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Titre: Renaissance of the Territory: Mining for a Sustainable Future

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RÉSUMÉ

This thesis addresses the revitalization of territories affected by deindustrialization and economic decline, with a focus on the region of Centre near La Louvière in Wallonia. The study examines the challenge of how to rejuvenate areas plagued by economic, social, and environmental issues. By repurposing mining infrastructure for geothermal energy production, this project aims to breathe new life into these regions. The proposed solution involves converting former mining sites into geothermal energy hubs, thereby fostering surface revitalization. This initiative will be complemented by the creation of an urban park, designed to connect villages and establish a heritage trail. This dual approach seeks to not only provide sustainable energy but also to enhance the social and cultural fabric of the community, promoting economic recovery and environmental sustainability.

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MINING INFRASTRUCTURES AS A LEVER FOR TERRITORIAL DEVELOPMENT

Guillaume Marsille

Renaissance of the Territory: Mining for a Sustainable Future

End-of-study work of

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Fig. 1 - Panorama of *Le Centre* region, 2024





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Fig. 3 - Mining infrastructure atop a slag heap, 2024





Fig. 4 - Working-class houses in Havre, 2024





1.1 INTRODUCTION

In Wallonia, 44% of the population live in the coalfield (Contrat de bassin minier, 2021). This is due to the geology and the presence of the coal seam. Industrialisation has led to considerable development in the coalfield. Coal mines were once an important energy resource in Europe, particularly around the time of the first industrial revolution, characterised by the invention of the steam engine at the end of the 18th century. At the same time, these infrastructures enabled significant economic and demographic growth. In the wake of globalisation, a new economic and social system gradually emerged, namely capitalism. However, with the advent of new technologies and the complex extraction of coal in the Belgian coalfield, this infrastructure gradually fell into oblivion until it was finally closed down at the end of the twentieth century. In this thesis, we are going to study how such infrastructures were able to leave an indelible mark on the area, so that it became one of the most important economic crossroads in Europe, while at the same time becoming one of the most unattractive areas, leaving many infrastructures as wastelands. In fact, the coalfield, with its numerous economic infrastructures such as canals, motorways and railways, has become a deserted place, prone to decline. What was once an ideal location for industry is now filled with industrial wasteland, although some industries retain their economic status. This duality has been a revealing factor in reviving the glorious past of these industries.

In the course of this research, we are going to look at how coal mines in Wallonia are being rehabilitated. The aim is to reuse these mines from an energy point of view and return them to their original purpose of producing energy, this time in a sustainable way. We will also be able to see the possible consequences of this on a regional scale.

To do this, we are going to study coal mining and analyse its territorial impact. This work will enable us to understand and recognise one of the symbols of Wallonia's economic growth.

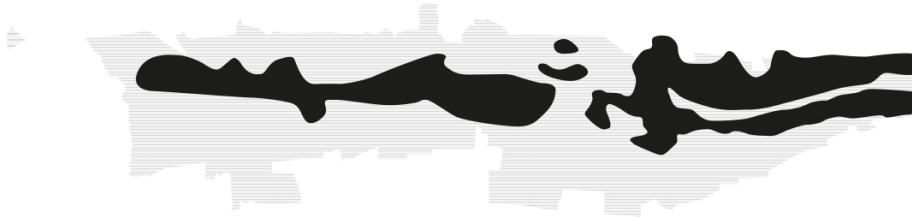
1.2 LOCATION

This research will focus on the border area between *Le Centre* and Borinage regions in Hainaut, more specifically between the towns of Mons and La Louvière. However, we will sometimes take a broader view, on the scale of Wallonia, in order to understand the consequences on a wider scale of certain characteristics studied in this thesis. This region is a perfect example of the history of coal industrialisation, thanks to its development of unique economic networks.

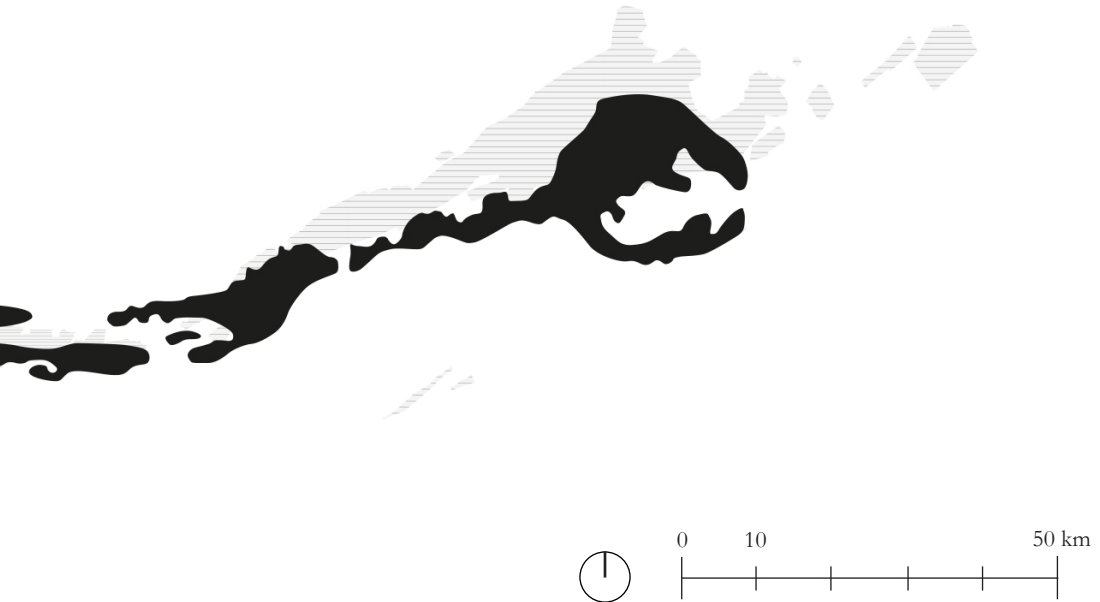
By re-imagining the mining infrastructure from an energy perspective, we aim to revitalise *Le Centre* region and make it potentially self-sufficient. This would be an initial approach that we hope could work on a large scale. This approach would revitalise *Le Centre* region, boost its economy and improve its social situation by integrating new areas for sharing. This new centrality could become the heart of a new way of living with its environment.

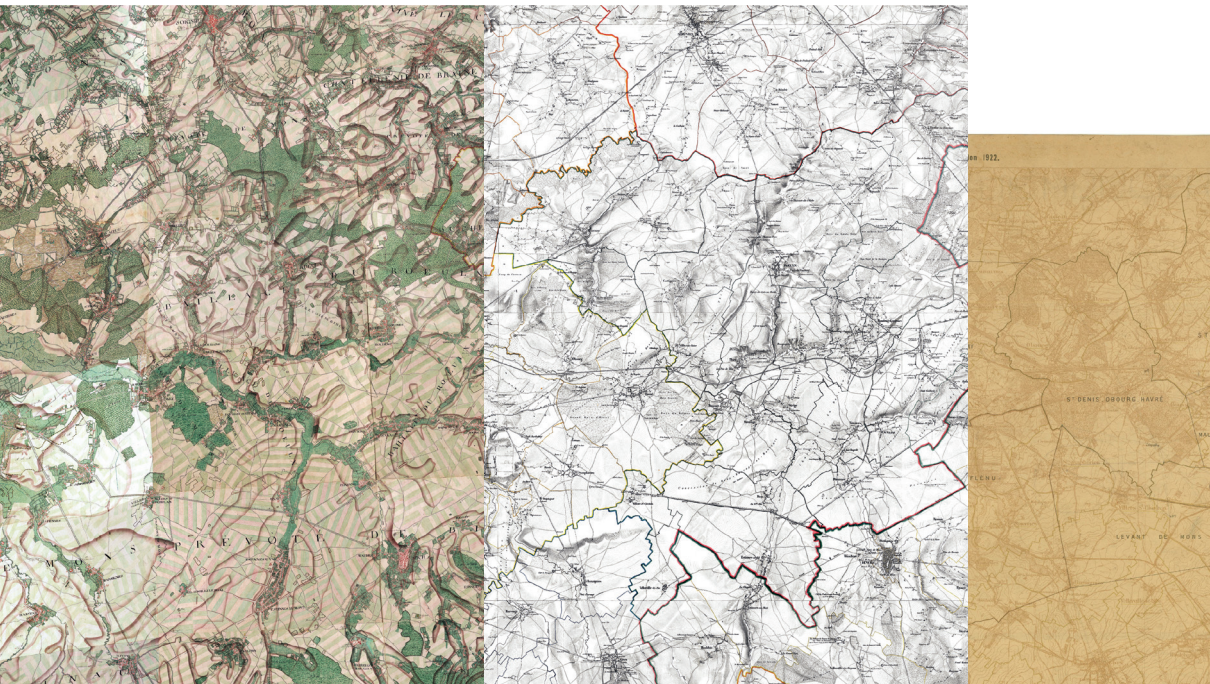
1.3 THE BELGIAN COELFIELD

For the purposes of this thesis, we will be looking at the mining basin that crosses Belgium. This basin, which begins in northern France and extends as far as western



Germany, is around 170 km long and between 3 and 16 km wide (Crul et al., 2012). In reality, this basin is divided into two distinct parts at the level of the city of Namur. A carboniferous limestone uplift interrupts the coal basin at Samson. As a result, we have a coalfield in the west of Belgium made up of several regions: the Borinage (town of Mons), *Le Centre* (town of La Louvière), Charleroi and the Basse-Sambre (town of Namur), and in the east of Belgium with the regions of Andenne, Huy, Seraing, Liège and the Herve plateau. Part of the Kempen, in Belgian Limburg, is also part of this basin. One of the special features of the Belgian coalfield, and what has made it so competitive, is its very fine coal seams. In fact, the mines can reach depths of over 1,000 metres in the western basin of Wallonia. Its length is what makes it so complex, because the layers of coal are scattered and not concentrated in the same place, as could be the case in Germany, in the Ruhr region, where these veins could be up to 3 metres thick. This is due to movements in the earth's crust. Indeed, these movements caused folding that formed these fine veins with sharp angles, which can be as small as ten centimetres (Crul et al., 2012).

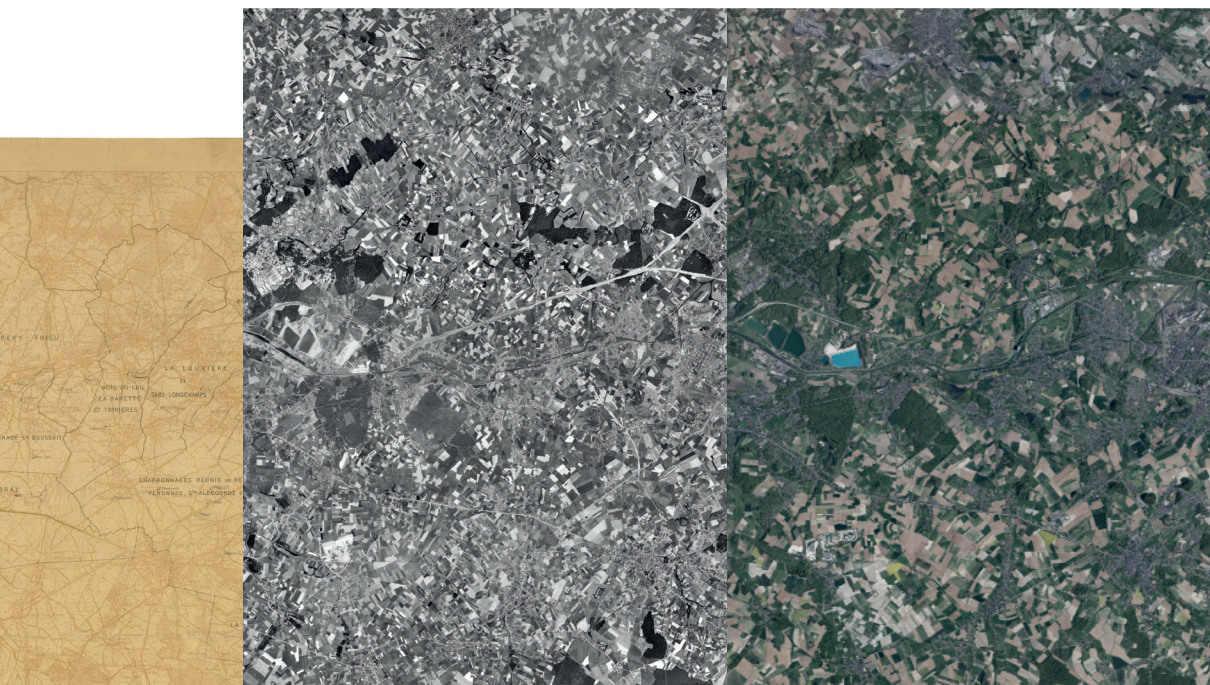




1777

1854

1922



1971

2020



2.1 A REGION OF DISPERSED CENTRALITIES

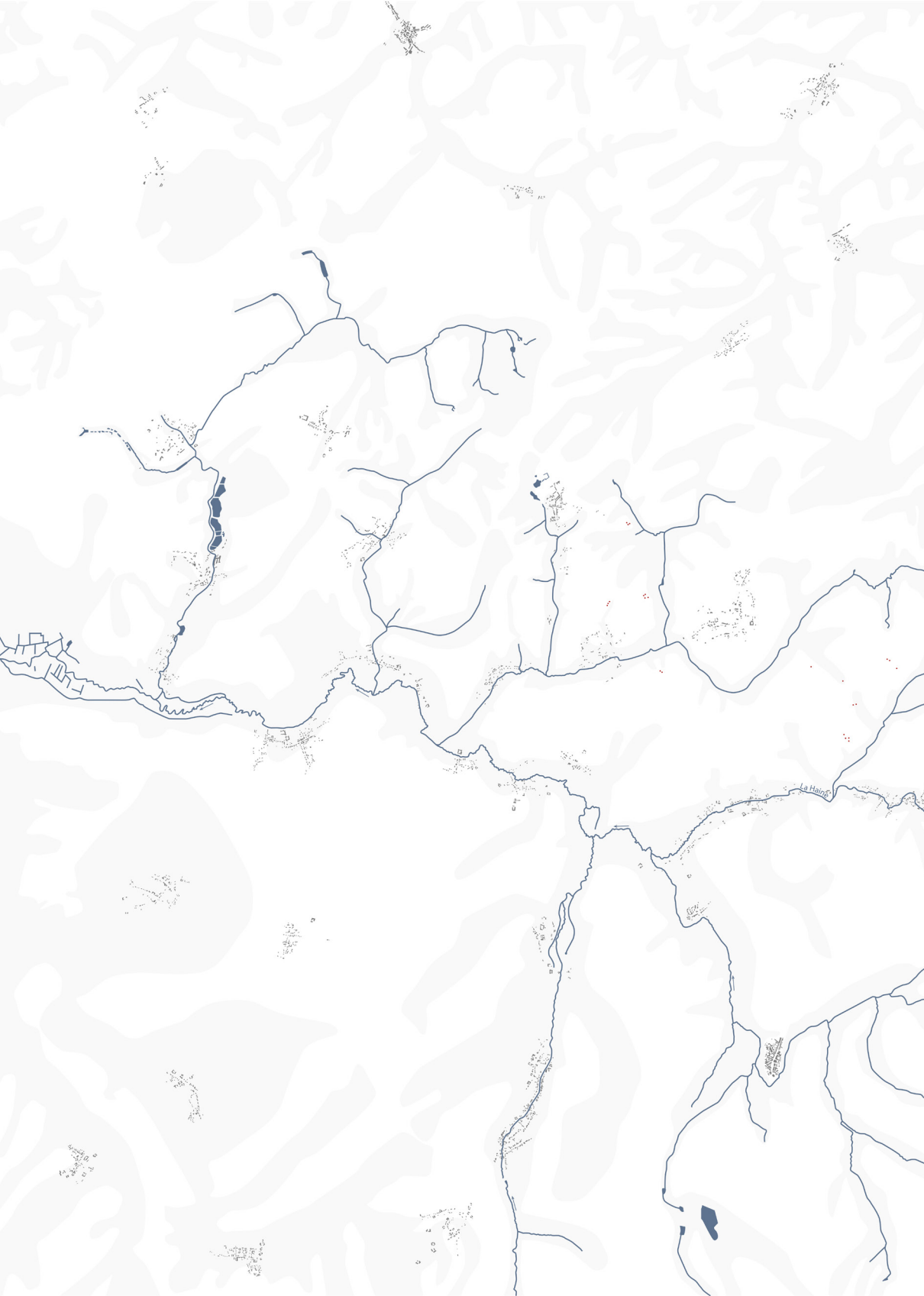
Before the first industrial revolution, *Le Centre* was known for its wide meadows. Most of the market towns were located near watercourses to benefit from the power of water in their daily tasks (Hasquin et al., 2016). As a result, significant demographic growth has been recorded around the valleys. La Haine valley is characterised by the river of the same name, which is itself served by numerous tributaries such as La Samme and the Estinnes stream, for example.

