pgegiek.pl; PGE Górnictwo i Energetyka Conventional Spółka Akcyjna. https://pgegiek.pl/Nasze-oddzialy/Elektrownia-Belchatow

Pope, A. (2020, December 15). CORKTOWN. Medium. https://zoneresearch.medium.com/corktown-b515c11c2dfe

Pope, A., & Vasallo, J. (2019). Cellulose, Carbon, and Urban Reform . In D. Ibañez, J. Hutton, & K. Moe (Eds.), Wood Urbanism: From the Molecular to the Territorial (pp. 318–323). Actar Publishers.

Rocha, M., Parra, P. Y., Sferra, F., Schaeffer, M., Roming, N., Ancygier, A., Ural , U., & Hare, B. (2017). A stress test for coal in Europe under the Paris Agreement. In Climate Analytics. https://climateanalytics.org/media/eu-coalstresstest-report-2017.pdf

RWE. (n.d.). Neurath lignite-fired Power Station. Www.rwe.com. Retrieved December 23, 2022, from https://www.rwe.com/en/the-group/countries-and-locations/neurath-power-plant

Schirmer, T. (2020, October 23). Erntezeit im Lausitzer Reku-Land. Www.leag.de. https://www.leag.de/de/seitenblickblog/artikel/erntezeit-im-lausitzer-reku-land/

Schirmer, T. (2021a, March 21). LEAG-Nachwuchs in der Mischwald-Kinderstube. Www.leag.de. https://www.leag.de/de/seitenblickblog/artikel/leag-nachwuchs-in-der-mischwald-kinderstube/

Schirmer, T. (2021b, June 18). Vielseitiges Schilfgras - LEAG unterstützt EU-Projekt. Www.leag.de. https://www.leag.de/de/seitenblickblog/artikel/vielseitiges-schilfgras-leag-unterstuetzt-eu-projekt/

Sijmons, D., Hugtenburg, J., Anton Van Hoorn, & Feddes, F. (2014). Landscape and energy : designing transition. Nai010 Publishers.

Strub, N. (2002). Black triangle: On the way to environmental recovery. In unepgrid.ch. https://unepgrid.ch/en/resource/n164

Turgeon, A., & Morse, E. (2022, July 30). Coal | National Geographic Society. Education.nationalgeographic.org; National Geographic Society. https://education.nationalgeographic.org/resource/coal

Waldheim, C. (2016). Landscape as urbanism : a general theory. Princeton University Press.

Windkraft-Journal. (2022, September 8). Wind- und Solarkraftwerke: Energiepark-Übergabe in der Lausitz erfolgreich | Windkraft-Journal. Windkraft-Journal - Windenergie Erneuerbaren Energien Nachrichten. https://www.windkraft-journal.de/2022/09/08/wind-und-solarkraftwerke-energiepark-uebergabe-in-der-lausitz-erfolgreich/179176

Energy related:

https://www.eea.europa.eu/en/datahub/datahubitem-view/9405f714-8015-4b5b-a63c-280b82861b3d
https://app.electricitymaps.com/map
https://globalenergymonitor.org/projects/global-coal-plant-tracker/
https://globalenergymonitor.org/projects/global-coal-mine-tracker/
https://globalenergymonitor.org/projects/global-nuclear-power-tracker/
https://globalenergymonitor.org/projects/global-geothermal-power-tracker/
https://globalenergymonitor.org/projects/global-wind-power-tracker/
https://globalenergymonitor.org/projects/global-solar-power-tracker/
https://globalenergymonitor.org/projects/global-oil-gas-extraction-tracker/
https://globalenergymonitor.org/projects/global-coal-terminals-tracker/
https://globalenergymonitor.org/projects/global-oil-infrastructure-tracker/
https://globalenergymonitor.org/projects/global-gas-plant-tracker/
https://globalenergymonitor.org/projects/global-bioenergy-power-tracker/

