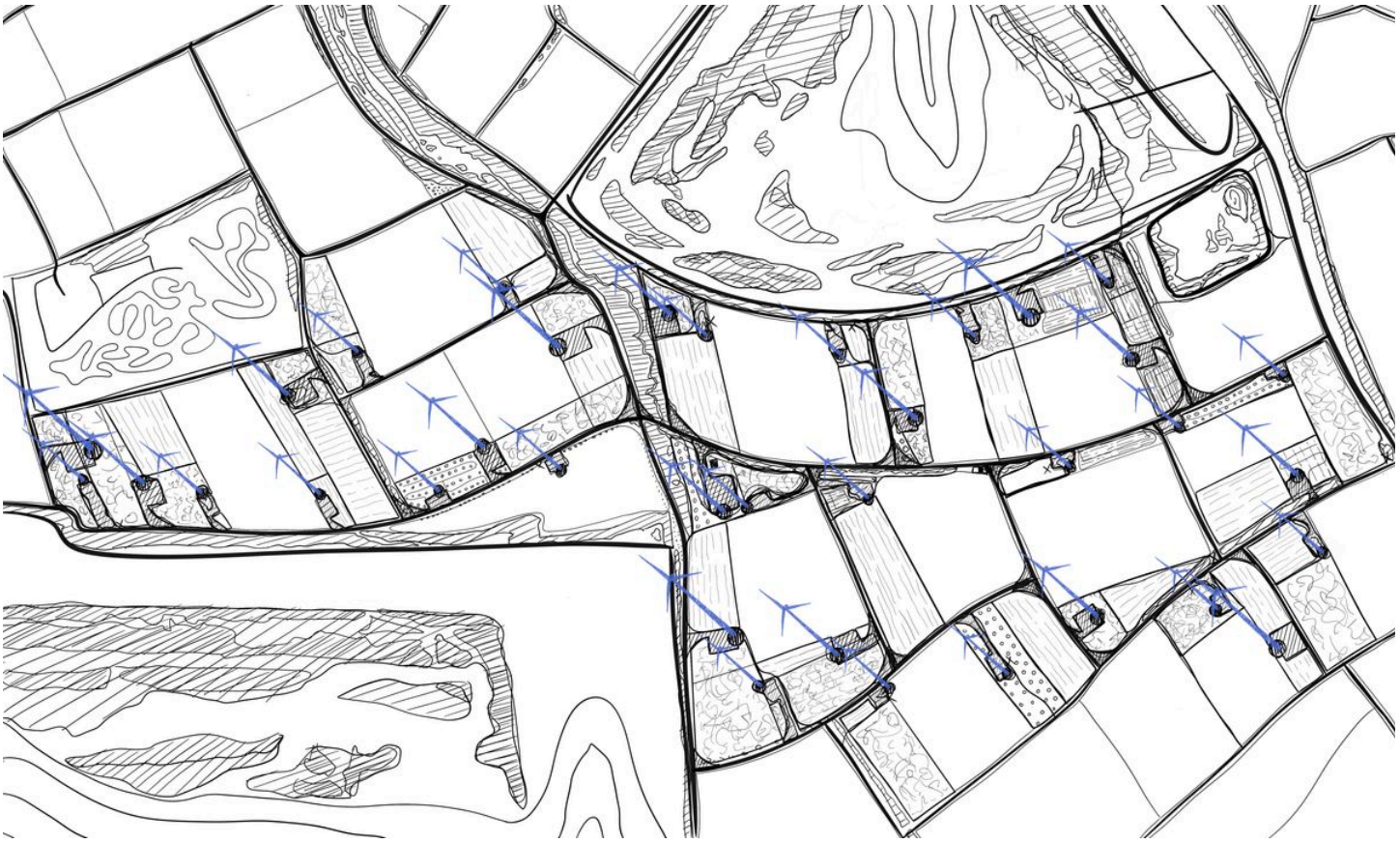
ETH Zurich Department of Architecture
ARCHITECTURE OF TERRITORY
Chair of Architecture
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Professor Milica Topalović

Power to the People
Fall 2022

Energy and Wind

Beyond the Monotony of a Productive Landscape

Mario Bieri, Jérome Ammann, and Salome Roggensinger



Large scale landscape transformations in the form of gigantic open pit mines defined the territory of the “Rheinische Revier” in the last century in order to satisfy Germany’s energy needs. As fossil energy carriers like brown coal are phased out in favour of new, sustainable ways to generate energy, the region is facing a paradigm shift not only in terms of energy production, but also in regard to the territory. The holes and recultivated surfaces left behind by RWEs excavators are gigantic in scale, but there is precedent for dealing with the aftermath of mining operations.

The wind park however, though not foreign to the region, is a relatively new and so far undesigned typology of energy infrastructure. The turbines dot the landscape according to planning regulations and zoning laws with no overarching design principle. Combined with the big scale industrial agriculture that occupies the ground in-between, the whole landscape becomes space for production and is left uninhabitable for both humans and animals. Is it possible to reimagine the way wind parks relate to the territory and transform them from necessary infrastructure into diverse, urbanised spaces?

Rheinisches Revier—Former Coal Mining Site Turning Renewable



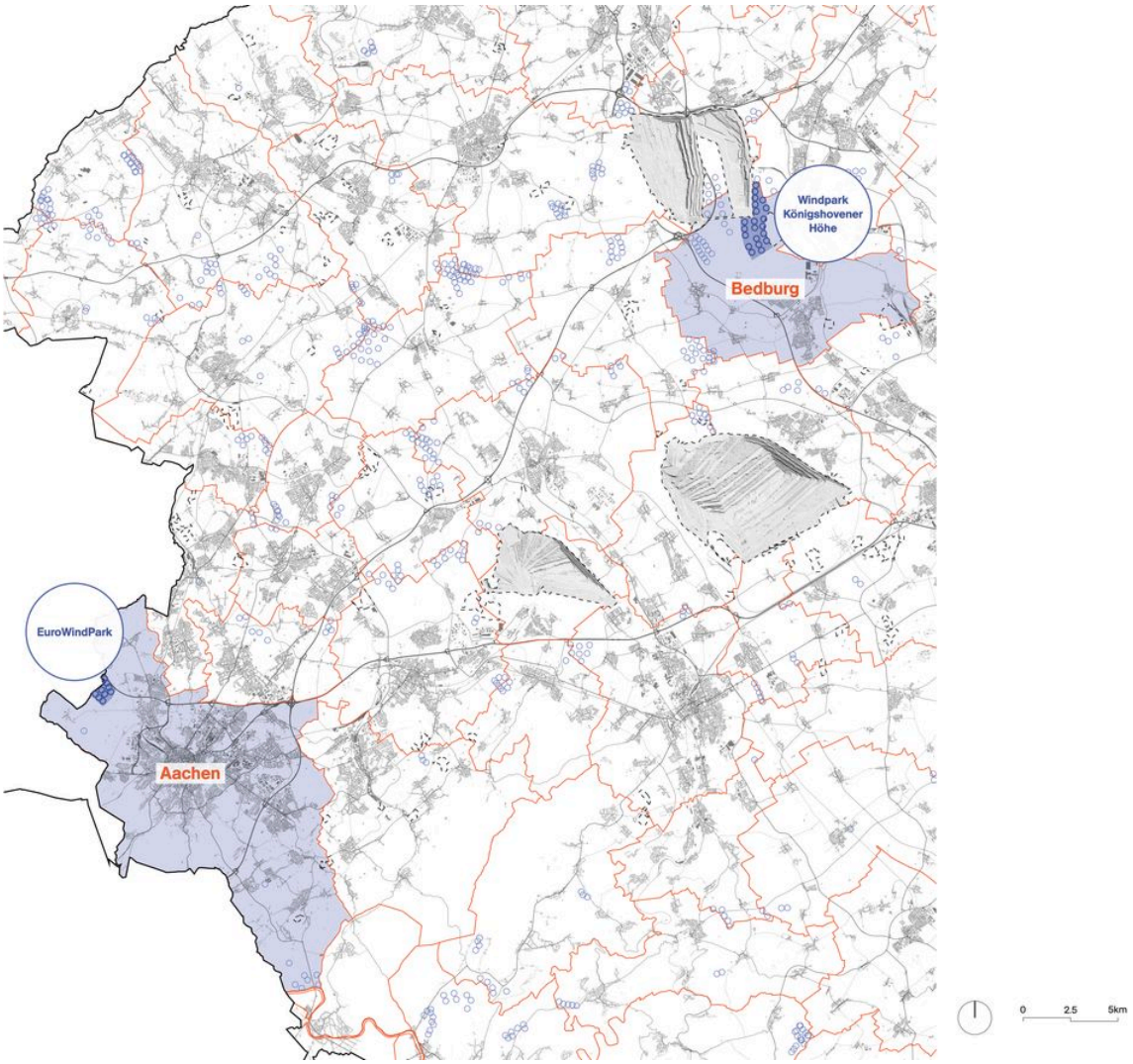
The region where Germanys largest open lignite mines are situated is primarily defined by its flatness. The horizon is dotted with wind turbines and the occasional chimney of coal burning plants, visible from far away because of the lack of topography. A territory that seems to be made for energy production now has to undergo a fundamental change in the pursuit of a sustainable future.