Villages such as Havré, Maurage, Trivières, etc. also existed before the future town of La Louvière, which came into being around the time of the first industrial revolution at the end of the 18th century. Each of these villages had clear characteristics, such as its own church, squares and so on. This gave them their centrality. As a result, we can see their impact on the land, and that it was a rather agricultural area, and therefore already productive for its time.

Coal had already been mined since the 13th century, but in a small-scale, non-industrial way. The coal was extracted using mills powered by water (Hasquin et al., 2016).



Fig. 6 - Large agricultural areas, 2024



LEGEND

-  Valley
-  Built centrality
-  River
-  Mining infrastructure

— 4 km —

The coal bed dates back to the Carboniferous period between 354 and 297 million years ago. It was formed from an accumulation of layers of ancient vegetation that had been submerged under water during numerous climatic variations. This accumulation was accelerated by the mud and sand that covered these layers of vegetation. This phenomenon is more commonly known as houillification. This succession of layers was formed thanks to these multiple events and the growth in pressure of these numerous layers. These layers also make it possible to classify types of coal on the basis of their carbon content (Nolf, 2008). These different types are qualified for different uses. Due to the many movements of the Earth, these layers have been brought closer to the surface, enabling them to be extracted.

— 12 km —

The first machines, such as Newcomen's fire pump for removing water from underground galleries, were invented at the end of the 18th century. It enabled collieries to extract coal much more deeply and thus to industrialise coal production. This machine marked the first use of the steam engine, due to British innovations that would give rise to the first industrial revolution. It was from 1766 onwards that *Le Centre* region saw the appearance of this type of machine (Crul et al., 2012). The coalfield in general then gradually gave up its agricultural past to make way for the industrialisation of coal (Varetz et al., 2019).

— 16 km —

We can also see the Bois-du-Luc mining site, one of the four mining sites listed as a UNESCO World Heritage Site. Bois-du-Luc was one of the first mining corons to bring together miners and the bourgeoisie, who contributed their knowledge and financial support respectively. This remains one of the earliest forms of capitalism (Crul et al., 2012).

UNESCO WORLD
HERITAGE SITE

The aim of this listing was to recognise the legacy of the mines as a lever for cultural foundations. In all, four mining sites have been listed as World Heritage Sites, namely Grand-Hornu, Bois-du-Luc and Bois du Cazier in Hainaut and Blegny-Mine in the province of Liège (Crul et al., 2012)).

— 20 km —



Fig. 7 - Large agricultural areas, 2024



Fig. 8 - The old rue de Mons, to the south of the site, 2024



Fig. 9



2.2 FIRST INDUSTRIAL REVOLUTION

The 19th century saw the industrialisation and extraction of coal in Wallonia thanks to the Industrial Revolution and the arrival of the steam engine. This was an important turning point for Wallonia, as it enabled much greater production, as well as the export and import of materials. The construction of canals also began at this time, which also favoured the transport of goods. The railway and waterway networks worked in symbiosis.

As Pierre Paquet, Inspector General of the Department of Cultural Heritage (DGO4) explains: « Le charbon a apporté l'énergie nécessaire à l'industrie de la métallurgie, de la chimie, du verre... Il est à l'origine du développement économique de notre région [la Wallonie]. Il a contribué à faire de la Belgique du XIXe siècle, une des plus grandes puissances industrielles du monde. Il a profondément marqué les paysages et les populations » (Coal provided the energy needed for the metallurgy, chemical and glass industries... It was at the origin of the economic development of our region [Wallonia]. It helped to make 19th-century Belgium one of the world's greatest industrial powers. It had a profound effect on the landscape and the people (free translation)).

MINING CONCESSION

Mining concession refers to a subsoil cadastre, a legal act granting the right to exploit a material, these concessions usually linked communal or natural boundaries. Even today, many concessions are still open. In the case of hard coal, although the last colliery closed in 1984, 99 out of 150 concessions are still open, although some of them have been in the process of being withdrawn since 2012.



Fig. 10- Coal mining of Hornu-Wasmes - Philippe de Gobert, n. d.



LEGEND

Valley

Built centrality

River

Mining infrastructure

Mining cavalier

Rail network

Mining concession

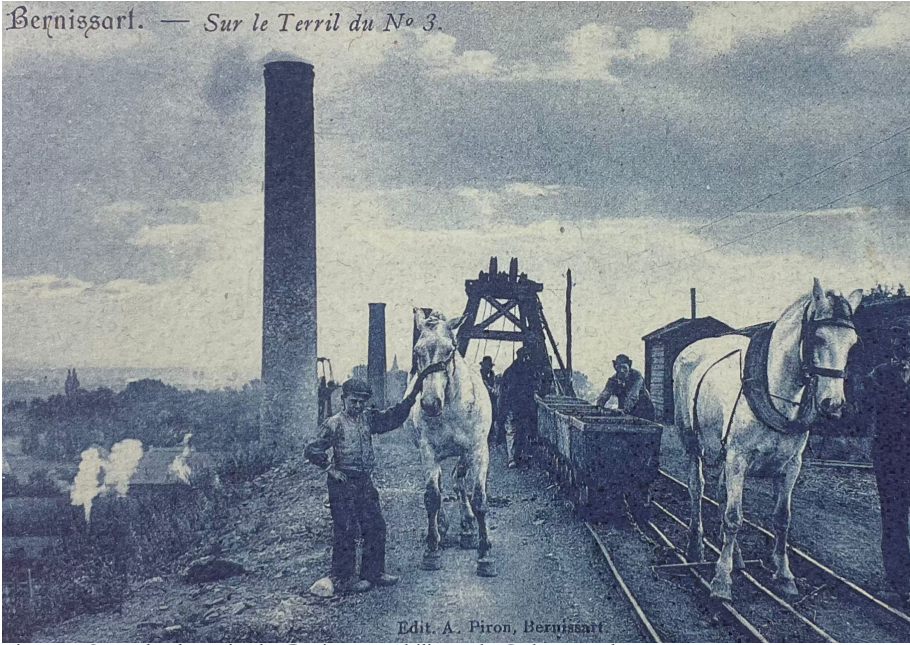
We can therefore understand the importance of coal mining at the time, as coal was once used in many fields. It was the main source of domestic energy at the time, as well as powering various industries and transport. This can be seen on historical maps such as the Vandermaelen map of 1846-1854 or the map of the Dépôt de la Guerre of 1865-1880, which already show the various mining sites. With the invention of the coke oven and other types of machinery and industry, coal became the mainstay of this revolution. The delineation of mining concessions is already taking shape and various surveys have been carried out to find potential underground mining deposits.

Robert Halleux says: « L'exploitation houillère a modelé le paysage physique, le paysage social et le paysage mental. Du point de vue physique, elle a suscité la prolifération anarchique d'agglomérations autour des charbonnages et des raccordements de chemins de fer et la création de bassins industriels. Du point de vue social, elle a fait de la Wallonie une terre de luttes ouvrières » (Coal mining shaped the physical, social and mental landscapes. From the physical point of view, it led to the anarchic proliferation of agglomerations around collieries and railway connections, and the creation of industrial basins. From a social point of view, it made Wallonia a land of workers' struggles (free translation)). Indeed, we can see the emergence of new centralities thanks to the new industrial brownfield. The railways would later enable people to travel longer distances. The 'cavaliers' were the railways that linked the collieries to the economic networks. They also shaped the landscape in a way, as it was possible for a mining site to be located a long way from a goods transport network. The first slag heaps appeared, along with the replacement of wooden and brick headframes by iron ones, which would remain the symbol of mining. Some extraction towers were built in concrete in more recent mines. Numerous buildings, such as marshalling yards and wash-houses, also left their mark on the landscape.

I N D U S T R I A L BROWNFIELDS

Mining corons are characterised as mining villages. In principle, each coal factory was accompanied by a miners' village to bring them closer to the extraction site. Other mining infrastructures were built in the vicinity of the site, such as the mine manager's house, a church, a school and a hospice, in order to operate almost self-sufficiently and find everything a mining family would need on the spot.

Bernissart. — *Sur le Terril du No 3.*



Edit. A. Piron, Bernissart

Fig. 11 - On a slag heap in the Borinage - Philippe de Gobert, n. d.

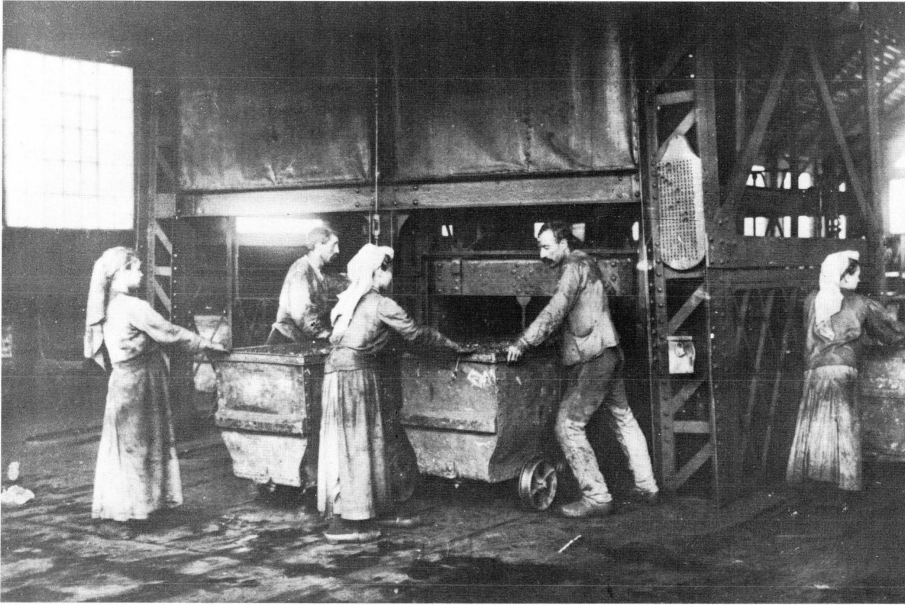


Fig. 12 - Miners washing coal - HBNPC, n. d.

tion 1922.



Fig. 13 -



2.3 THE BEGINNING OF THE END

The golden age of coal mining in Belgium was at the beginning of the 20th century. In total, with an annual production of more than 25,117,940 tonnes of coal, there were 294 collieries in operation at this time (Delaet et al., 2023). The coalmines became public limited companies, confirming their importance.

The inter-war period also marked an important turning point in the history of mining. The mines in the Kempen had recently opened after the First World War, which would begin to have an impact on competition from Walloon coal. The advent of coal mines in Germany's Ruhr region only strengthened the race for coal. The Belgian coalfield is characterised by very fine coal seams. In fact, the mines can reach depths of over 1,000 metres in the western basin of Wallonia. The length of these seams is what makes them so complex, because the layers of coal are scattered and not concentrated in one place, as might be the case in Germany, where the seams can be up to 3 metres thick. This is due to movements in the earth's crust. Indeed, these movements caused folding that formed these fine veins with sharp angles, which can be as thin as ten centimetres in the Belgian coalfield (Crul et al., 2012).

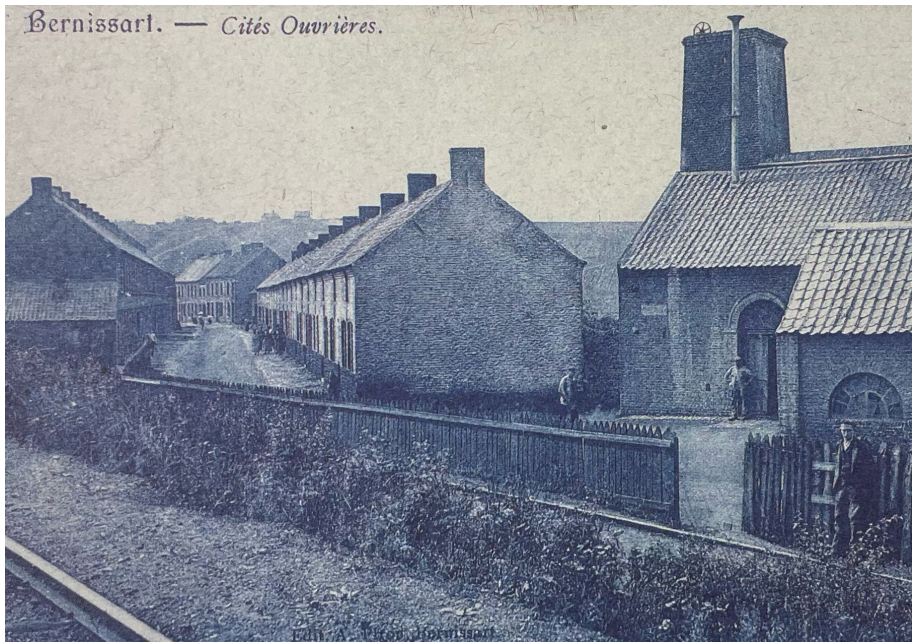


Fig. 14 - Worker's housing estate in the Borinage region, Philippe de Gobert , n. d.



LEGEND

- Valley
- Built centrality
- River

- Mining infrastructure
- Mining cavalier
- Rail network

- Mining concession
- Hydraulic network
- Slag heap

Although the old Centre Canal was completed in 1888 providing the connection for the commodity, coal slowly began to decline 50 years later. Indeed, the topography of *Le Centre* region was quite uneven. As a result, the rivers were not suitable for navigation. The difference in level between Charleroi and Mons was around 90 metres. As a result, a canal project to link Charleroi and Brussels, and then Antwerp, enabled Charleroi to export its goods. At the same time, *Le Centre* joined in the project by installing several boat lifts to cross this important topography (Nolf, 2008). The Borinage and Centre regions are the first to be affected. Mining was no longer profitable due to its complexity and its competitiveness with other countries. After the First World War, there was significant immigration of miners (Varetz et al., 2019). Italians, Spaniards and Greeks came to Belgium to work in the mines after Belgian Minister Achille Van Acker mobilised Belgian and foreign miners to launch the Battle for Coal, which involved producing 100,000 tonnes of coal a day. The Italian state agreed to send miners as labour in exchange for cheaper coal (Crul et al., 2012). Numerous strikes also began at this time. The miners were demanding lower wages, dangerous working conditions, long working hours, etc. These strikes enabled the miners to get a better deal. These strikes enabled miners to obtain better working conditions and recognition of their trade union rights (Varetz et al., 2019).