Land Uses, OpenStreetMap data, urban settlements:

https://ghsl.jrc.ec.europa.eu/download.php
http://download.geofabrik.de/europe.html
https://land.copernicus.eu/pan-european/corine-land-cover/clc2018?tab=download

Nature elements:

https://land.copernicus.eu/local/natura/n2k-2018?tab=download
https://land.copernicus.eu/local/riparian-zones/riparian-zones-2018
https://land.copernicus.eu/imagery-in-situ/eu-hydro/eu-hydro-river-network-database?tab=download
https://land.copernicus.eu/pan-european/high-resolution-layers/forests/tree-cover-density/status-maps/tree-cover-density-2018?tab=download
https://efi.int/knowledge/models/efiscen/inventory

-Tree cover/gain/loss:

Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850–53. Data available on-line from:https://glad.umd.edu/dataset/global-2010-tree-cover-30-m. Accessed through Global Forest Watch on 25/05/2023. www.globalforestwatch.org

Potapov, P., Hansen, M.C., Pickens, A., Hernandez-Serna, A., Tyukavina, A., Turubanova, S., Zalles, V., Li, X., Khan, A., Stolle, F., Harris, N., Song, X-P., Baggett, A., Kommareddy, I., and Kommareddy, A. 2022. The Global 2000-2020 Land Cover and Land Use Change Dataset Derived From the Landsat Archive: First Results. Frontiers in Remote Sensing, 13, April 2022. https://doi.org/10.3389/frsen.2022.856903

-Carbon flux, carbon density:

Harris et al. (2021). Global maps of 21st century forest carbon fluxes. Accessed on 25/05/2023 from Global Forest Watch. www.globalforestwatch.org/

-Potential Carbon gains:

Cook-Patton et al. 2020. Carbon accumulation potential from natural forest regrowth in potentially reforestable areas. Accessed through Global Forest Watch 25/05/2023. www.globalforestwatch.org

-Forest Landscape Integrity Index:

Grantham, H. S. et al. (2020). "Forest Landscape Integrity Index". Accessed on 25/05/2023 from Global Forest Watch. www.globalforestwatch.org/

-Intact Forests Landscape:

Greenpeace, University of Maryland, World Resources Institute and Transparent World. "Intact Forest Landscapes. 2000/2013/2016/2020" Accessed through Global Forest Watch on 25/05/2023. www.globalforestwatch.org

-Forest map of Europe:

https://efi.int/knowledge/maps/forest
Sources:
Kempeneers, P., Sedano, F., Seebach, L., Strobl, P., San-Miguel-Ayanz, J. 2011: Data fusion of different spatial resolution remote sensing images applied to forest type mapping, IEEE Transactions on Geoscience and Remote Sensing, in print.
Päivinen, R., Lehikoinen, M., Schuck, A., Häme, T., Väätäinen, S., Kennedy, P., & Folving, S., 2001. Combining Earth Observation Data and Forest Statistics. EFI Research Report 14. European Forest Institute, Joint Research Centre - European Commission. EUR 19911 EN. 101p.
Schuck, A., Van Brusselen, J., Päivinen, R., Häme, T., Kennedy, P. and Folving, S. 2002. Compilation of a calibrated European forest map derived from NOAA-AVHRR data. European Forest Institute. EFI Internal Report 13, 44p. plus Annexes;

General, Regional data, Statistics:

https://ec.europa.eu/eurostat/databrowser/view/PROJ_19RP3/default/table?lang=en&category=proj.proj_19r
https://ec.europa.eu/eurostat/databrowser/view/TGS00005/default/table?lang=en&category=reg.reg_eco10.reg_eco10gdp
https://ec.europa.eu/eurostat/databrowser/product/view/LFST_R_LFU3RT?lang=en&category=reg.reg_lmk.lfst_r_lfu
https://data.europa.eu/data/datasets/estat-nuts-classification?locale=en
https://www.czso.cz/csu/czso/home

Figures

Coal Regions in transition: Reinventing the carbon economy

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