INTRODUCTION VIDEO.
https://youtu.be/Yf6G3xnfQmo

One of the most pressing issues of our time is the reduction of man-made greenhouse gases. Germany, among many other countries, signed the Paris Agreement in 2015, which stipulates that global warming has to be limited to 2°C. This union is essential to prevent climate catastrophe and thus needs to be taken more seriously than previous agreements. In order to uphold this accord, Germany set the goal to supply 80% of the nation-wide energy demand through renewable energy sources by 2050.

The expansion of sustainable power generation however is lagging behind the ever-growing demand for energy. Wind energy is currently the largest contributor to renewable energy production and one of the most promising sources of energy with its high output and minimal impact on the environment. Thus, wind energy is set to play a major role in the move away from coal as Germanys main energy carrier.

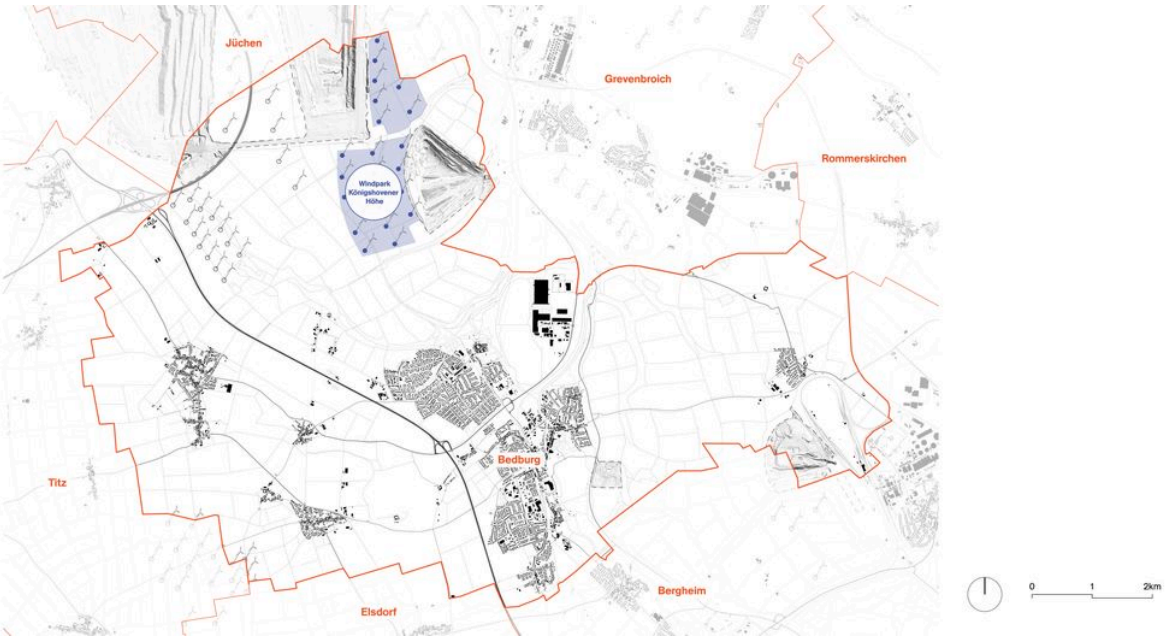


THE PRODUCTIVITY OF THE RHEINISCHE REVIER. To uncover the mechanisms behind wind turbines we looked at two case studies in the region: the wind park Königshovener Höhe in Bedburg and the Bürgerwindpark Eurowindpark in Aachen.

Spatial Restrictions Constraining Wind Power



The physical impacts of wind turbines on their surrounding environment are an obstacle for the needed expansion of wind energy. Their sheer size, as well as continuous movement and noise emissions are often a cause of contention that doom new wind power projects to fail. These impacts are subject to prejudices, which are often an expression of personal sentiment and do not necessarily correspond to objective reality. Nevertheless, the distance requirements wind parks need to adhere to because of these impacts are real, and they limit the potential areas where turbines can be built. This makes the planning process for wind farms complex, despite being privileged construction projects.



MUNICIPALITY OF BEDBURG. The wind park Könighovener Höhe is located between the former brown coal mines.

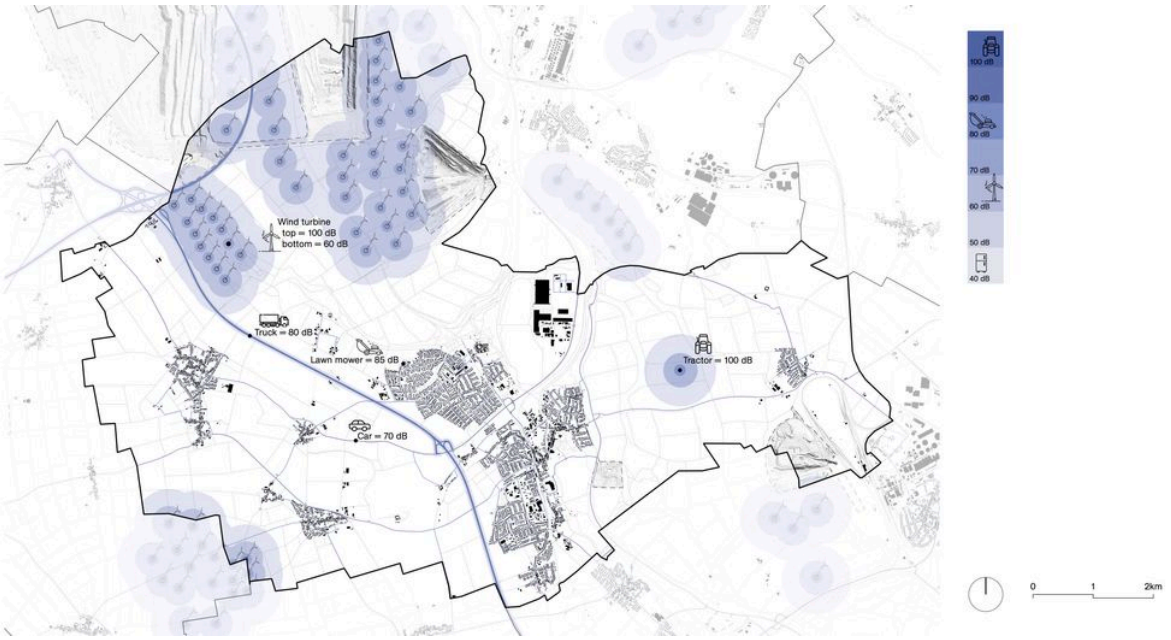
Physical Impacts of Wind Turbines on Their Surroundings



IMPRESSIONS OF LOCAL CITIZENS AROUND BEDBURG.