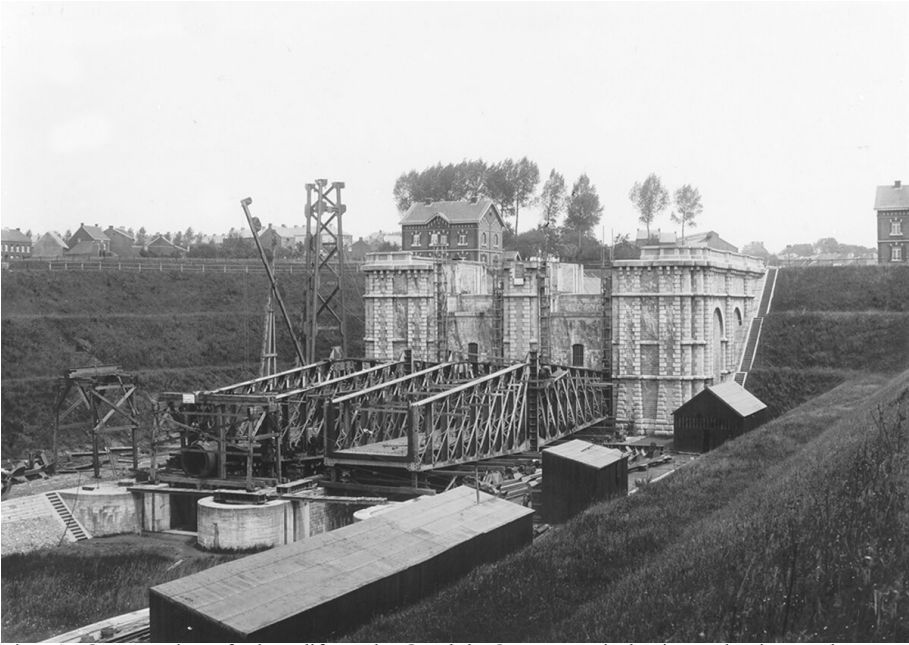
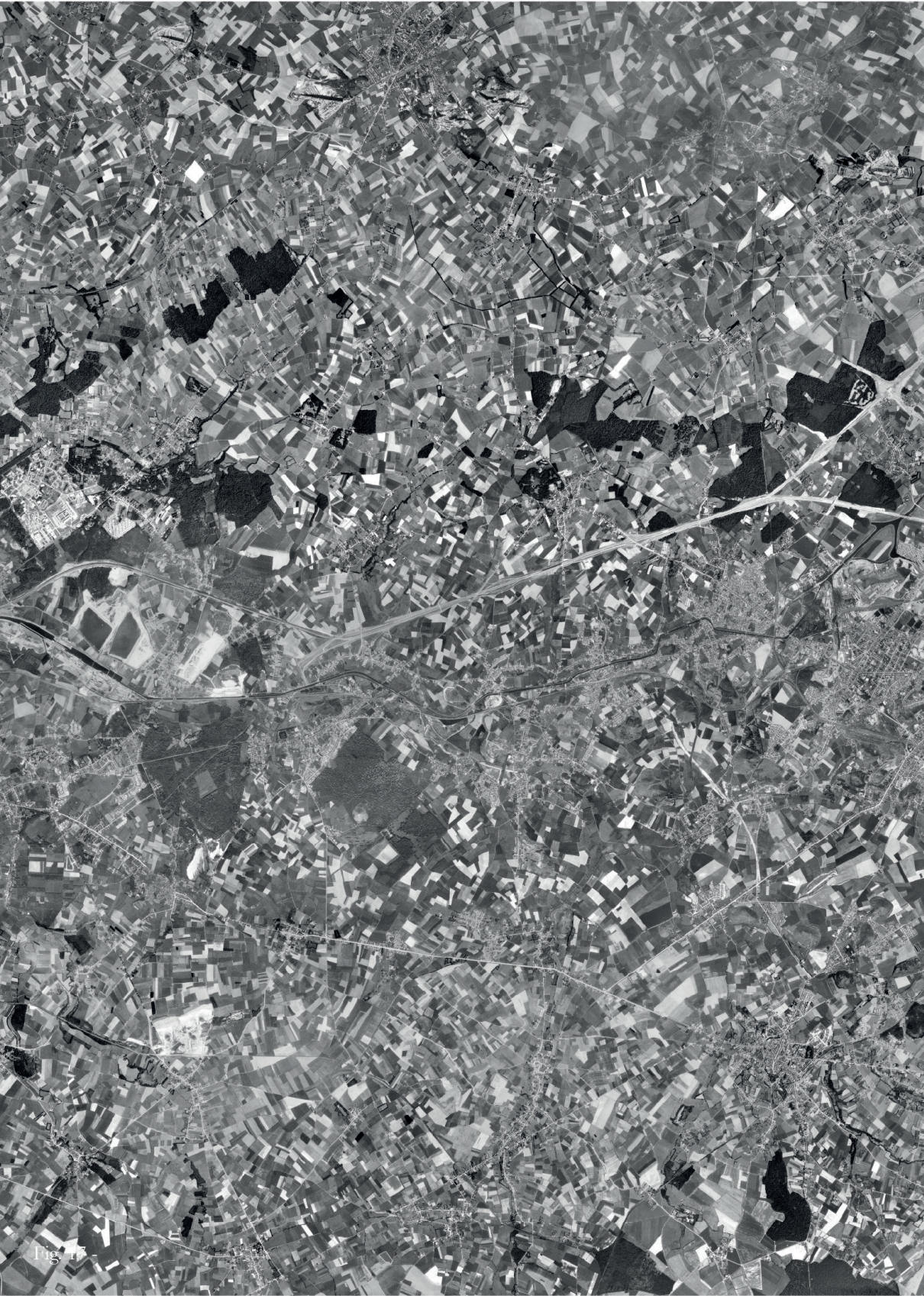


Fig. 15 - Construction of a boat lift on the Canal du Centre - Noir dessin production, n. d.



Fig. 16 - Treaty of Paris - European Parliament, 1951



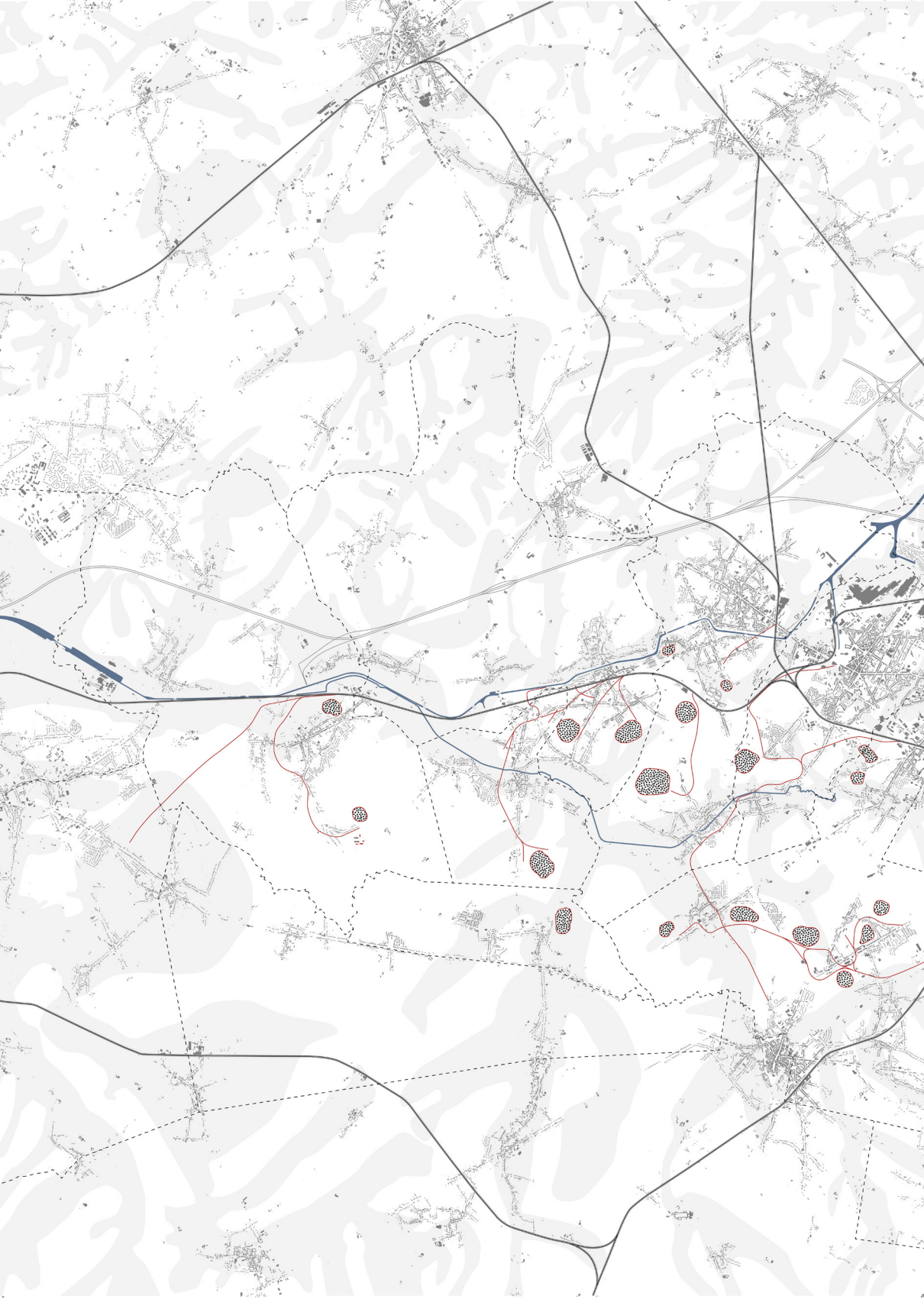
2.4 TOWARDS DEINDUSTRIALISATION

After the disaster of 8 August 1956 at Bois du Cazier in Charleroi, many people became aware of the risks of mining. On that day, 262 miners fell victim to a firedamp explosion 975 metres underground (Crul et al., 2012). The unsanitary conditions, lack of safety and numerous accidents did not make coal mining any better. Indeed, many risks can occur several hundred metres below the surface. The most common is firedamp, but floods, collapses and even fires were common in mining tunnels (Varetz et al., 2019). Firedamp is a natural gas made up of 80-90% methane. It comes from the decomposition of plants during geological movements that took place millions of years ago. When coal is mined, this gas can be released into the air. Between 6 and 15% of firedamp in the air, the firedamp-air mixture becomes very dangerous because it is explosive at the slightest spark. (Capouillez, 1994). This cost the lives of thousands of miners.

In 1951, six European countries (Belgium, France, Germany, the Netherlands, Luxembourg and Italy) signed up to a free coal market, thus forming the European Coal and Steel Community (ECSC). The main aim was



Fig. 18 - The Bois du Cazier disaster - Camille Detraux, 1956



LEGEND

- | | | |
|------------------|-----------------------|-------------------|
| Valley | Mining infrastructure | Mining concession |
| Built centrality | Mining cavalier | Hydraulic network |
| River | Rail network | Slag heap |

to strengthen the coal industry. However, in addition to a lack of investment, a shortage of labour and increasing competition from new energy sources, Belgian coal was becoming too expensive, which led to further rationalisation of mining. From 1959, the ECSC called for the closure of unprofitable mines. *Le Centre* region was the first to close its coal mines entirely, with the Bois-du-Luc mine in 1973. The last mine closed in 1984 with the Roton colliery in Farciennes (Charleroi) (Crul et al., 2012).

At the same time as coal mining was declining, new energy sources such as oil, electricity, gas and nuclear power were being developed. The second industrial revolution is characterised by these new energies, as well as the growth in the use of cars (Varetz et al., 2019). Deindustrialisation will deal the final blow to the coal industries, as well as making them unprofitable.

These changes will once again transform the landscape with the appearance of major trunk roads, such as the E42 and E19 in *Le Centre* region, and industrial estates adjoining them.

The dismantling of railways and cavaliers is happening little by little. Even the main railway lines are being used less and less, to the point where they have to be demolished too, like the one linking the town of La Louvière and Soignies. The region is adapting to new sources of energy and transport.



Fig. 19 - Construction of the E19 motorway - Wegen-Routes.be, 1967



Fig. 20 - Mining infrastructures, 2024



Fig. 21 -

2.5 POST-INDUSTRIAL TERRITORY

4 km *Le Centre* region has become a post-industrial area, with many industrial wastelands visible across the landscape. We can see the many slag heaps that were once the symbol of the coal mines, but have now been reduced to piles of rubbish, mostly covered in vegetation. We can also see the old railway lines and bridleways, which have either become RAVeL circuits or are covered in vegetation. The only existing railway line today is the one between Mons and La Louvière.

8 km The appearance of the new canal continues to show that the hydraulic network is still a strong economic network today. The Strépy-Thieu lift is a 21st century feat of engineering, replacing 4 boat lifts and a lock on the old canal built in 1888, which corresponds to a difference in level of 73.15 metres (SOFICO, 2022). This wide canal runs to the north of the old canal, creating a sharp divide in the landscape. Many streets find themselves cut off or redirected to pass over or under the canal.

12 km The role of the car also has an impact on the area. The two motorways running parallel to the canals reinforce this divide in the landscape. The many roads divide the area between the built-up area and the landscape. The causeways



Fig. 22 - Motorway E19, 2024



LEGEND

- | | | | |
|------------------|-----------------------|-------------------|---------------------------|
| Valley | Mining infrastructure | Mining concession | Levelled slag heap |
| Built centrality | Mining cavalier | Hydraulic network | Abandoned mining cavalier |
| River | Rail network | Slag heap | Abandoned rail network |

that existed in the eighteenth century are still in use today, linking the various towns together. After the second industrial revolution, with the exponential growth in car use, industries followed suit and positioned themselves close to motorways. This also saw the emergence of industrial parks, a principle that originated in the United States of America. As a result, a new typological form was born. Industries were located on the outskirts of towns, unlike in the past, when they were sometimes an integral part of the urban fabric. These parks were the result of the 1959 law on economic expansion in Belgium (Gouvernement Belge, 1975), which aimed to counter the social and economic difficulties of certain regions, particularly *Le Centre*, which was already in slight decline at the time.

We can also see two wind farms, a power station and a solar farm, leading us to believe that the region is adapting to new technologies.

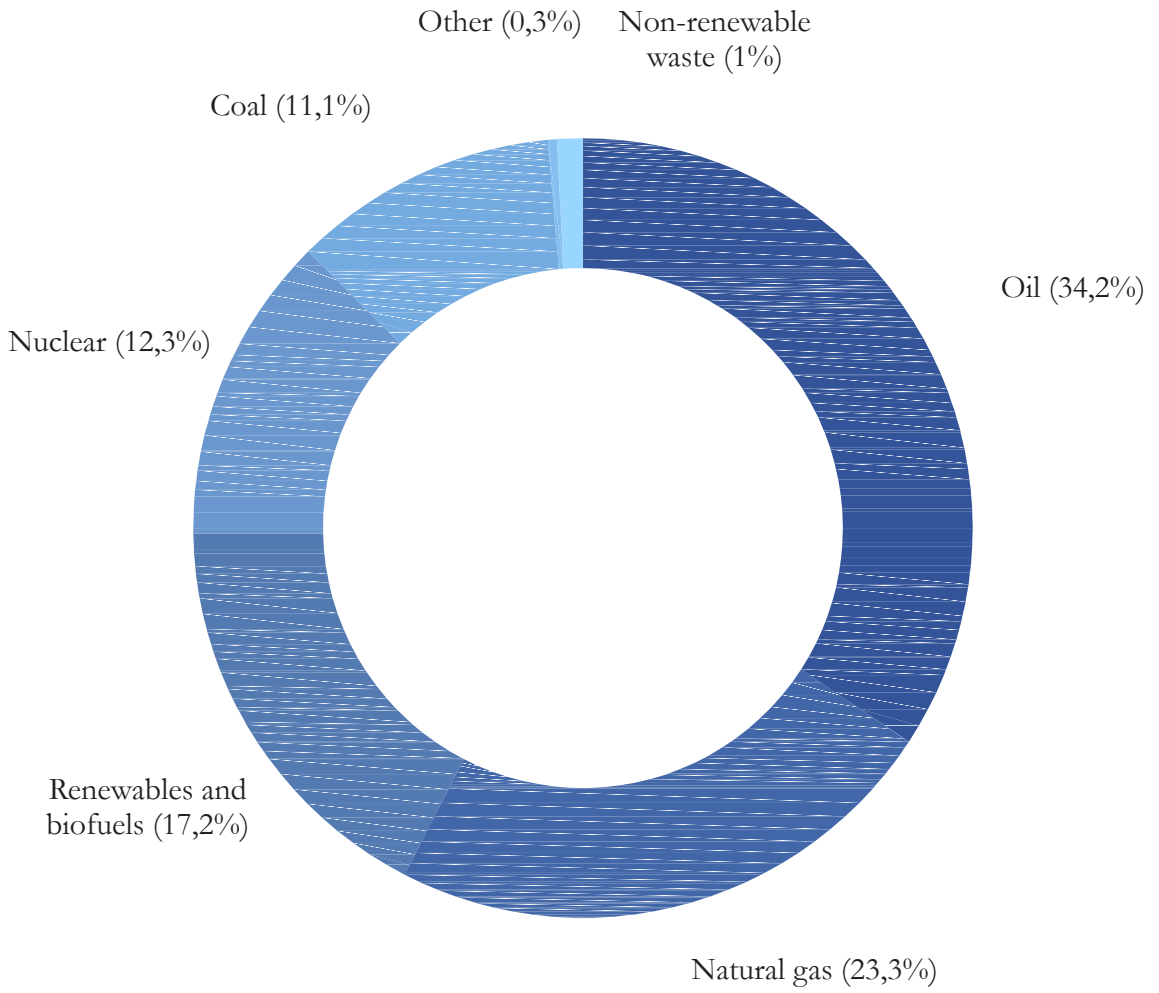
Urban areas are much more diffuse today. We can see that the old centralities that were once the landmarks of the villages are now blurred. What's more, the built environment is much more diffuse than it used to be, which leads us to a new analysis of the centralities.



Fig. 23 - Construction of the boat lift in Strépy-Thieu, Archives régionales de Wallonie - 1994



Fig. 24 - Industry on the new canal, 2024



3.1 ENERGY IN EUROPE

Energy is an important issue today. The Paris Agreement signed in 2015 aims to reduce global warming to 1.5 degrees by the end of the 21st century. In order to guarantee these global objectives, a number of actions need to be implemented (United Nations, 2015). In Europe, the European Green Deal (EGD) mentions various targets that need to be put in place to achieve this agreement (Fetting, 2020). Not to mention the European objective of limiting its carbon emissions to 100% by 2050 and becoming the first continent with zero CO₂ emissions (United Nations, 2021).

In 2021, almost 70% of the energy available in the European Union, which is comparable to the energy consumed, came from fossil fuels (oil (34%), gas (23%) and coal (11%)) (Eurostat, 2021). Although renewable energies are increasing in popularity, this is not enough. More sustainable production needs to be established in Europe in order to guarantee its energy autonomy. On top of this, over 55% of Europe's energy is imported due to its lack of resources. Belgium ranks 8th with 70.6% imported (Eurostat, 2021). As a result, Europe consumes more energy because of these imports.

In the case of the Centre, we can still see that it is active in terms of energy. As explained above, two wind farms have been set up in the area, as well as a solar farm near the junction between the old and new canals, north of La Louvière. The most interesting mining site is the power station on the former Le Quesnoy mine site belonging to the Bois-du-Luc colliery at Trivières. Today, high-voltage lines run from this power station to supply the surrounding area with electricity. In terms of energy consumption, the municipality of La Louvière ranks 10th in Wallonia, with 2,405.5 GWh (WalStat, 2019).