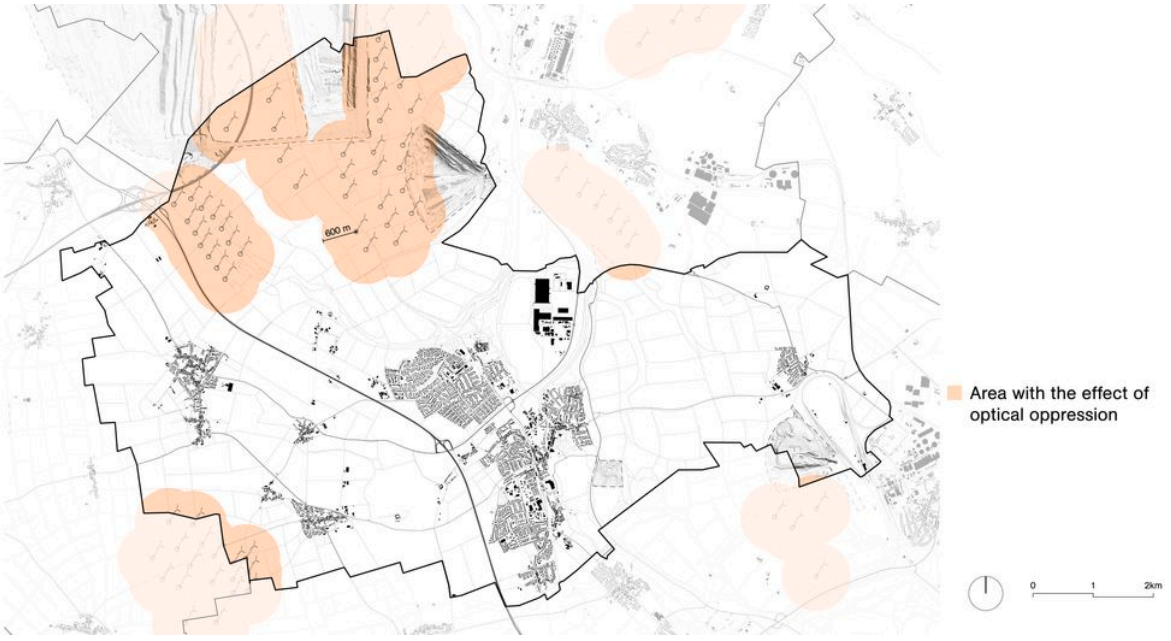
PHYSICAL IMPACTS OF WIND TURBINES ON THEIR ENVIRONMENT.
https://youtu.be/Ri70qioizx8



THE IMPACT OF NOISE EMISSIONS. In the city, the noise of the streets far outweighs the turbine sounds.



THE IMPACT OF SHADOW CASTING. The course of shadows differs greatly between summer and winter.



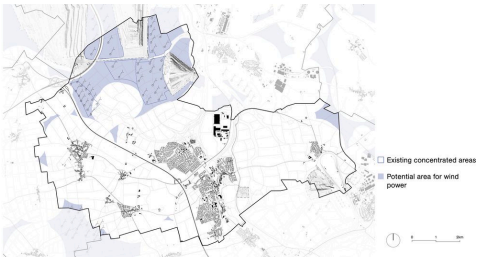
THE EFFECT OF OPTICAL OPPRESSION. The scale is not really perceptible because there is no point of comparison in the landscape.

The only measurable emission from a wind turbine is noise. The airplane like sound is produced by the blades cutting the air, as well as a feint whistling created by the generator inside. Even though they are only audible when standing close to a turbine, wind parks are strictly regulated concerning noise emissions.

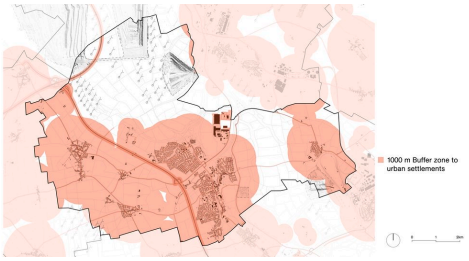
The unpleasantly flickering shadow, cast by the rotating blades on houses and windows is another irritating effect. Since it has been proven that they can affect the wellbeing of people, special shutdown tables are created for each turbine in order to limit exposure to such moving shadows. The official regulation states that an individual must endure no more than 30 minutes of shadow flickering per day and a maximum of 8 hours per year

Optical oppression caused by wind turbines is another reason why wind parks must be placed at a distance to human settlements. While not directly measurable, the ever-increasing size of these turbines can have an intimidating effect on people. As a rule, wind turbines have to be placed at a distance of two to three times their own height from human settlements. This is only an estimate however and can vary.

Residual Ground
Designated for Wind Energy



POTENTIAL AREA FOR WIND POWER. Residual areas that remain after the protection zones have been excluded.



HUMAN PROTECTION ZONE. In densely populated areas a distance of 1000m applies, for hamlets the distance is reduced to 400m.



ECOLOGICAL PROTECTION ZONE. Wind turbines are excluded from ecological areas in order to protect the region from disturbances.

To avoid these impacts affecting humans, a 1000m buffer area between wind parks and adjacent settlements was defined, which we termed the “human protection zone”. The distance is arbitrarily chosen and is not based on any clear facts, since the disturbing factors depend on the type of turbine and on the environment.

Along with the zones that protect humans there are ecological zones meant to protect non humans who could be affected by wind turbines. Particularly birds and bats are at risk of colliding with the long moving blades. The number of animal deaths caused by wind turbines each year however are miniscule compared to the ones caused by cars, glass facades or even housecats. To protect nature and animal habitats from disruption by the new infrastructure, wind turbines are strictly prohibited in certain areas. Consequently, we called these areas the “non-human protection zone”.

Combined, these two protection zones cover a substantial amount of the territory. Finding areas for wind energy production is therefore difficult, not least because decentring urban sprawl has led to a situation where there are hardly any wide open and flat areas left in Western Europe.

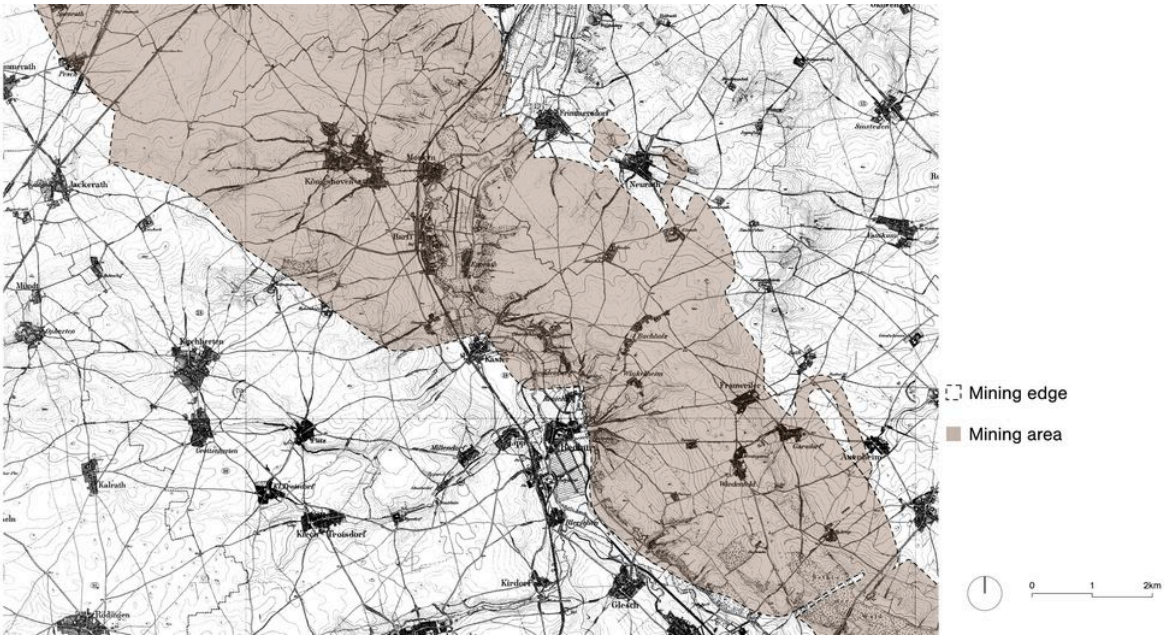
Post Fossil Wasteland Used For New Wind Energy Infrastructure



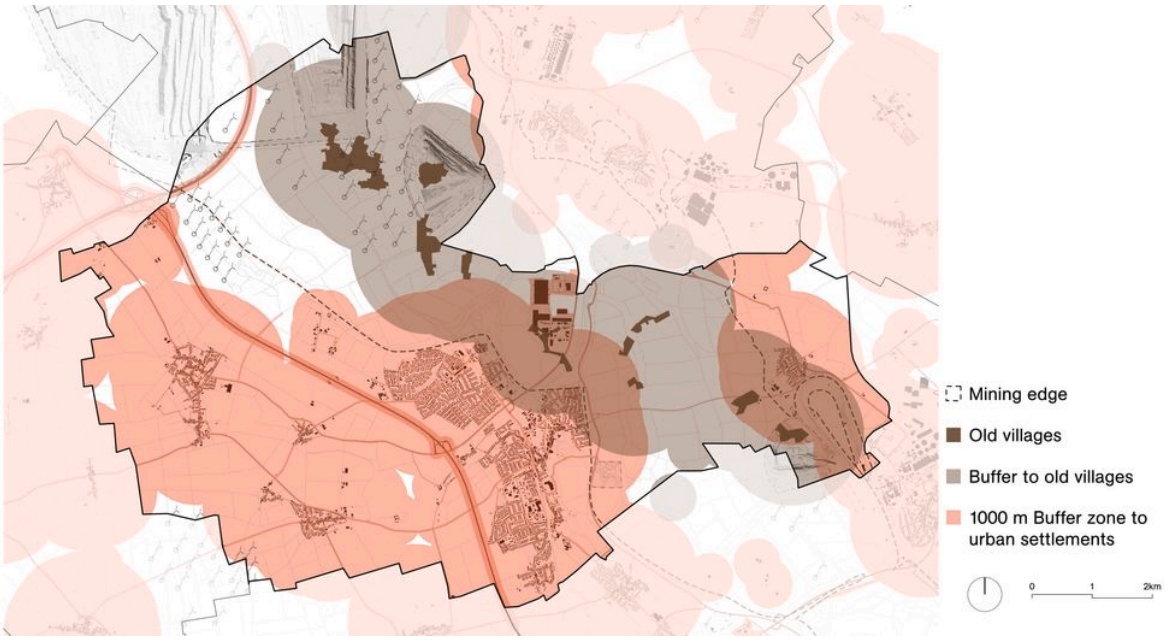
The most dominating landmark features of the Rheinland are the open pit mines, which were used to source lignite since the early 1900s until today. Large scale extraction projects like this do not pass by a territory without leaving scars, some of which are more visible than others. The wind park in the commune of Bedburg near the Garzweiler open pit mine is an example of new infrastructure that replaces the former source of energy on its erstwhile site.

A Territory Shaped Through Mining

The legacy of brown coal mining can still be felt in Bedburg today. From the 1970s to the early 2000s, about one third of the commune's total land mass was dug up and filled back in, as the mine that is now called "Garzweiler" made its way through the territory. Several villages were razed for the profit driven remodelling of the earth. These villages were then resettled and integrated into Bedburg as new adjacent districts. The most visible remnant of the gigantic venture is a vast patch of recultivated land that stretches over the northern parts of the municipality. But perhaps the invisible consequences are the most intriguing, as recultivated land has very specific properties: The lack of human settlements and ecological areas—except for the ones designed by the brown coal mine operator—make it the perfect territory for the development of a windfarm. There are no distances to keep, no people that are disturbed and thus feel inclined to pursue legal action, and most importantly, only one landowner: RWE.



HISTORIC VILLAGES AND THE MINING PATH.



HUMAN PROTECTION ZONE WITH OLD VILLAGE FABRIC. The old villages projected back onto the area with the distance parameters applied.



RECULTIVATED ZONE DESIGNED BY RWE.

Without the tabula rasa conditions left by of the coal mine, it would not have been possible to build a wind park at Königshovener Höhe. If the resettled towns still existed today, their spatial restrictions as well as existing ecological areas would not have allowed for the building of wind turbines in the area. In a way, the communes coal mining legacy created the territorial conditions that enabled the new wind energy infrastructure to be built.

Coal And Wind—Two Resources Under One Monopoly

The collaboration between Bedburg and RWE reaches deeper than just the building of a wind park. The energy company also provides over two thousand jobs in the commune and has a significant impact on the planning of one of its new neighbourhoods. It is a partnership that benefits both actors, but there is one important thing missing from the equation. In keeping with the tradition of energy production, the locals were never directly included in the decision-making process, which leads to them feeling disenfranchised with the project. Even though the profits are invested locally, they are not really tangible and thus do not resonate with the citizens. And a big part of the money still goes to RWE, a company that has profited off the land for years. The wind park's approval suffers as a consequence.



INTERVIEW WITH TORSTEN STAMM, LEADING CITY PLANNER OF BEDBURG.
https://youtu.be/pplchVtKd88

It Takes More Than Land to Build a Wind Park



Wind parks are always the result of the specific conditions that led to their construction, but that is not legible from their physical appearance, as they tend to look the same from a distance. Due to the limited number of manufacturers, there is no great diversity in types of models. Moreover, their arrangement adheres to the physical effect of wake, the weakening of the wind directly behind a turbine. The distinguishing factor that differentiates one wind park from another is therefore the planning process and the ownership structure behind it.

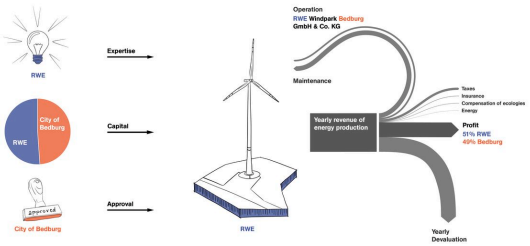
Different Approaches
Create Uniform Outcomes



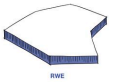
KÖNIGSHOVENER HÖHE, BEDBURG.



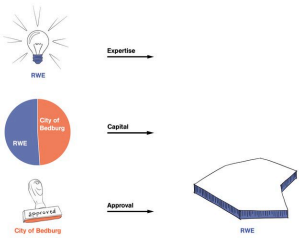
EUROWINDPARK, AACHEN.



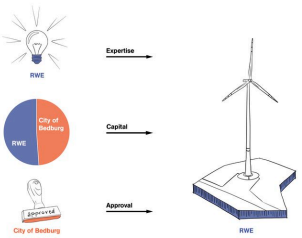
SYSTEM OF ACTORS FOR THE WIND PARK KÖNIGSHOVENER HÖHE IN BEDBURG. In this case the resulting profits is only split between the two actors.



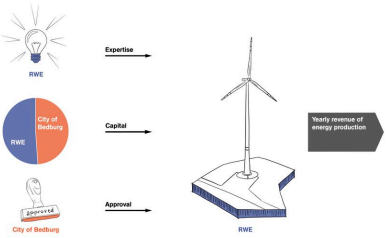
FIRST STEP: THE LAND. The sites for the turbines are provided by RWE, which still own the land because of the former mining operations.



SECOND STEP: CREATING THE CONDITIONS. RWE can provide the expertise as an energy provider, while the city of Bedburg has the power to approve the project. The capital is supplied by both parties.

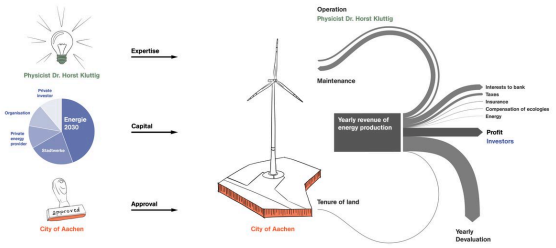


THE CONSTRUCTION OF A WIND TURBINE.

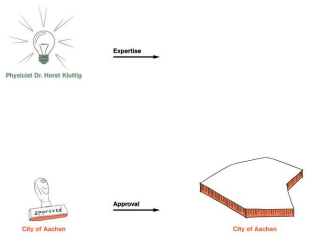


THE YEARLY REVENUE.