LEGEND

- High-voltage lines
- Solar energy
- Wind energy



Fig. 25 - View from the power station from the Quesnoy slag heap, 2024

3.2 SOCIO-ECONOMIC CONTEXT

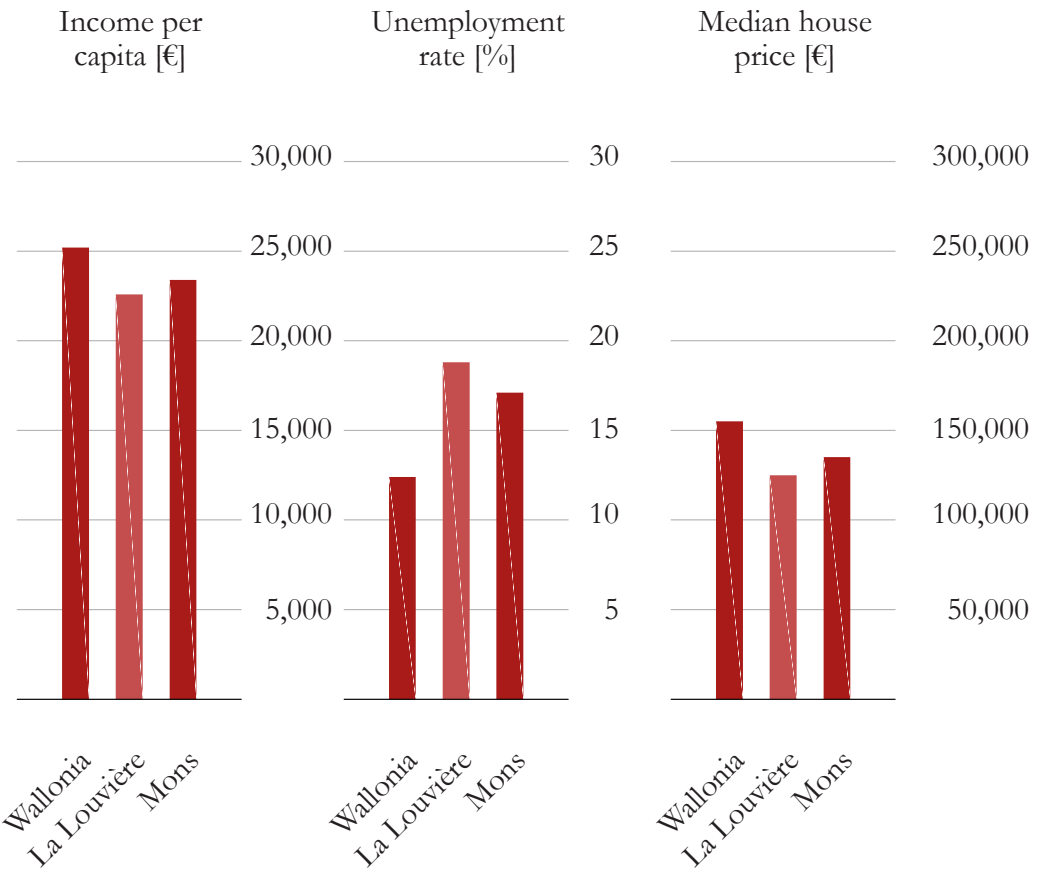
The socio-economic context underwent major upheaval after the closure of the various collieries in the coalfield. The de-industrialisation of the area led to considerable economic decline for its inhabitants. The closure of the mines had a cascading effect on the various industries directly or indirectly linked to coal extraction.

WalStat, the local statistical information portal for Wallonia, provides statistical proof of this precarious situation with data such as median per capita income, unemployment rate and median house price.

In the case of La Louvière, per capita income is €22,522 compared with an average of €25,193 in Wallonia (SPF économie - StatBel, 2021), the unemployment rate is 18.8% compared with an average of 12.4% in Wallonia (CENSUS 2011) and the median house price is €125,000 in La Louvière compared with an average of €155,000 in Wallonia (SPF économie - StatBel, 2020). This data is interesting from several points of view. Per capita income and the unemployment rate show that the current situation has not improved since the industries closed. As a result, housing prices have deteriorated. The majority of homes in the Centre region are working-class houses dating back to the 20th century.

This regression has not only caused economic problems. The state of health of the miners, but also of the local population, is still an issue today. Due to exposure to coal dust, working conditions and lack of air, many miners developed respiratory problems during their lives. In addition, their mental health was damaged by not being exposed to sunlight for several hours (Varetz et al., 2019). On the surface, the state of the soil played a role in the general health of the inhabitants. Pollution from economic activities has rendered the soil unfertile. In addition, the smoke also caused respiratory problems for the inhabitants (Varetz et al., 2019).

The same phenomenon can be seen in all the municipalities in the Belgian coalfield.





LEGEND

 Slag heap

 Levelled slag heap

3.3 SLAG HEAPS

The slag heaps were one of the symbols of the mining era. These artificial mountains of mine waste have grown over the years to become real monuments in the coalfield. Their generous topography has shaped the landscape. However, they have also given rise to much debate among local residents. Some claim that the slag heaps symbolise the memory of the mining past, while others see them as dirty heaps of rubbish, contributing to the repulsive and unpleasant appearance of an area that is already dilapidated and unattractive as a result of economic decline. However, the spoil heaps are a cultural, social and tourist resource.

These spoil heaps were designed using ramps or cable cars and easily reached a height of at least 100 metres for a radius of around 100 to 200 metres. They were placed next to the main shaft or shafts so that the waste could be easily removed. In fact, they are not really waste at all. Slag heaps are made up of 70% carboniferous shale and sandstone (Ardenne & Gaume, 2020).

In all, 333 of the 543 slag heaps that existed in Wallonia remain today (Ardenne & Gaume, 2020). Not all of these spoil heaps have remained in their original state; some have been levelled, while others have been brought up to

EROSION

Erosion is a natural event aimed at degrading soils in our case due to wind, rain or water runoff. This can have a significant impact on the area, as the spoil heaps are at risk of erosion.

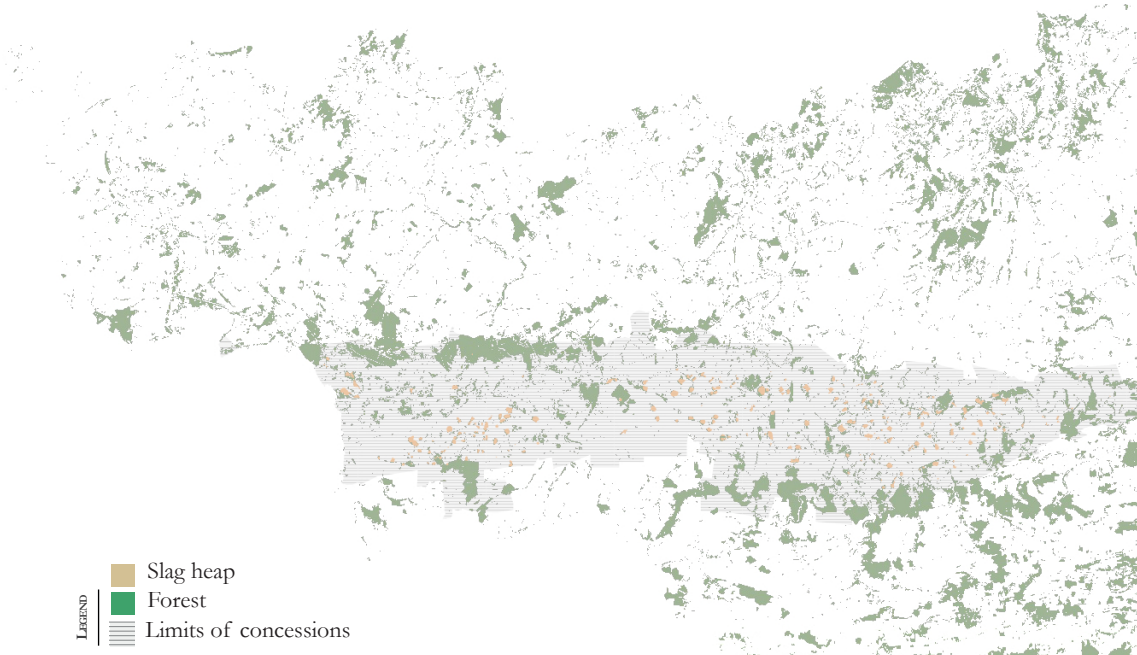


Fig. 26 - Quesnoy slag heap, 2024

standard to prevent them collapsing, as was the case with the Aberfan spoil heap disaster in 1966 in Wales, which collapsed onto a school (Maquet and Henne, 2019). Waste tip erosion is therefore an important factor to take into account. Indeed, they are known to be a risk. Most spoil heaps have not been developed in such a way as to prevent them from collapsing in on themselves.

Various projects for the redevelopment or enhancement of slag heaps in Wallonia have already been implemented, such as ‘Destination Terrils’, supported by the European Union through an Interreg project between 2017 and 2021. The aim of this programme was to highlight the cultural, environmental and tourist assets of the slag heaps in France and Belgium. At the end of the programme, a website was made available to everyone, listing the various slag heaps and explaining their history, as well as ranking them in relation to the above-mentioned assets.

At the same time, the Chaîne des Terrils CPIE (Centre Permanent d’Initiatives pour l’Environnement - Permanent Centre for Environmental Initiatives) has been active in the coalfield with educational initiatives to raise awareness of



the environment, heritage and eco-citizenship (Varetz et al., 2019).

In addition, various studies such as ‘Le Contrat du Bassin Minier’ (The Mining Basin Contract) in 2021 have been produced in order to proceed with ends for the slag heaps. As a result of this study, an idea for a table was put in place to enable slag heaps to be classified according to their characteristics for their redevelopment. The table contained 3 categories: slag heaps that could benefit from environmental or heritage protection, those that could be developed for cultural or tourist purposes and, finally, slag heaps that could be used for economic purposes (Contrat de Bassin Minier, 2021).

These slag heaps have also been at the heart of certain projects to recover energy from them, such as the Royal Decree of 21 March 1975 allowing slag heaps to be exploited to recover mineral substances, in particular shale (Delaet et al., 2023). In addition, some engineers have tried to recover the heat still present on the spoil heaps, without success.

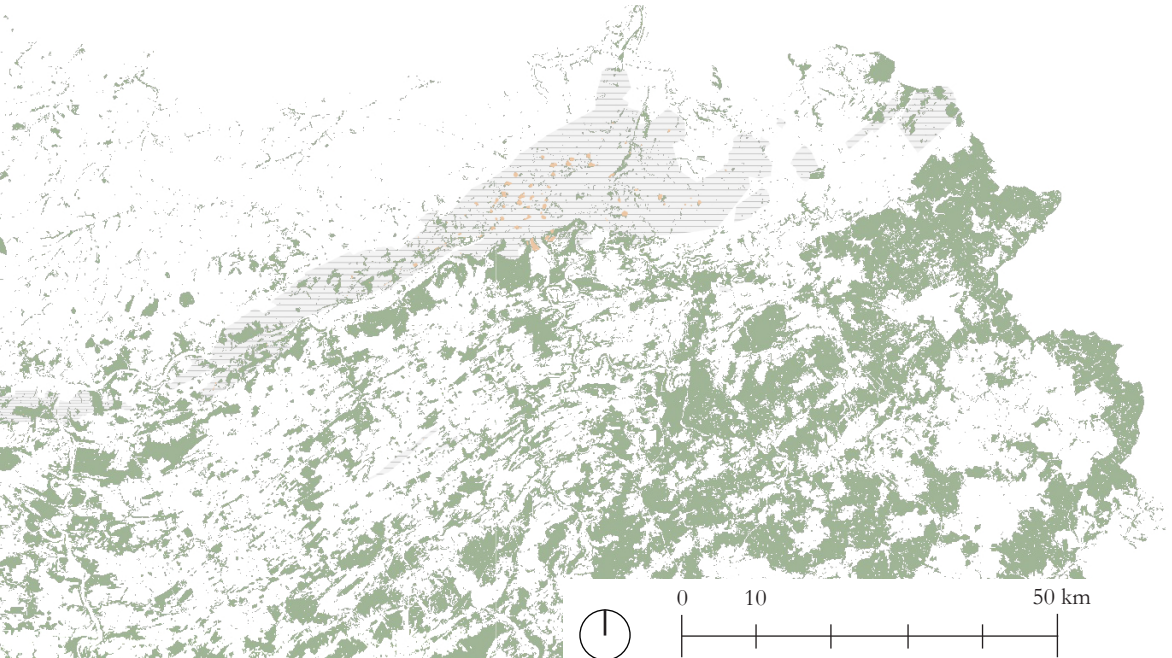




Fig. 27. Composition of slag heaps, 2024

The slag heaps are also a source of exceptional flora and fauna thanks to the heat that still emanates from them today. As a result, a new biodiversity has developed within the spoil heaps. For example, 170 new plant species have taken their place on these mounds in 50 years (Ardenne & Gaume, 2020).

From a cultural and tourism point of view, various initiatives have already been launched to include the slag heaps among the local population. In Marcinelle, for example, the Panorama festival takes place on the Hiercheuses slag heap. This is a cultural event featuring artistic activities such as film screenings and concerts. In addition, a number of walking routes have already been designed to take advantage of the view from the top of the slag heaps. This is the case, for example, of the Boucle Noire (Black Loop) in Charleroi, which is part of the Grande Randonnée (GR) 412 trail running through the Belgian coalfield from the city of Liège to the French-Belgian border.

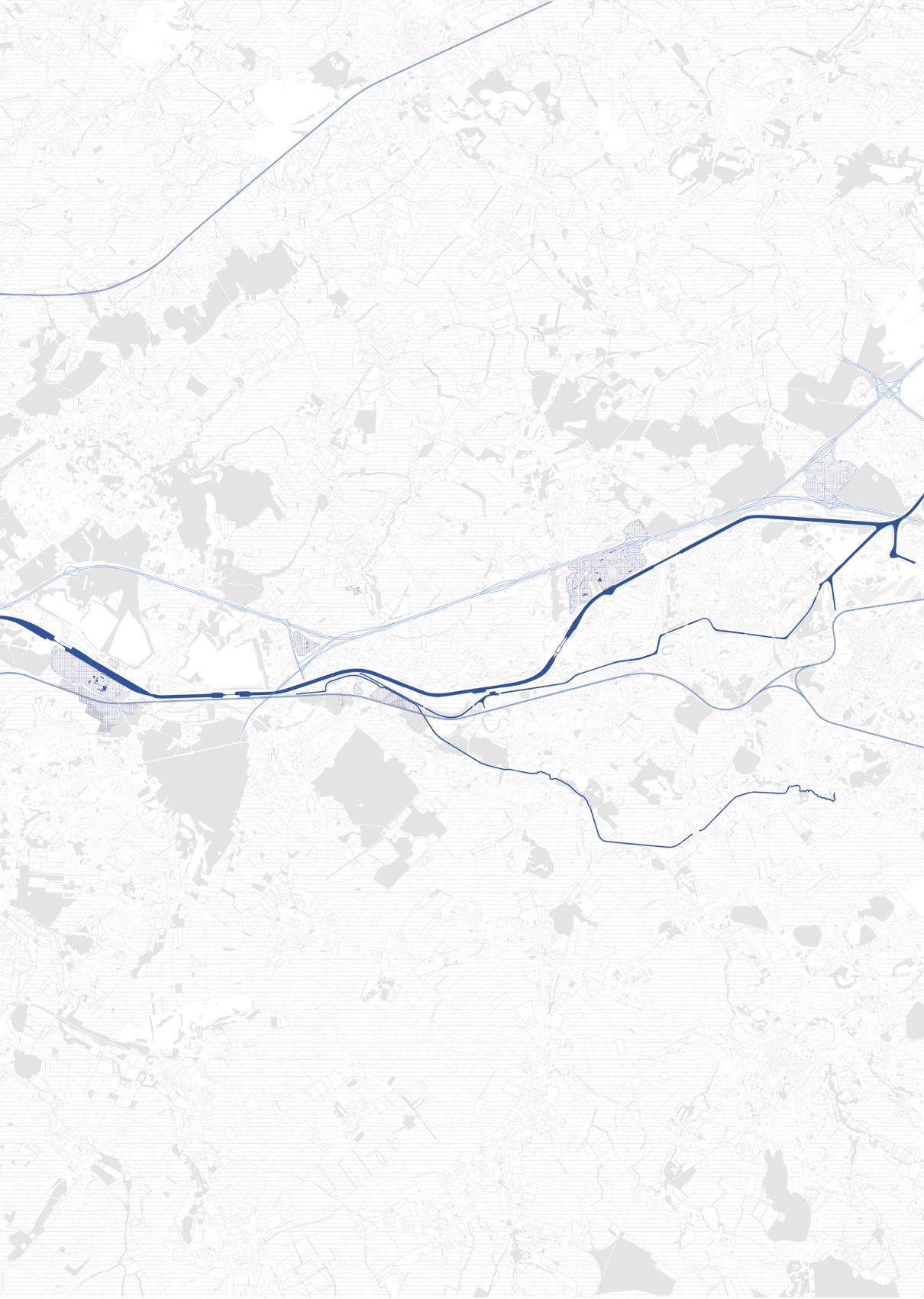
3.4 ECONOMIC NETWORKS

As explained in the historical analysis, Le Centre has undergone major changes as a result of economic networks. These networks have artificially altered the topography of the land. Thanks to these networks, Wallonia has become one of the most powerful economic crossroads in the world. It's no coincidence that the coalfield is also the industrial heartland, thanks to the ease with which goods can be imported and exported.