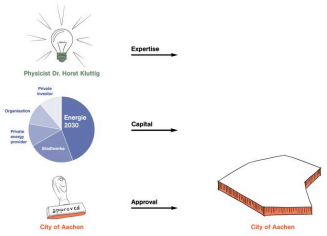
All the turbines at “Königshovener Höhe” are owned by one cooperative, which was launched by RWE and Bedburg specifically to build this wind park. The collaboration is effective for a multitude of reasons. RWE still owns and can therefore provide the land, as well as the technical expertise as an energy producer. The city on the other hand controls the regulatory framework and approval process, the hindering of which could drastically slow down or even altogether stop the development of a wind park. Through this top-down cooperation, the planning process is streamlined and efficient.



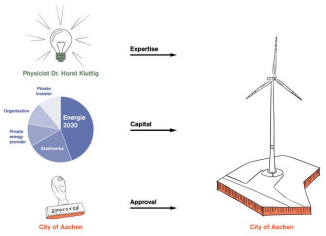
SYSTEM OF ACTORS FOR THE EUROWINDPARK AACHEN. In this case, part of the profit must be deducted for the payment of interest at the bank.



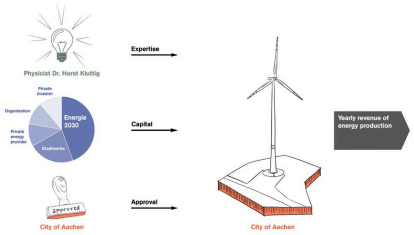
FIRST STEP: THE INITIATIVE. The whole planning process starts with the expertise of Horst Kluttig.



SECOND STEP: FINDING INVESTORS.



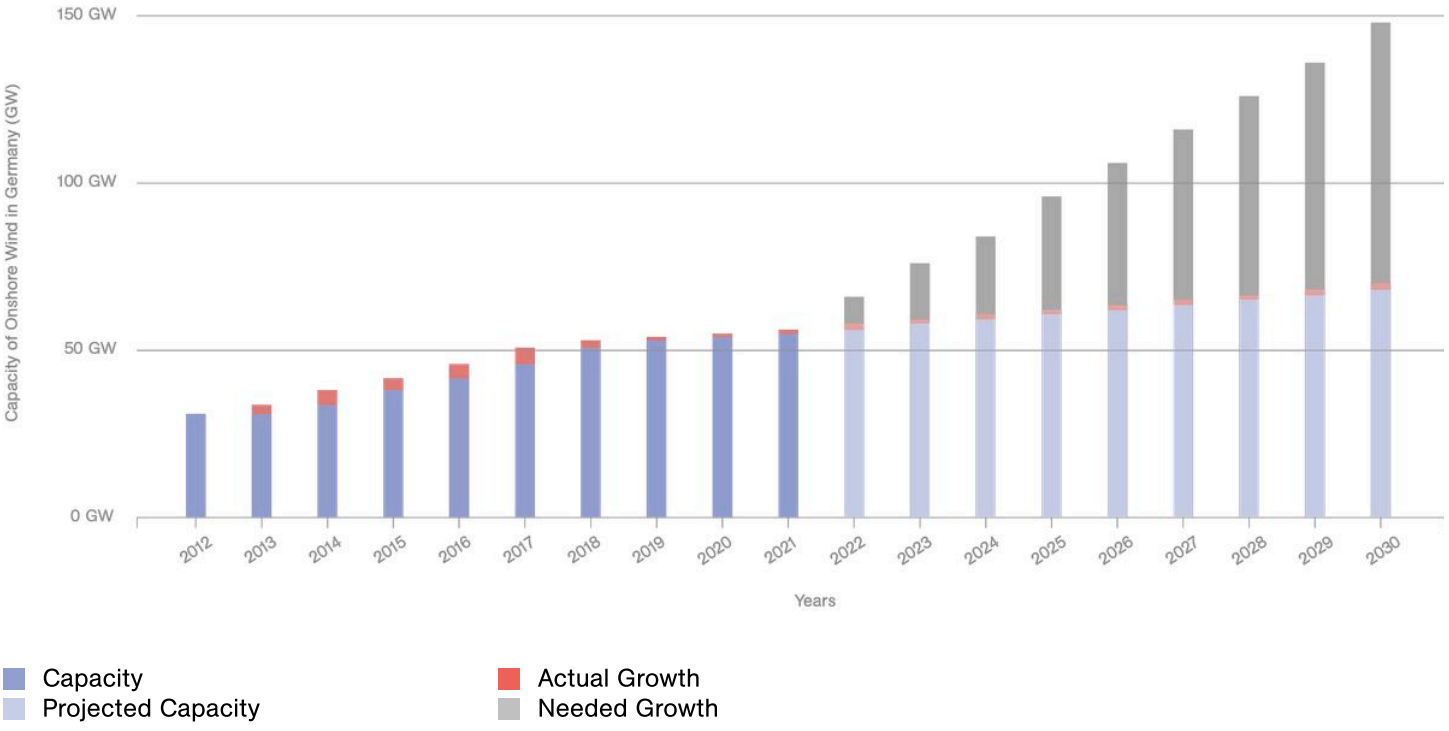
THE CONSTRUCTION OF A WIND TURBINE.



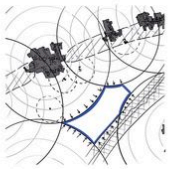
THE YEARLY REVENUE.

The “EuroWindPark” in Aachen might also have a sole investor given its uniform appearance, but its ownership and governance structure are much more complex. During the planning process, different investors were able to apply to invest in the individual turbines. The “Energie 2030” cooperative applied to finance four turbines of the infrastructure project. Together with the local “Stadtwerke” and other private organizations, they were able to realize the project without the participation of a big investor. In this case a larger number of people profit directly from the turbines. Thus, the value production stays in the region. But because of the many actors associated with the park and the lack of direct institutional involvement, the planning process can become complicated and prolonged to the point where the project is abandoned. To overcome these obstacles, an operator is needed to oversee the complex system. In Aachen, physicist Dr. Horst Kluttig acted as planner and operator throughout the entire life cycle. The Eurowindpark functions as a Bürgerwindpark. By involving the public, the entire process becomes more bottom up.

Mobilizing The Right Agency For Wind Energy



Despite numerous successful projects like the ones in Bedburg and Aachen, the construction of wind parks in Germany has stagnated in recent years. In order to reach its climate goals, the country would have to drastically increase the amount of wind energy it produces.



Spatial restrictions



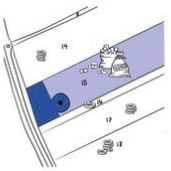
Approval process



Physical impacts



Perception



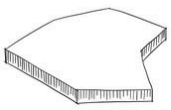
Conflicts of interest

NEGOTIABLE OBSTACLES.

After analysing the case studies, these are the obstacles we identified that prolong or even hinder the development of wind parks: the spatial restrictions, the approval process, the physical impacts of wind turbines, the subjective perception and the conflicts of interests that arise, especially in land ownership. In the areas of planning and spatial restrictions, new regulations are already being introduced to open up more space for wind energy and simplify the approval process. With the Wind-on-Land Act, the government will regulate the designation of areas for wind energy in each federal state starting in 2023. Two percent of the nationwide area is to be made available for the expansion of wind energy within the next 10 years. The other three obstacles act more on a social level and represent indifference or even lack of acceptance within the population.



Initiative



Land



Expertise



Capital



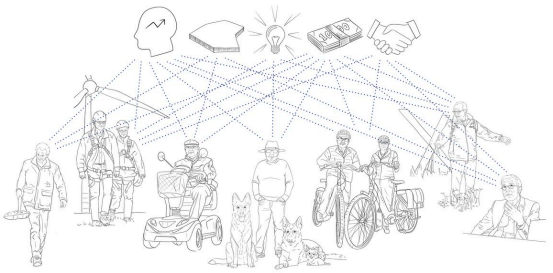
Cooperation

NECESSARY CONDITIONS.

Opposite to that are the conditions that have to be met for a wind park project to succeed: the initiative to start the process, land outside of the restriction zones, the expertise for planning, the capital to invest and the cooperation between different actors. By creating these conditions, the chances of a project being realized increase substantially. The current urgency of energy production calls for new actors and models to provide these requirements.



MOBILISING THE RIGHT AGENCY.



INDIVIDUALS HAVE THE CAPABILITY TO FULFILL A CONDITION.

If Germany wants to build more wind parks and in so doing reach its climate goals, the communities have to be activated and show initiative. Wind energy has to be taken seriously as one of the main energy sources of the future and shift in our collective imagination from a luxury commodity to a necessary part of the energy infrastructure. Ideally, wind turbines would integrate into the landscape as natural parts of it instead of being seen as obstacles that destroy the view.

Lifecycle as a Catalyst—A Design Strategy For Wind Parks



The impact of infrastructure on the landscape could be the key factor for an inclusive and sustainable integration of wind farms into the territory. If done well, the wind park could become a benefit for the community and the landscape, instead of being just accepted as a necessary evil. Using the lifecycles of wind turbines, we attempt to design the in-between of wind parks in order to lastingly transform the landscape from the industrialized production space that it is today into a habitable, human scale territory.

Technological Monuments —Symbols of Progress

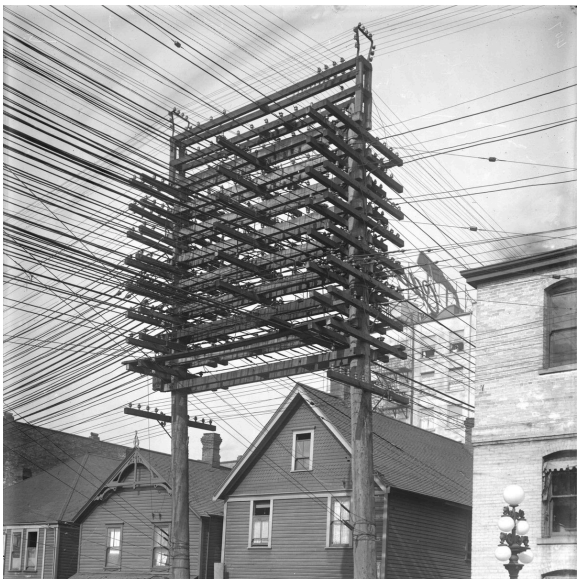
Man-made structures adorn our landscapes as visible traces of our common human history. These artefacts tell the story of our interaction and impact on the territory. With infrastructure, the focus is not on their aesthetics, thus they are not always appealing to the contemporary eye. In contrast to the free forms of nature, infrastructure is often perceived as ugly. But it still remains an important indicator of the development of society and marks how far we as a species have come. Are there other ways to be recognized as a monument of human progress beyond being aesthetically pleasing?



FIRST ELECTRICITY POLE ON CRANBOURNE ROAD IN 1920s.
Source: Frankston City Libraries, 2016.
[https://live.staticflickr.com/2747/4421421128_90c896263b_b.jpg]



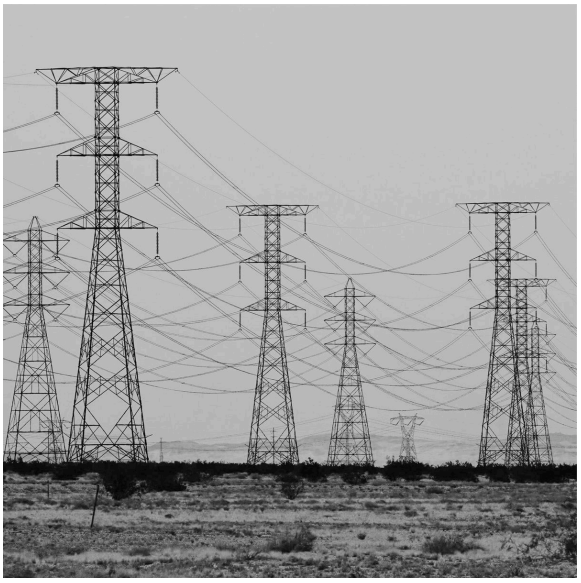
TRANSMISSION POLES FOR ELECTRICITY AND TELECOMMUNICATION IN 1930s.
Source: The Corvallis Advocate, 2018.
[https://www.corvallisadvocate.com/wp-content/uploads/2018/11/telephone-poles.jpg]



LIMITS OF DISTRIBUTION—H-FRAME POLE HOLDING UP COUNTLESS ELECTRICITY CABLES.
Source: City of Vancouver Archive, 1914.
[https://searcharchives.vancouver.ca/uploads/r/null/8/4/845909/cc8097b0-7bcc-4321-9ea5-70b1f3dcb346-A08574.jpg?utm_source=vancouver%20is%20awesome&utm_campaign=vancouver%20is%20awesome%3A%20outbound&utm_medium=referral]



HIGH VOLTAGE POWER LINE LEAVING ITS TRACES IN THE LANDSCAPE.
Source: City of Seattle, 2010.
[https://powerlines.seattle.gov/2010/08/24/new-rules-for-transmission-lines-drive-enhanced-vegetation-management/#sthash.h6JooJT0.dpuf]



CROWDING OF THE HORIZON WITH MODERN ELECTRICITY POLES.
Source: Bing Guan/Getty, 2020.
[https://media.wired.com/photos/615cfdbe40a25929277da944/1:1/w_1600,h_1600,c_limit/Science_powergrid_GettyImages-1284725010.jpg]



TYPICAL DUTCH WINDMILL AT
THE HIGHEST POINT OF ITS
TECHNICAL DEVELOPMENT IN 1792.
Source: E. Hau, *Windkraftanlagen*, 2016.



FIRST WIND TURBINE THAT COULD PRODUCE
ELECTRICITY IN DENMARK IN 1891.
Source: E. Hau, *Windkraftanlagen*, 2016.



DANISH GEDSER-PLANT IN 1957—ONE OF THE
INNUMERABLE WIND TURBINE PROTOTYPES.
Source: E. Hau, *Windkraftanlagen*, 2016.



FIRST WIND PARK OF GERMANY
IN SCHLESWIG-HOLSTEIN
CONNECTED TO THE GRID IN 1987.
Source: WirtschaftsWoche, 2017.
[https://www.wiwo.de/technologie/green/deutschlands-erster-windpark-als-vor-30-jahren-die-energiewende-begann/20202770.html]



THE ONGOING INCREASE IN SIZE
OF MODERN WIND TURBINES.
Source: Financial Times/Reuters, 2022.
[https://www.ft.com/content/29cb5f2b-9b09-49bf-b306-c3a782191f6c]

Besides the social monuments like elaborately decorated churches, there are also industrial and infrastructural ones. The territory is filled with the numerous electric poles of distribution networks, highways, transmission towers and even machines for extracting mineral resources, such as the bucket wheel excavators in the open pit mines. These objects bear a meaning in themselves, that is of greater importance than the material form they take on. In the chapter “Promising Forms” in the book “Promise of Infrastructure”, the author Brian Larkin wrote: “One layer is a higher order of meaning in which technology is treated as a historically situated discursive entity representing ideas such as progress or civilization.”. He stands up for a deeper understanding of such objects in the landscape. The collective perception of infrastructure can change over time, because the promise of a better future they carry with them could be of greater interest, than the disrupting traces they leave visually.



LINEUP—INFRASTRUCTURAL, TECHNOLOGICAL AND CULTURAL MONUMENTS.