They still play an important economic role today. However, the facades of these networks have been razed to make way for their immense size. These projects are on a huge scale, with many buildings having to be demolished to create this network. As a result, they have created a sharp divide in the area. Most of the old industrial sites along these routes have now been replaced by new, modern industries along the motorways. Beyond that, the Centre region is more of a transit area than a stopover or production area on the scale of Wallonia.



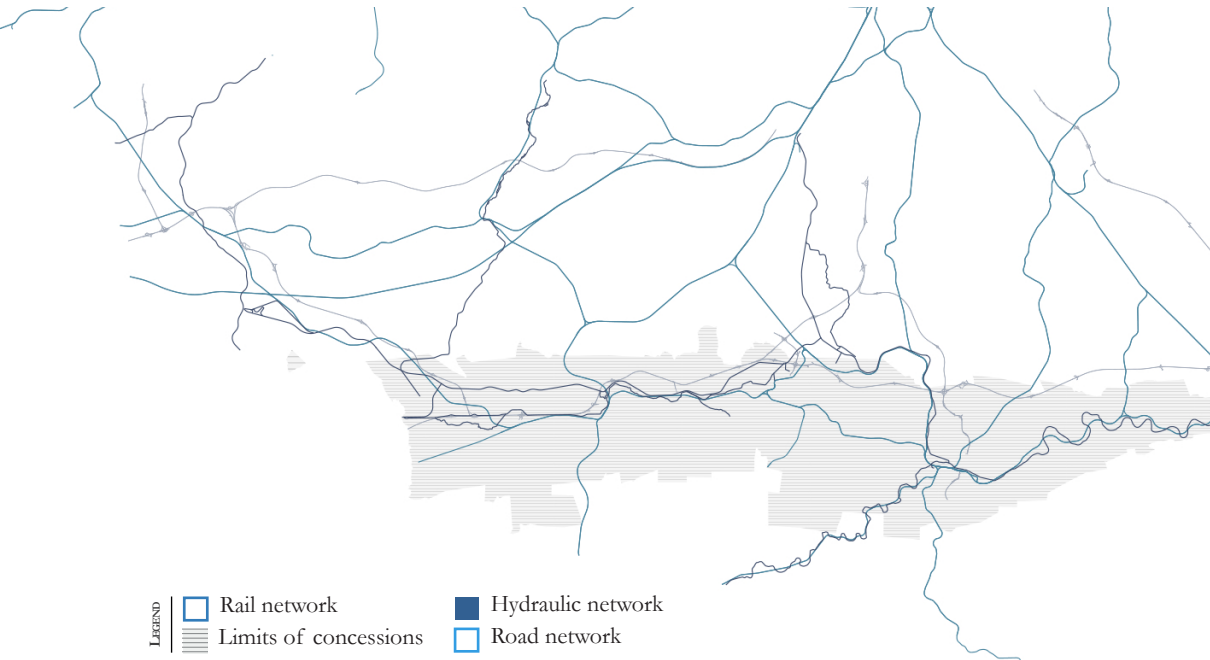
Fig. 28 - The railway line linking La Louvière to Mons, 2024

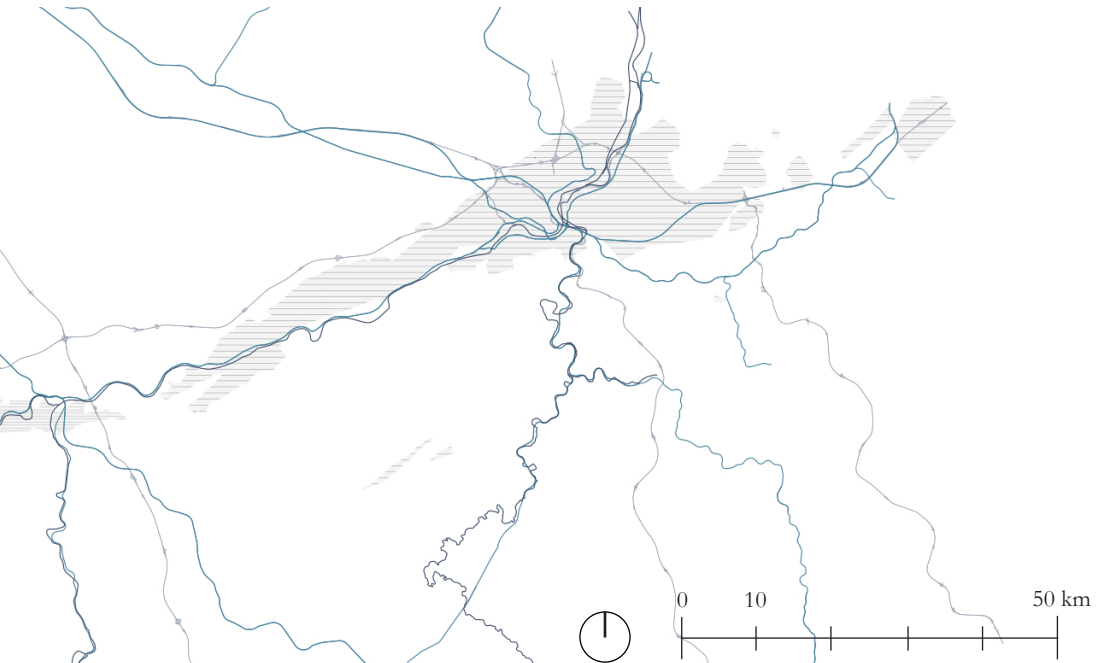


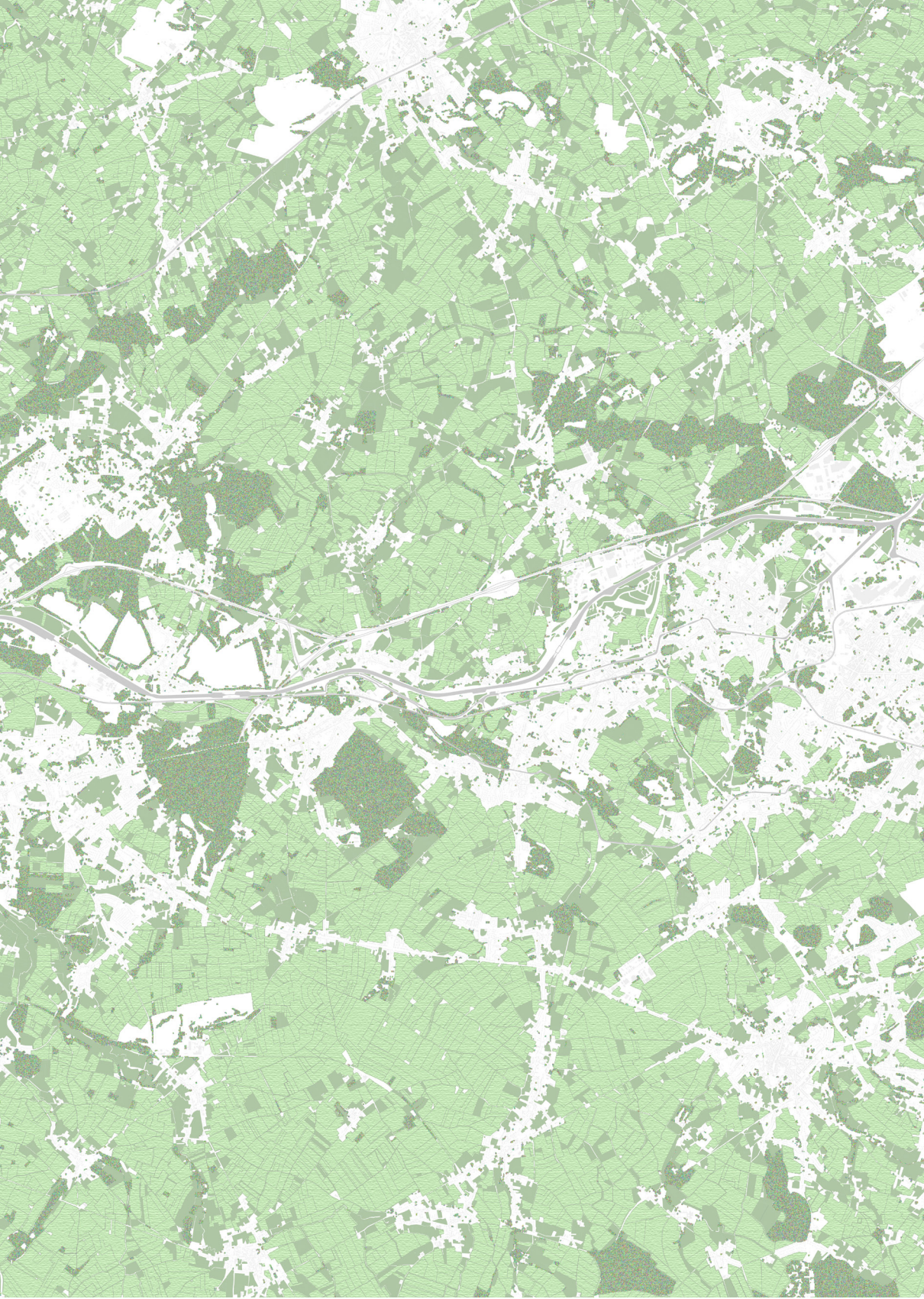
LEGEND

-  Rail network
-  Hydraulic network
-  Road network

Most of the bridleways have been dismantled and no measures have been taken to reallocate them, with the exception of some that have become RAVeL lines, such as line 422 linking the town of Binche to La Louvière. The towpaths along the new and old canals have also been designated as RAVeL lines. Apart from these minor improvements, the bridleways have been naturally renatured, but we can still see their traces in the landscape.







LEGEND

- Forest
- Agriculture
- Meadow

3.5 AGRICULTURAL AREA

Soil fertility is an important territorial issue in Europe. Indeed, the state of Europe’s soils is in crisis, with over 60% of them unhealthy (European Commission, 2023). This is detrimental to the climate and the development of biodiversity. This is due in particular to the sealing, contamination and over-exploitation of fertile land. As a result, soils are no longer able to function properly, increasing the risk of natural disasters such as flooding or subsidence. Alongside the European targets mentioned in the section on energy consumption, the European Union is suggesting that all soils should be healthy by 2050 (European Commission, 2023). In this way, soil decontamination would help to guarantee soil resilience.



Fig. 29 - Meadows and fields, 2024

3.6 NEW CENTRALITIES

As we have already explained in the historical analysis, the collieries created a new form of centrality in the urban landscape. Mining infrastructure was concentrated in one place in order to facilitate the living conditions of miners and their families and to regulate their daily lives. This form of centrality was inspired by the ideologies of the time, namely utopian socialism and Fourier's phalansteries of the early 19th century. These were based on the equality of each individual and autarky, where individual satisfaction led to collective well-being. This cooperative system led to significant social reorganisation for its time. As a result, the mining districts were built in such a way that every element important to the development of each individual was present within the community, such as a school, a hospital, a village hall, and so on. Bois-du-Luc is a perfect example of this, with its orthogonal organisation and spatial layout. This contrast between the centralities of the old villages, which we recognise by their features such as the church and its juxtaposed square, and the new ones with the mining corons has led to an increase in the diffuse town, i.e. horizontal urban expansion. In our case, although the



Fig. 30 - The mining village of Bois-du-Luc, 2024

area around the town of La Louvière has always been relatively diffuse, with these villages along the valleys, this has nevertheless accentuated this diffuse effect within the area.

The workers' house, in particular, is a heritage feature in its own right. They are recognisable by their red brickwork and two- or three-bay facades. Today, they have an unconditional value in people's hearts.