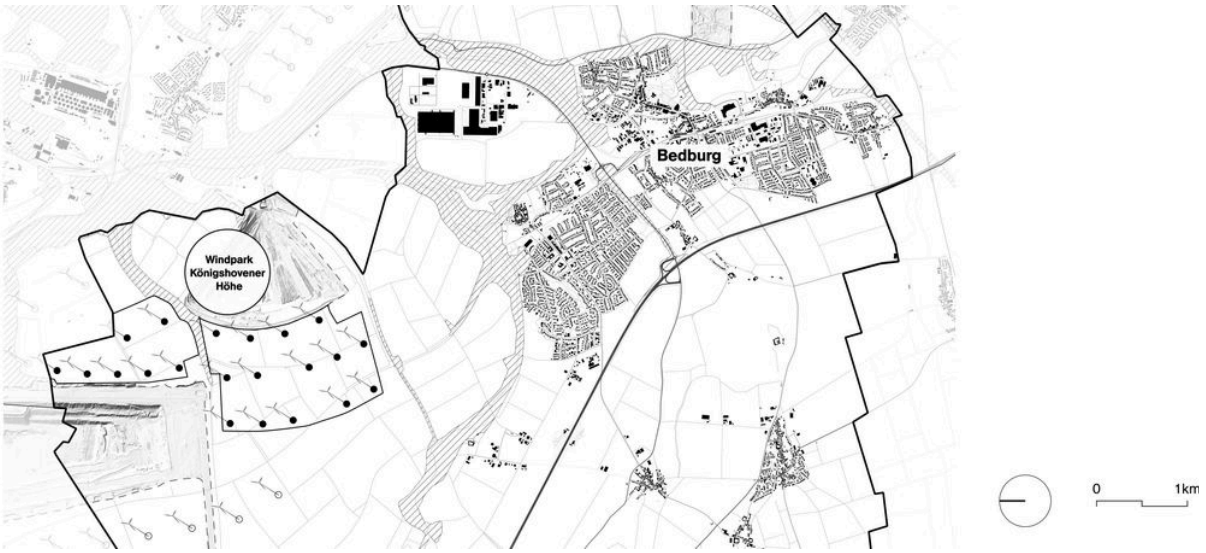
In time, it may be possible for wind turbines to achieve such a change in meaning, as they represent not only progress but also a more sustainable way of generating electricity. In addition, with the generational transition, a certain normalisation takes place, the so-called shifting baseline syndrome. Today, many people already recognize their worth. They may not like the wind parks emerging on the horizon aesthetically, but it is generally acknowledged that they are essential to achieve the global climate goals. This attitude could be the key to changing the perception of wind turbines from eyesores to technical monuments.

A Layered Landscape—From Monoculture To A Diverse Territory



WASTELAND FORMED BY INDUSTRIALISED PRODUCTION.

Regardless of perception however, countless sacrifices were made in the name of energy security and economic prosperity. These impacts on the landscape were never limited to the villages razed to make way for the giant excavators. Indeed, the whole “Rheinische Revier” was heedlessly transformed into an industrial wasteland, defined primarily by infrastructure that makes the entire hinterland part of either the agricultural or the energy production process. A vast but empty monocultural landscape that is mostly uninhabitable for both humans and non-humans. Can we design the next generation of energy infrastructure to not only be environmentally sustainable, but also socially and aesthetically acceptable?

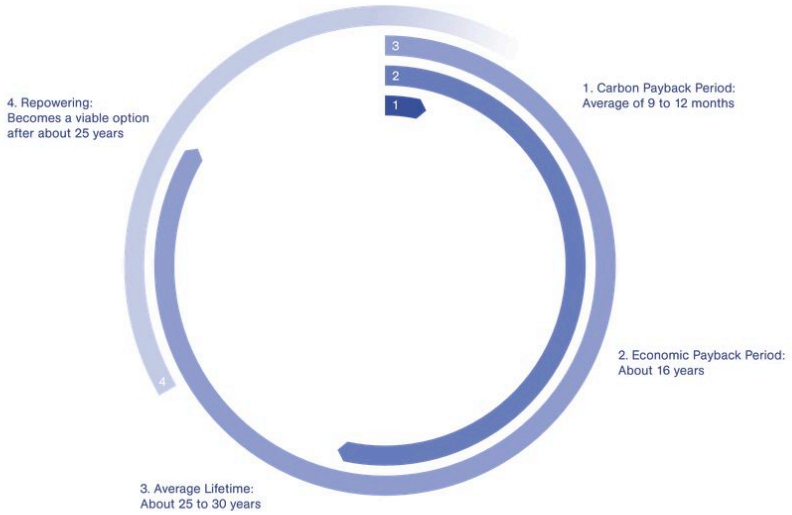


THE SPACIAL SEPARATION BETWEEN THE CITY AND THE WIND PARK IN BEDBURG.

Going back to “Königshovener Höhe”, the wind park is located in the hinterland of the city and is separated from it by recultivated forest. The spaces in-between the network of turbines is used for large scale industrial agriculture. Thus, hardly anyone ventures out into this lost territory.



THE CURRENT CONDITION. Different layers of infrastructure, nature and production shape the territory.



LIFECYCLE OF A WINDTURBINE.

The small-scale interventions in the territory necessary to build a turbine were our starting point for not only making wind parks less unpleasant for the landscape, but to use them to improve their environment. These transhipment points, required for the construction of wind parks, cannot be used for agriculture and are therefore used as ecological compensation areas. Today, the transhipment points already have greater biodiversity than the surrounding agricultural fields and are more permanent than the infrastructure itself, since wind turbines have a limited lifetime and are replaced by newer, larger ones after about 25 years. These also require greater spacing from each other to ensure optimal efficiency, which often entails a reshuffling of the entire wind park. The original locations of the wind turbines and their adjacent spaces however cannot be retransformed into agricultural land and therefore remain as a “terrain vague”. Unless, that is, we use them as incubators for an incremental transformation of the landscape.



WIND TURBINES. 21 turbines dot the landscape today.



WIND TURBINES. These turbines have a lifecycle of about 25 years.



First repowering after 25 years.

WIND TURBINES. The old turbines are replaced by a few but larger turbines with a higher individual output.



Second repowering after 50 years.

WIND TURBINES. The number of turbine decreases while the power capacity is increased.



Current condition.

STREET NETWORK AND SOCIAL SPACE.



Transformation through restructuring.

STREET NETWORK AND SOCIAL SPACE. By restructuring existing spaces can be used for diverse programs.



First repowering after 25 years.

STREET NETWORK AND SOCIAL SPACE. The new arrangement of the wind turbines creates new spaces in the in-between to be appropriated.

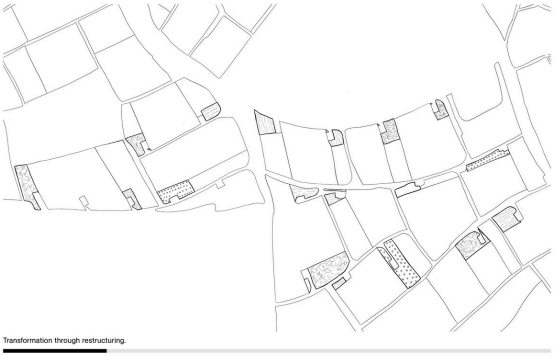


Second repowering after 50 years.

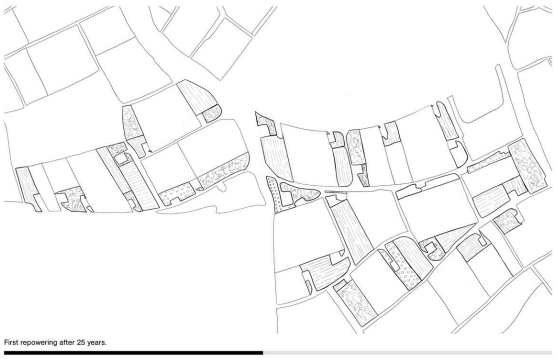
STREET NETWORK AND SOCIAL SPACE. The diversified landscape creates different atmospheres and a multitude of spaces to discover.



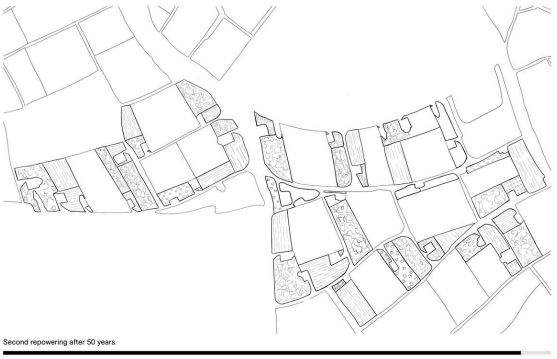
THE IN BETWEEN. Big open fields of monoculture dominate the landscape.



THE IN BETWEEN. The infrastructure surrounding the wind turbines fragments the area.



THE IN BETWEEN. With repowering, new residual areas are created.



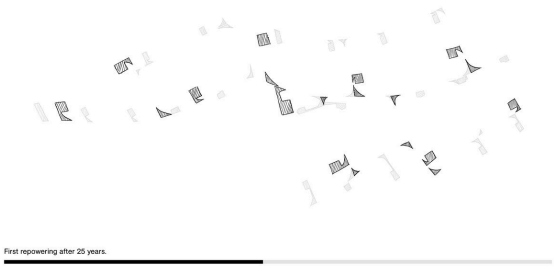
THE IN BETWEEN. Through repowering the wind turbines catalyse the transformation process into a small meshed landscape.



OPERATION AREA. The transhipment points are needed to install and operate the wind turbines.



OPERATION AREA. Over time more biodiversity develops because the land is left unused.



OPERATION AREA. New turbines require new transhipment points.



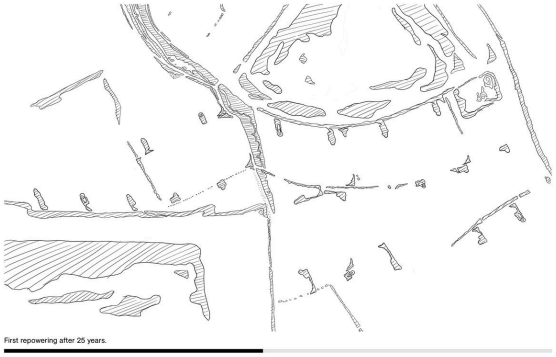
OPERATION AREA. New turbines require new transhipment points.



BOCAGE. The recultivation of the mining area introduced some ecological zones into the territory.



BOCAGE. The recultivation of the mining area introduced some ecological zones into the territory.



BOCAGE. Old, unused operational areas cannot be reintroduced into agriculture; instead, they become ecological zones.



BOCAGE. The repowering creates new islands of biodiversity that link the ecological areas.



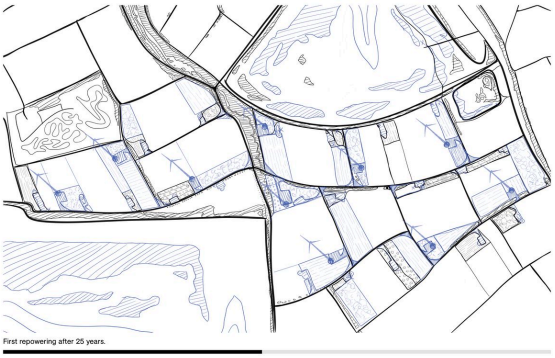
A LAYERED LANDSCAPE.



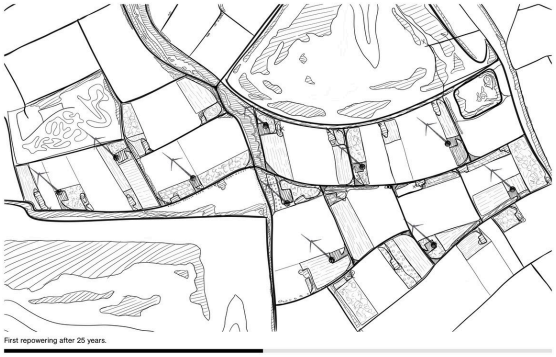
A LAYERED LANDSCAPE. A first transformation takes place.



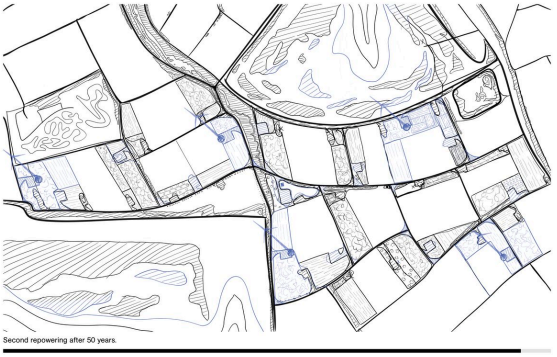
A LAYERED LANDSCAPE.



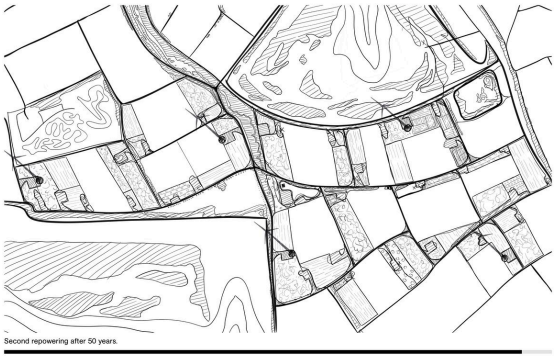
A LAYERED LANDSCAPE. The repowering leads to diversification.



A LAYERED LANDSCAPE.



A LAYERED LANDSCAPE. With a new life cycle, the area is transformed.



A LAYERED LANDSCAPE.

Using this method, the wind park can be the catalyst for introducing new programs and users into the landscape as it becomes smaller meshed and more diverse. Forests, community gardens, wetlands, fruit groves, hedgerows, participatory agriculture and meagre meadows could all coexist between the turbines with streets serving as the connecting structure. By precisely re-planning the spatial layout of the wind park with each cycle, the patchwork becomes tighter knit, biodiversity will increase and lay the base for a more sustainable future—globally as well as locally. By Designing wind energy infrastructure, we can catalyse a transformation of territory away from monotony and toward diversification. The wind park becomes a viable urban typology that can be integrated into the territory and produces value for all actors involved.



WASTELAND.



TRANSITION.



PATCHWORK.



TRANSFORMATION TO A SMALL MESHED AND DIVERSE LANDSCAPE.

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SOURCES

- “Die EuroWindPark Aachen KG.” Aachen hat Energie. Januray 2022. Accessed November 12,2022 https://www.aachen-hat-energie.de/wind/eurowindparkkg.htm
- “EEG in Zahlen 2019.” ÜNB, EVU and VNB. September 2019. Accessed October 2, 2022. https://opendata-esri-de.opendata.arcgis.com/datasets/esri-de-content::eeg-in-zahlen-2019/explore?location=49\.846331%2C11\.903811%2C6\.03
- Hau, Erich. Windkraftanlagen – Grundlagen, Technik, Einsatz, Wirtschaftlichkeit. Auflage 6. Krailling, Deutschland: Springer Vieweg. 2016. https://link.springer.com/book/10\.1007/978-3-662-53154-9
- “INSPIRE Download Service Feed-Landschaftsinformationssamlung NRW.” Open nrw. January 25, 2022. Accessed October 3, 2022. https://www.gis-rest.nrw.de/atomFeed/rest/atom/868aa994-ac2d-4bf1-9aeb-c0597a76c2db.html
- “Kartenlayer Windkraftanlagen NRW.” Open nrw. December 31, 2016. Accessed October 3, 2022. https://open.nrw/dataset/2dd18cf8-edc7-4e7f-8424-c4c72feb437f
- Larkin, Brian. Promising forms: the political aesthetics of infrastructure. The promise of infrastructure, Duke University Press. 2018.
- “Potenzialstudie Windenergie NRW.” LANUV Fachbericht 124. April 2022. Accessed October 2, 2022. https://www.lanuv.nrw.de/fileadmin/lanuvpubl/3_fachberichte/Potenzialstudie-Windenergie-NRW.pdf
- “Rheinisches Braunkohlerevier.” RWE Power AG. Accessed November 11, 2022. https://braunkohle.de/wp-content/uploads/2017/08/Revierkarte-RWE-Power-2021\.pdf
- Sieber, Sandra. Auswirkungen neuer Wahrnehmungsmuster im Bereich der regenerativen Energiesysteme im Orts- und Landschaftsbild und ihre Bedeutung für die räumliche Planung. PhD dissertation. April 2021. https://publications.rwth-aachen.de/record/819584/files/819584\.pdf
- “Windenergie in Deutschland-Zahlen und Fakten.” BWE Bundesverband WindEnergie. December 31, 2021. Accessed October 2, 2022. https://www.wind-energie.de/themen/zahlen-und-fakten/deutschland/

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