Fig. 31 - Village centre of Havré, 2024

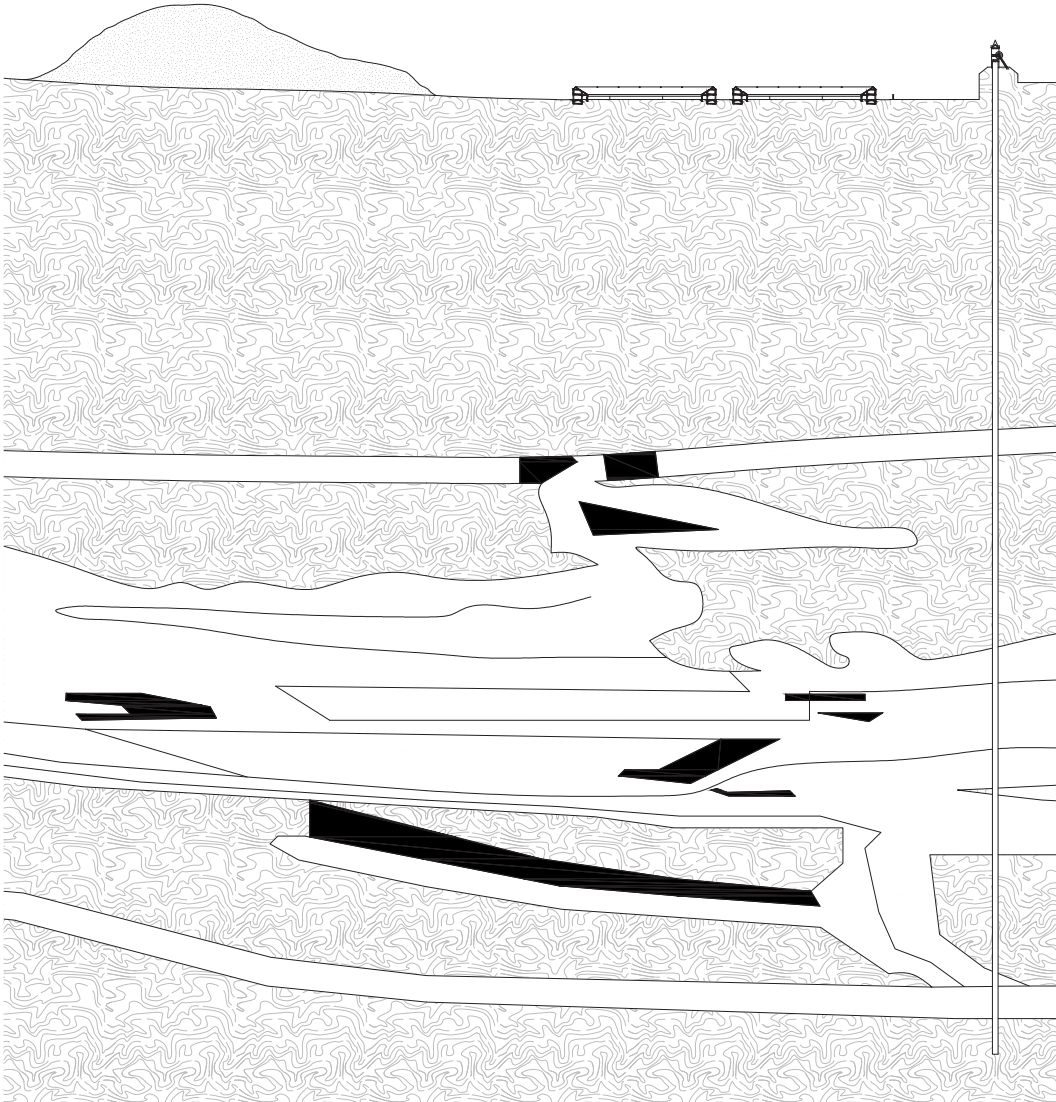


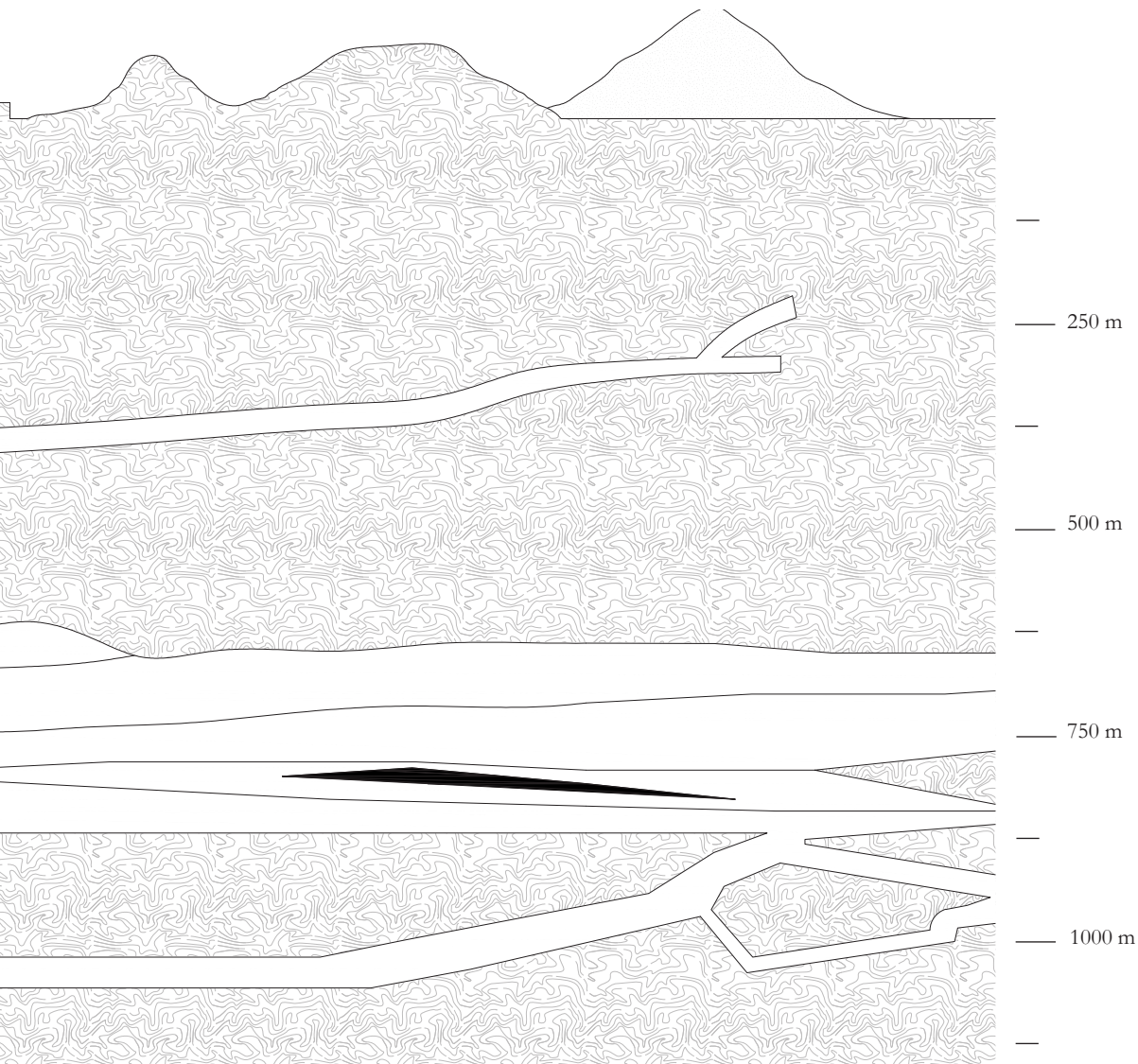
Fig. 32 - The blocked shafts at Le Quesnoy, 2024.

3.7 MINE SHAFTS

Alongside the central areas, the mine shafts are particularly important. These are the shafts through which the miners descended into the underground galleries using lifts. Today, they can only be located by means of a marker indicating various items of information, such as its depth and which colliery it belonged to. Although the galleries are currently flooded, the shafts were blocked up when the various mines were closed. At present, the galleries have flooded naturally for a number of reasons, including collapses due to lack of maintenance and infiltration of the water table (VITO et al., 2020). *Le Centre's* shafts are easily 1,000 metres deep. This depth can be explained by the geology of the coal seam. *Le Centre* region is located in the middle of the coalfield. The coal seams are therefore located deeper than at the extremities, such as the town of Namur (Crul et al., 2012).

The collapse of mines is also an alarming subject. Many landslides have already occurred as a result of underground mines. It is therefore important to maintain them in order to prevent this type of risk.





3.8 SYNTHESIS

The synthesis of the 3 distinct factors of the area, i.e. the economy, the landscape and the people, allows us to highlight all the elements that make up the area as we find it today. With all these elements analysed, indicating the territorial characteristics of the area, certain project levers will enable us to harmonise this area full of opportunities.

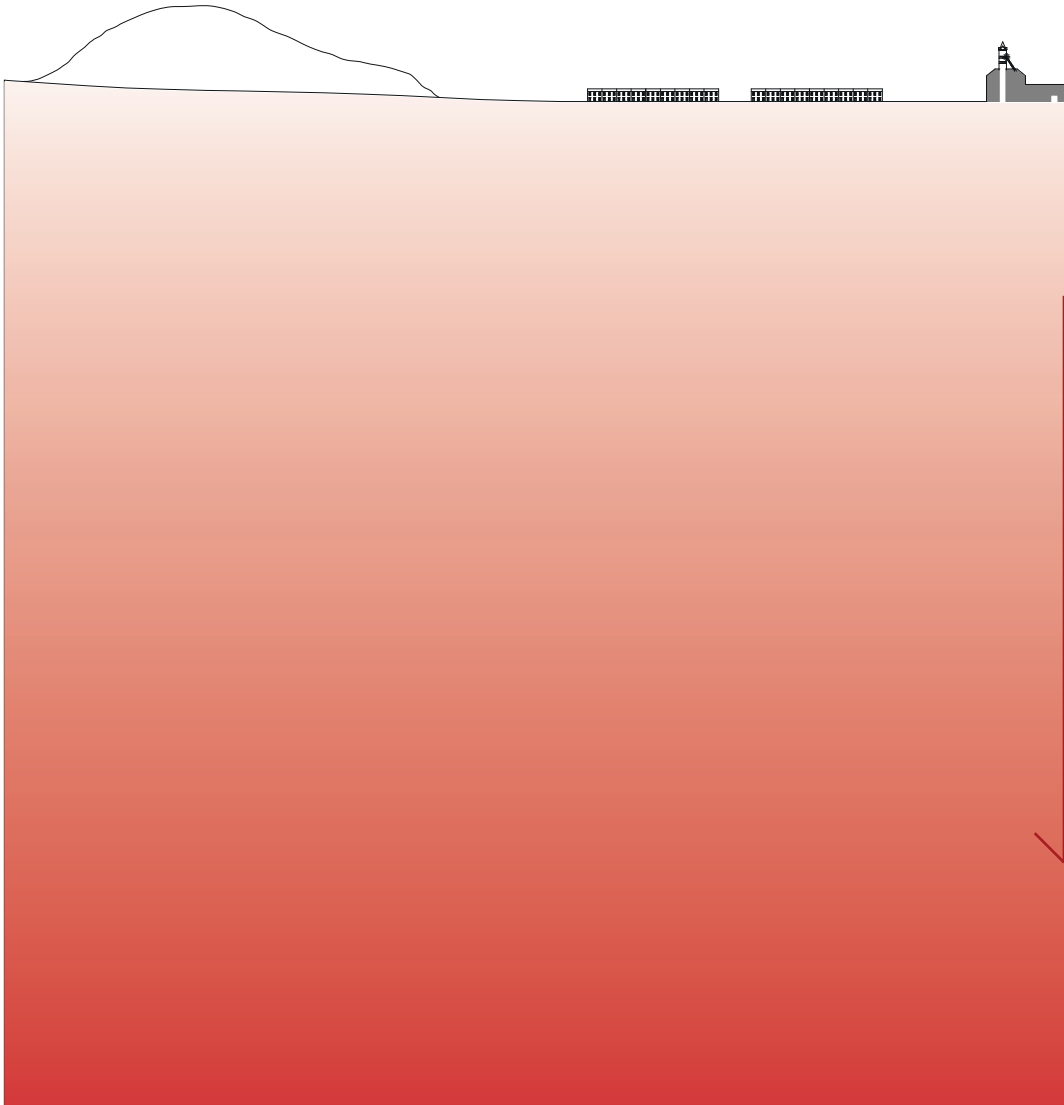
At the end of this thesis, we are going to study the area to the west of La Louvière, centred around the old villages of La Louvière, so that it becomes the focus of a resolute mining past.

The research question will then be based on:

‘How can mining infrastructures once again become an energy hub enabling its territory to be upgraded on the surface?’

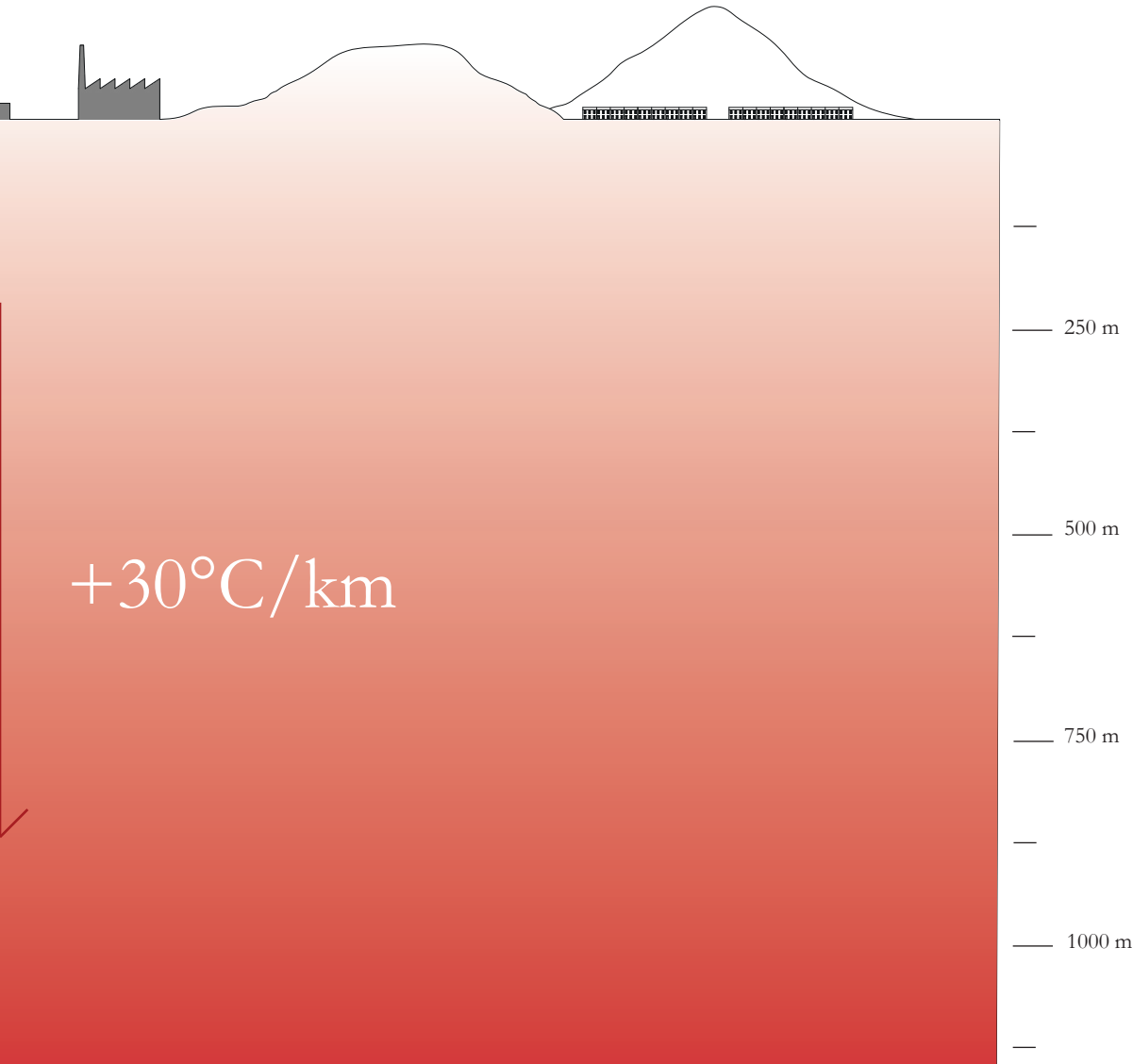
4.1 UNDERGROUND

As explained in the analysis, energy needs and consumption continue to increase year on year. So it's really important to find a sustainable alternative for energy production. That's why we've turned our attention to geothermal energy, using the earth's heat as a source. In fact, given that the mining galleries are hundreds of metres underground and are now flooded, as we have been able to analyse, we wondered whether it might be possible to reuse



this underground water to recover its energy for domestic heating.

Geothermal energy consists of recovering heat from the earth to produce electricity or heat. This heat is produced mainly (80 to 90%) by the radioactive decay of fissile atoms (uranium, potassium, etc.) in underground rocks. As a result, it can reach up to 7,000 degrees at the centre of the Earth. However, this heat can only be recovered when the geological formations below the surface are permeable or porous, and when there are bodies of liquid or vaporous





EARTH CRUST

The Earth's crust is the layer where the tectonic plates are located. It rests on the upper mantle, which heats up to nearly 1,200 degrees Celsius.

water (DGO4 et al., 2011). The Earth's crust becomes a real source of energy, as the temperature rises at greater depths. On average, the Earth's heat is around 10 to 15 degrees between the first 10 and 100 metres of depth, but it then increases by 3 to 4 degrees for every 100 metres of depth, i.e. almost 30 degrees every kilometre.

How it works is simple, and can be summed up in 4 key elements: the extraction shaft, the geothermal power station, the heating network and the injection shaft.

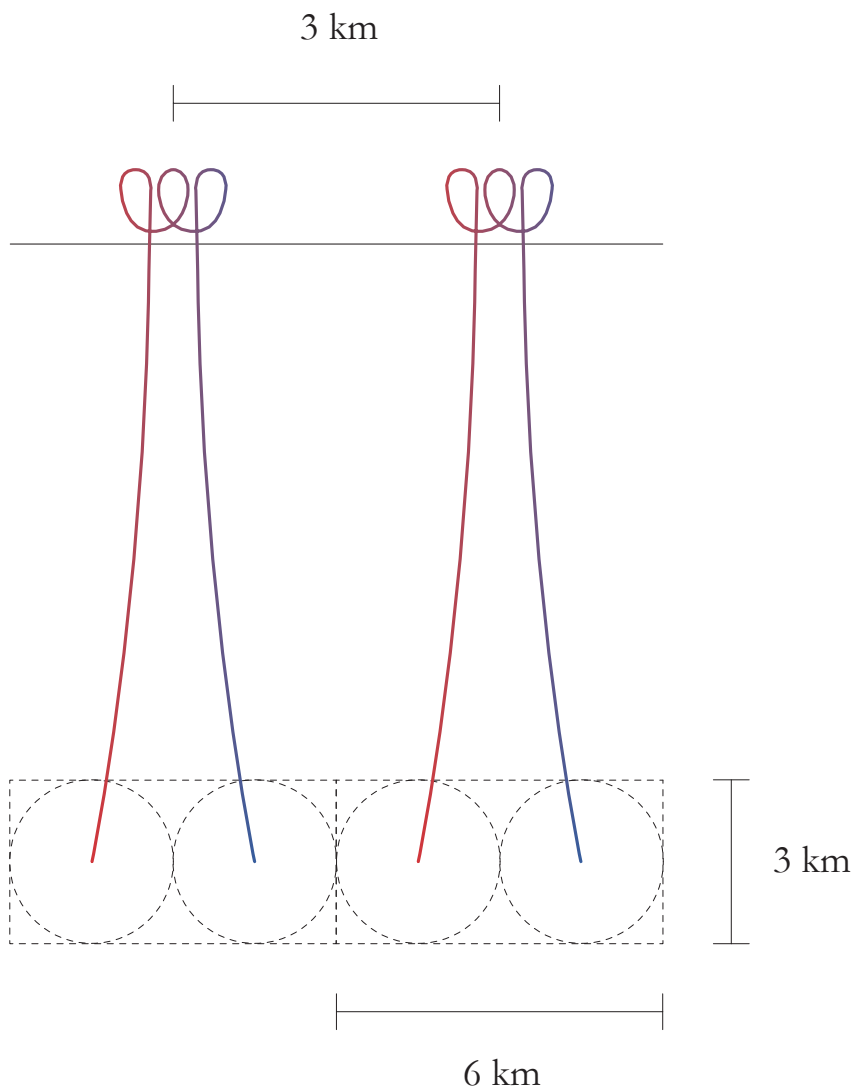
The extraction shaft consists of an initial borehole to reach the geothermal reservoir, i.e. an underground formation containing significant quantities of water or steam. This shaft will allow the groundwater to reach the earth's surface.

The geothermal power plant can have different configurations. This depends on whether it is going to produce heat, electricity or both. When producing heat, the plant will be equipped with heat exchangers to redistribute it to a secondary network, while when producing electricity, it will be accompanied by steam turbines to convert the steam into electricity. The plant will have little impact on the surrounding area, with a footprint of around 50 m². It can therefore be easily integrated into the urban fabric. What's more, as the shafts are underground, they are not visible from the surrounding area.

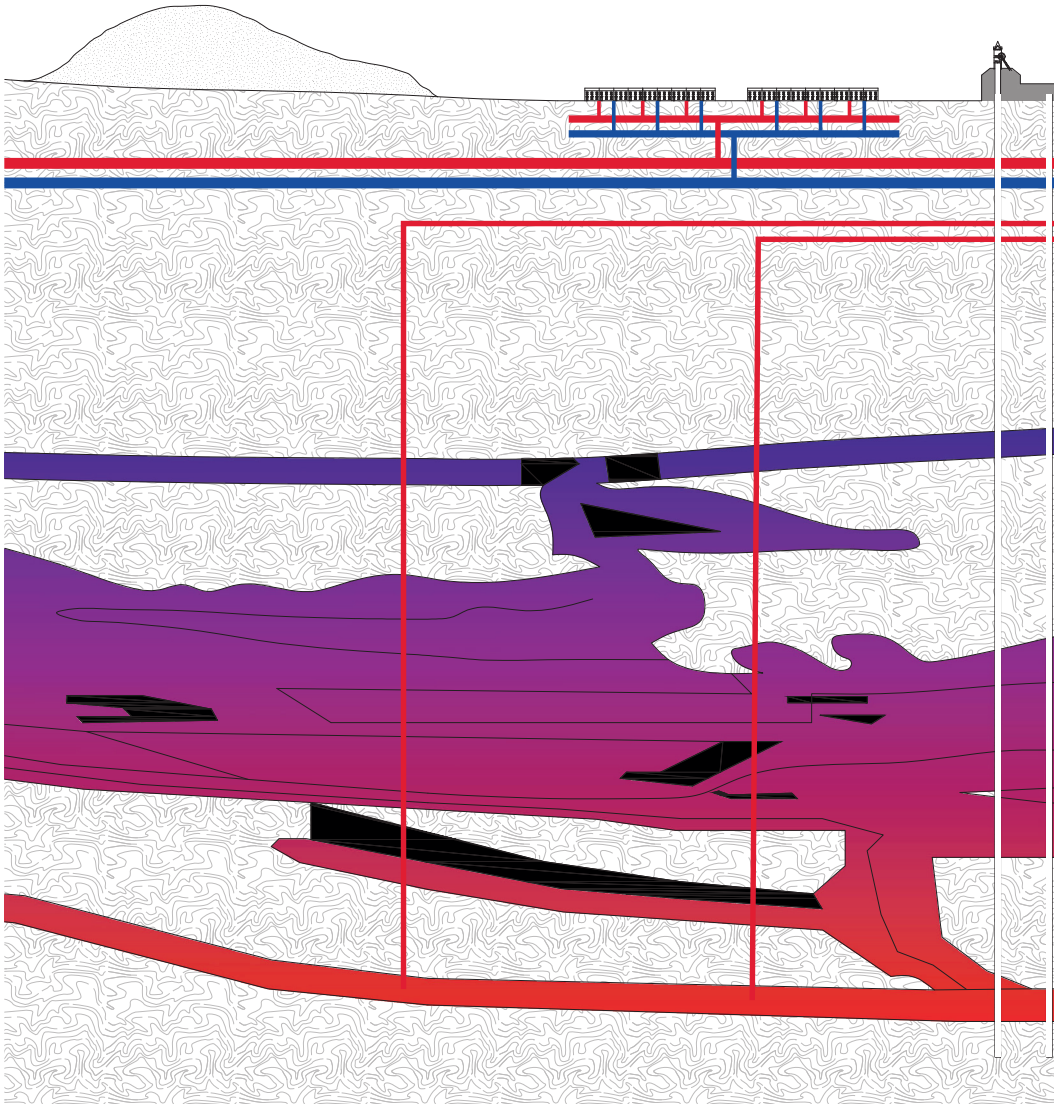
The heating network is very important. It enables heat to be transported. Serious work is involved in this process. However, it allows the area to be spatially redeveloped, in particular through new forms of mobility and new sustainable lifestyles.

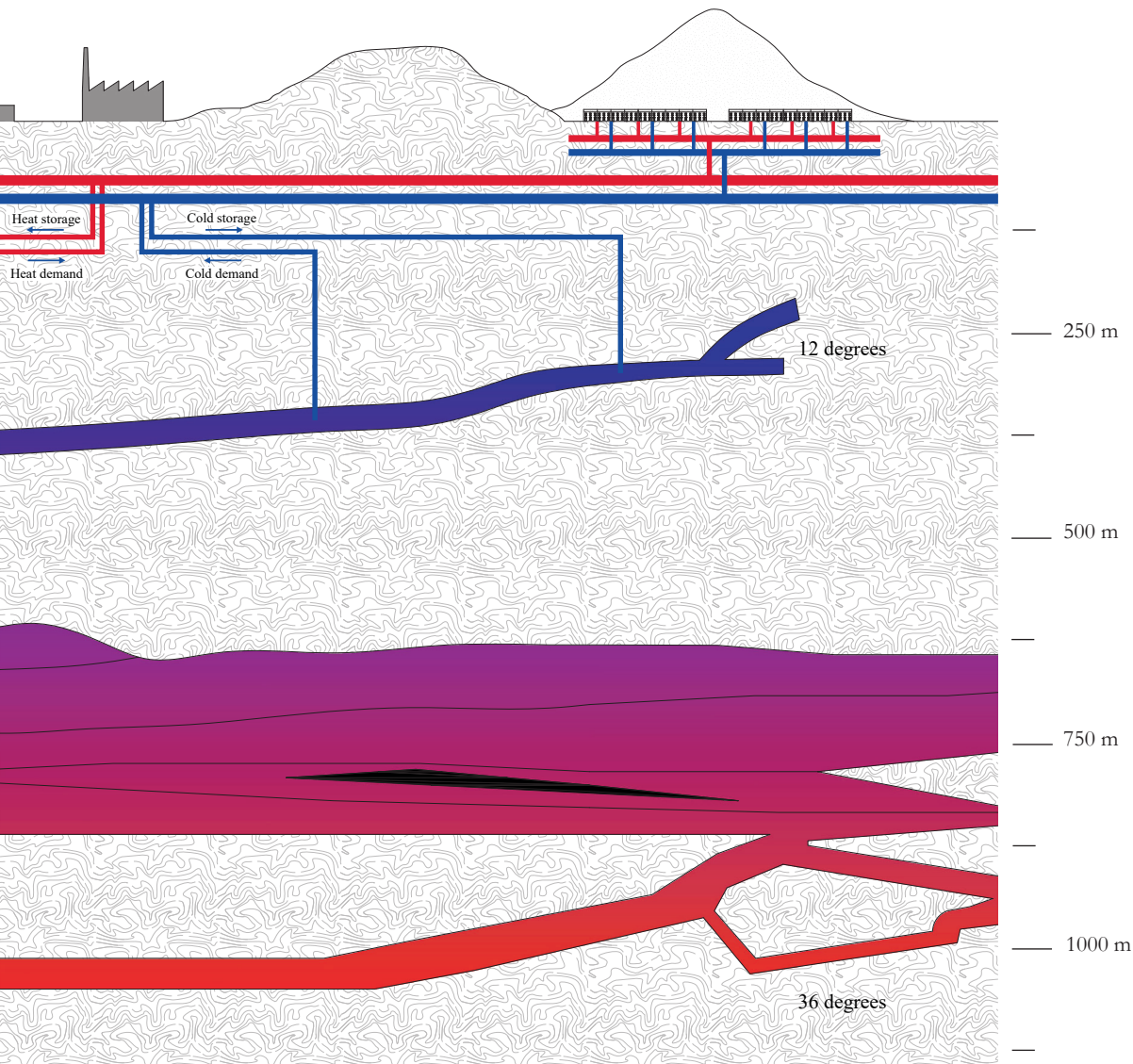
The reinjection shaft, as its name suggests, allows water to be reinjected after it has been used at the surface. This means of returning water to the subsoil ensures that the reservoir is not depleted (LABO RUIIMTE, 2015).

In addition to these four elements, there are a number of other rules that are important to know in order to use geothermal energy. For example, to guarantee the efficiency of geothermal energy, it is best to operate it from several power stations. This means that expansion is likely, enabling more buildings to be supplied. These power stations must be at least 3 kilometres apart to prevent disruption to the flow of water in the geothermal reservoirs. This could cause the reservoir to cool down. At the same time, each geothermal power station can supply heat to a radius of activity of



up to 8 kilometres. However, the demand for heat must be sufficient for such an investment. LABO RUIMTE recommends a minimum population density of 35 to 45 dwellings per hectare (LABO RUIMTE, 2015). The heating network must be as compact as possible to prevent heat loss during transport. On average, we can observe a loss of up to 0.5 degrees per kilometre travelled. Once the heat has been transported, it is used to supply homes via a heat exchanger.

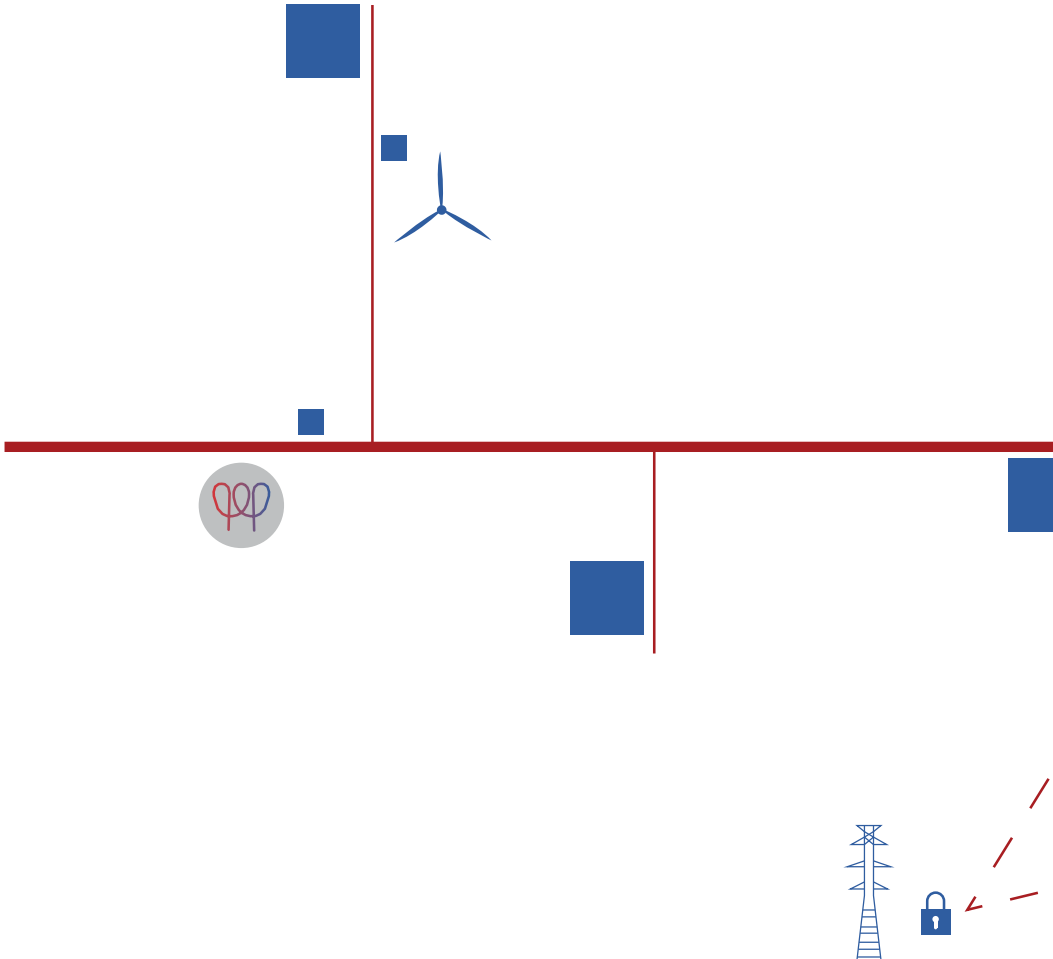




The use of geothermal energy depends on the heat extracted from the water. There are 4 types in all: very low-enthalpy geothermal energy, which is synonymous with temperature, low-enthalpy geothermal energy, medium-enthalpy geothermal energy and high-enthalpy geothermal energy.

Very low enthalpy geothermal energy consists of recovering water at a temperature of between 10 and 30 degrees, which means at a depth of between 100 and 1,000 metres. This technique can be used for individual heating in passive houses, for example.

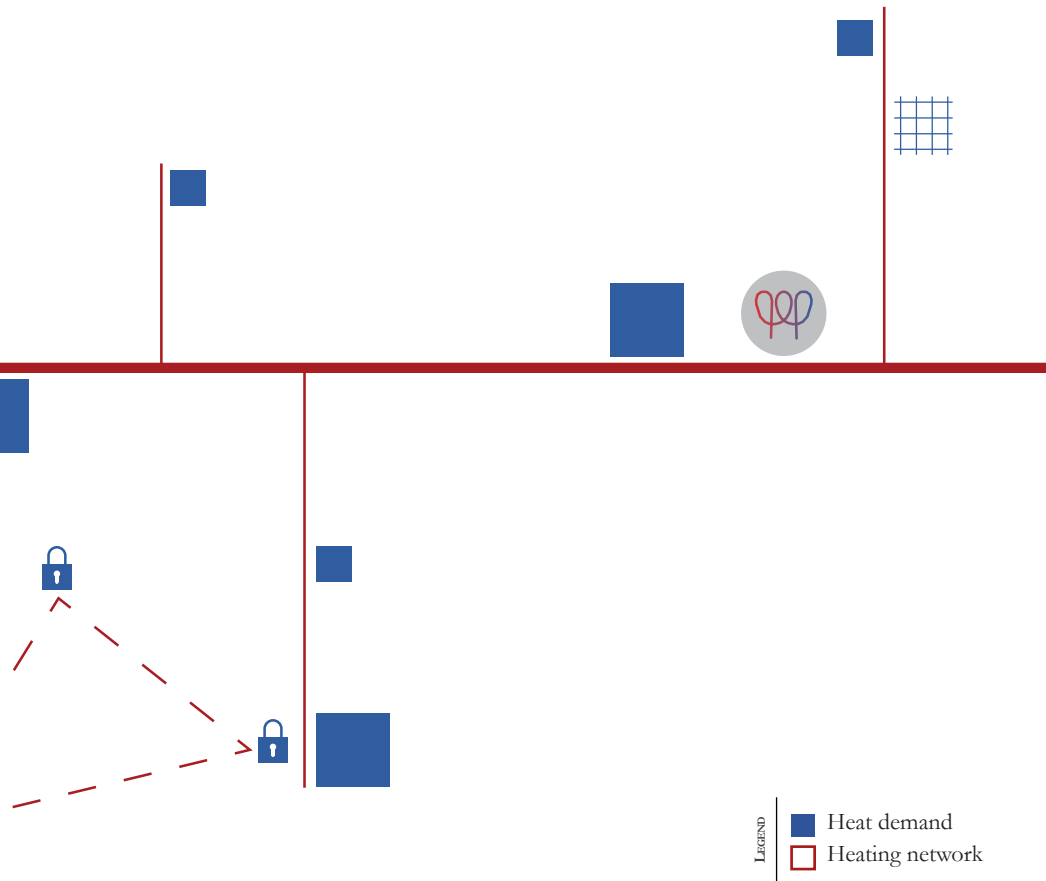
Low-enthalpy geothermal energy uses water heated to between 30 and 90 degrees. In other words, at a depth of between 1,000 and 3,000 metres. This technique can

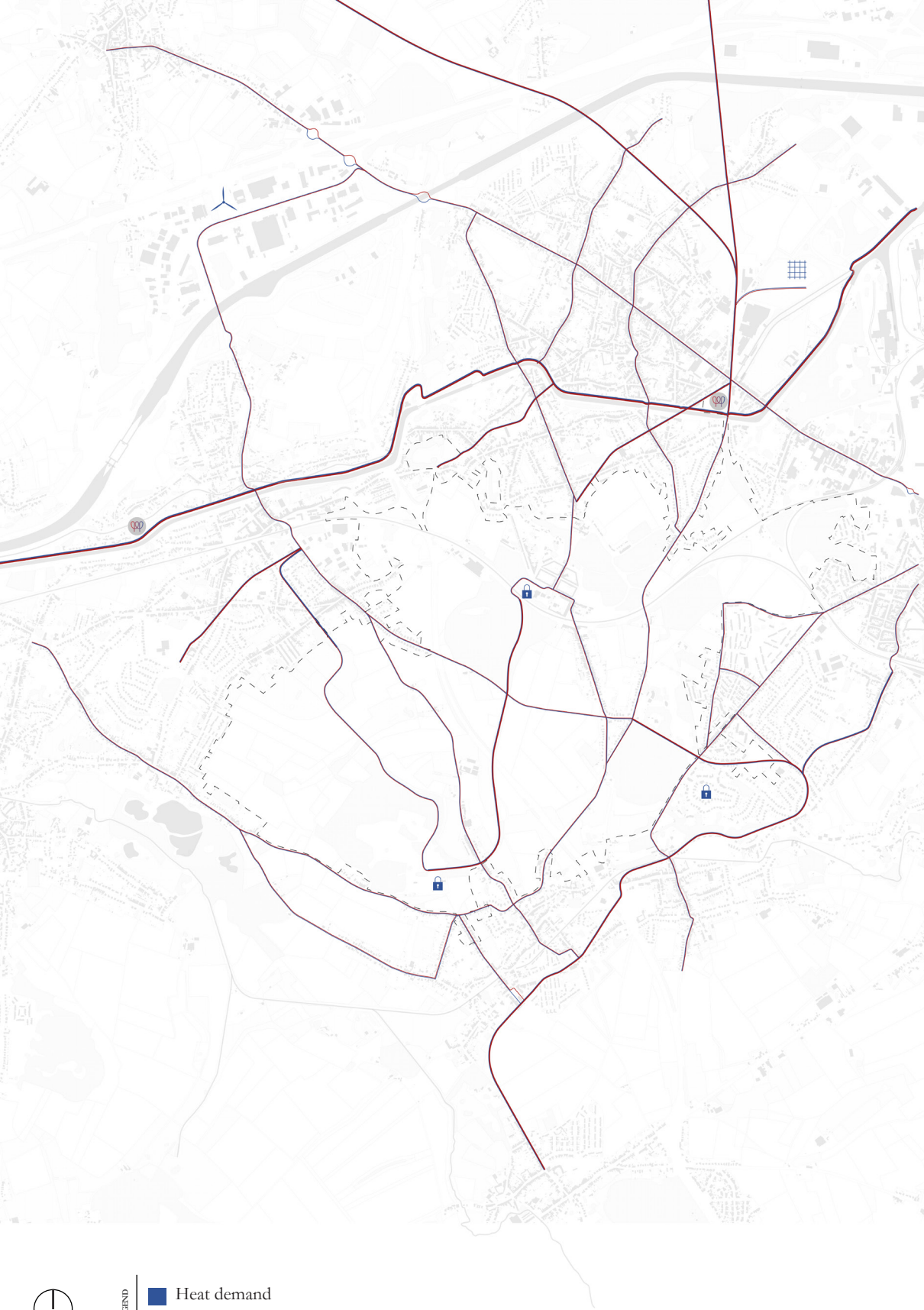


be used to supply heat for greenhouses, swimming pool heating, etc. The Mons basin in particular has already used this technique for its economic park (IDEA, 2014). However, this process can only be used in close proximity, as the heat yield is too high to transport it several kilometres.

Medium-enthalpy geothermal energy exploits the recovery of water between 90 and 150 degrees. Using water at this temperature can meet the energy demands of the textile and chemical industries, for example.

High-enthalpy geothermal energy uses temperatures in excess of 150 degrees. It is exploited at depths of over 5,000 metres. At this temperature, geothermal energy can be used to produce electricity using an exchanger that converts groundwater into steam.





Legend

- Heat demand
- Heating network

1 km In this thesis, we will be focusing on medium-enthalpy geothermal energy. To find out about the site's geothermal potential, we need to focus on the geothermal potential that the area has to offer. A study drawn up by the DGO4 and the Department of Energy in 2011 explains that three areas are suitable for geothermal energy in Belgium, namely the northern Kempen and the Antwerp region in Flanders, the north-eastern corridor of Liège and the Hainaut region. In addition to this, another study carried out by VITO and SPW Energie in 2020 on the geothermal potential of old disused mines in Wallonia proves to us that *Le Centre* region is favourable to geothermal energy from water trapped in underground galleries; we will discuss the mining possibilities below. In our case, we are going to place the primary network, i.e. the network linking the geothermal power stations together, along the old Canal du Centre. As a result, we will be able to install this network under the towpaths. La Haine valley provides evidence of the presence of aquifers beneath the surface. In addition, 3 km the proximity of the canal water and the depth of the new wells will make it possible to convert some of the water extracted into steam using turbines to create electricity. 4 km

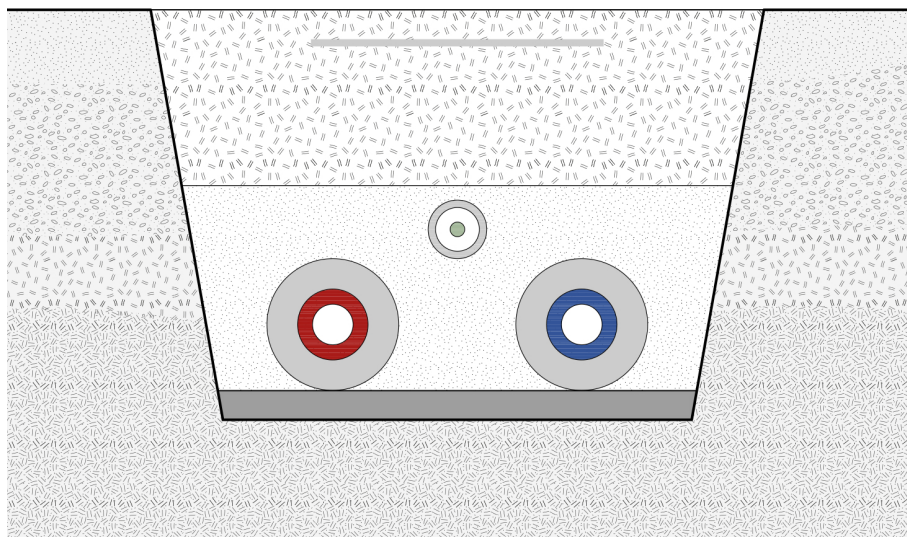
A number of studies have investigated the potential for reusing water that has flooded coal mines, notably by the VITO group, which has set up a convincing pilot project in the Netherlands. The MineWater project at Heerlen in Dutch Limburg was a unique and decisive project for the reuse of mine groundwater as a heat resource. It demonstrated the value of reusing old galleries as energy storage. In fact, the authors of the project carried out an initial project using groundwater heated naturally by the Earth to produce heat. However, the project was severely limited because demand from the town of Heerlen far exceeded the supply capacity that a single mine could produce. This process would not work in the long term because of the potential depletion of reserves it could cause. So they opted instead for a system of storing heat in old abandoned mines. This prevents the overproduction of heat and allows it to be stored when needed in a variety of situations. For example, thanks to this system, if there is a demand for heat in winter, or conversely a demand for coolness in summer, we can draw this demand from the storage in the mines. In fact, the heat from underground 5 km 6 km 7 km

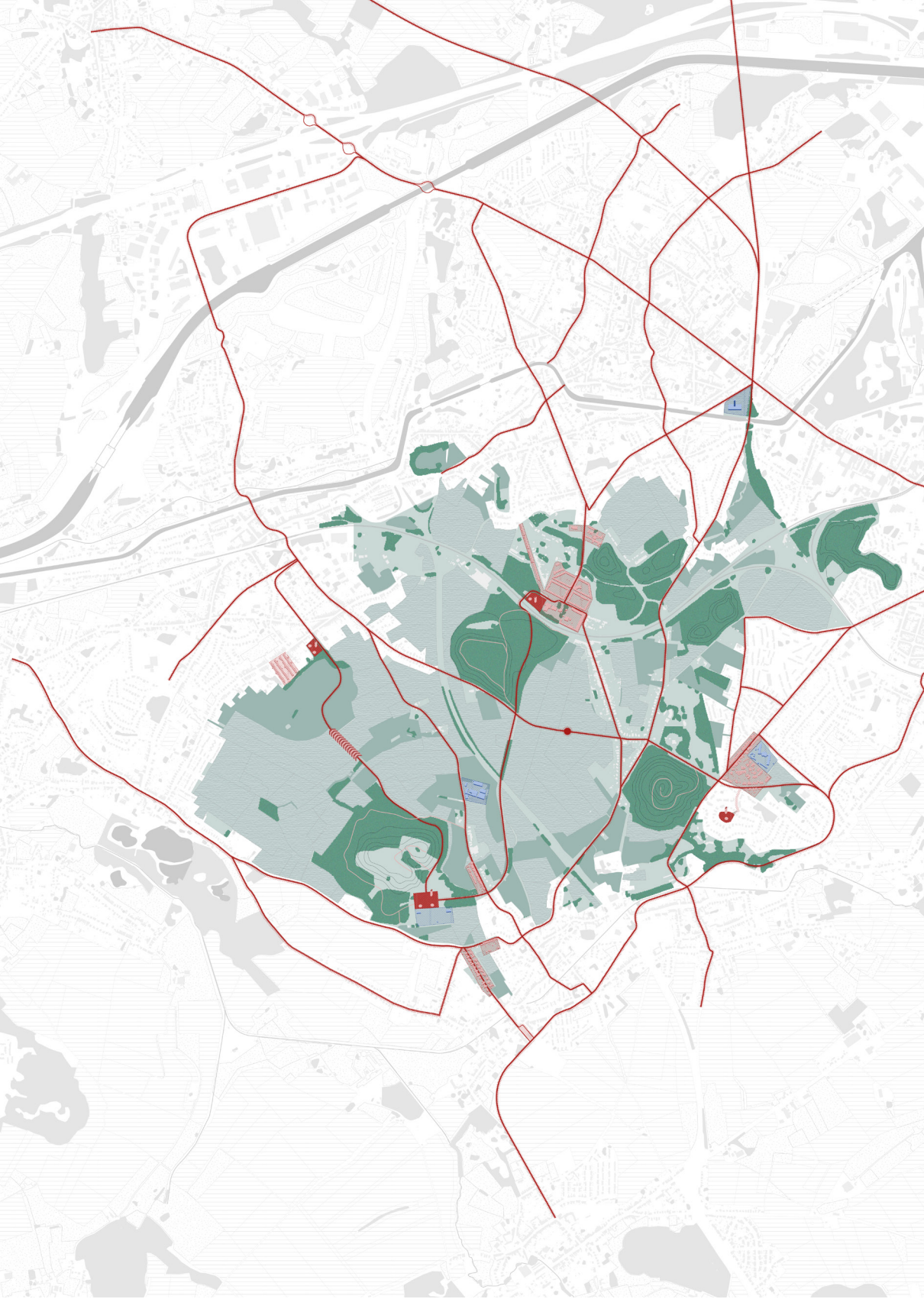
water, thanks to the principle of geothermal energy, can be used to meet this kind of demand. They then decided to combine this principle with a 5GDHC (5th generation district heating and cooling) system to improve the efficiency of the project (European Union, 2023).

We are going to use the same principle in our case study. Our project site has several shafts that are interesting from a geothermal point of view. These are the Bois-du-Luc shaft in Houdeng-Aimeries, the Quesnoy shaft in Trivières and the Albert 1er shaft in Saint-Vaast. These shafts are 1,200, 940 and 1,080 metres deep respectively. These three shafts will give us plenty of storage space in our heating network. On top of that, we're going to combine the different energy sources available on site, namely the solar farm to the north-east and wind power to the north. As a result, the network will have everything it needs to operate smoothly and profitably. Our heating network, for its part, will be based on the heritage remains offered by the area, namely the cavaliers, which we will discuss in the next few pages of this brief. The heat and electricity will be distributed underground. The pipes will be sufficiently insulated to prevent heat loss as far as possible. They will also be plunged to a depth of more than 90 centimetres to avoid freezing (Arcadis et al., n. d.). The heating network is connected to the domestic network by means of heat exchangers.

As mentioned above, it is vital these days to switch to renewable energies in order to meet European targets. In 2018, Wallonia consumed a total of 126 TWh, 69% of which came from fossil fuels. The housing sector alone consumed 39% of final consumption, with 49 TWh (IWEPS et al., 2021). The use of geothermal energy would enable the region to be more self-sufficient and, consequently, reduce energy consumption.

As a result of this new heating network, we are going to take advantage of it to redevelop the area. Indeed, geothermal energy allows us to create and benefit from a series of opportunities such as a productive landscape, sustainable mobility, reinterpretation of old production infrastructures and new communities.





LEGEND

Slag heap

Economic zone

Connectivity

Agriculture

Hub

Heritage interest

Meadow

4.2 SURFACE

Now that we have identified a series of problems and opportunities, we are in a position to understand how we can revitalise the Centre area. In fact, thanks to the elements that we can find on site, we're going to try to rehabilitate what already exists using geothermal energy to respond to the series of obstacles that this precarious region may encounter.

As mentioned earlier, we have identified the green, undeveloped area characterised by three slag heaps to the west of the town of La Louvière, between the villages of La Louvière. Given the precariousness of the Centre region, it is important to implement measures that allow light investment. So, for example, we're going to re-use the RAVeLs and GRs that have already been mapped out, to save as much as possible on expenditure so as to achieve a project that is genuinely feasible in the long term.

The idea behind the project is to define the park as a unifying element in the region. In this way, we will try to respond to economic, social and ecological concerns. This landscape of infrastructures will enable us to trigger and reuse these infrastructures as the heart of the project. In fact, it is thanks to them that this region has been able to develop to such an extent. As a result, this park will set its objectives on the development of new connectivity between and outside the villages, the creation of new hubs, and a recreational walk based on the mining past of the worked area. These objectives will considerably alter the living conditions of local residents, the economy and tourism. In developing the project, we will be working on the assumption that the area now has a geothermal heating network. The park borders the old villages of La Louvière, more specifically those of Strépy-Bracquegnies, Houdeng-Aimeries, Trivières and Saint-Vaast, as well as the western part of the town of La Louvière. In total, this park covers an area of around 600 hectares. Looking at the sector plan, this available space is an area mainly used for agricultural production. Only certain features such as slag heaps and green spaces are also found in this zone. We are going to focus on these two elements in the development of the park.



SECTOR PLAN

The sector plan characterises the areas intended for urban development or not. This plan is managed by the Direction de l'Aménagement Territorial (DAR) and is enshrined in the CoDT (Code du Développement Territorial).

1 km —

2 km —

3 km —

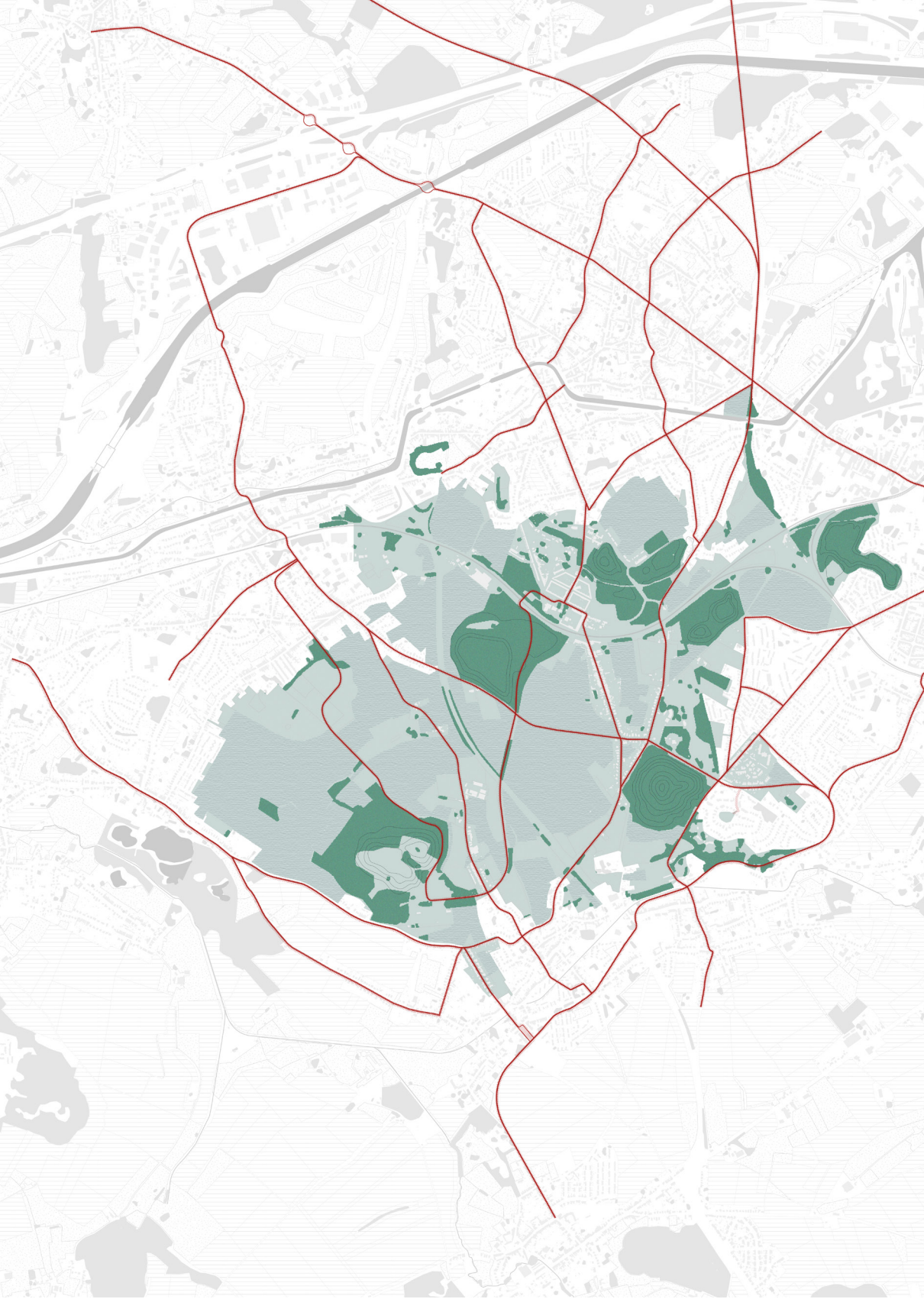
4 km —

5 km —

6 km —

7 km —

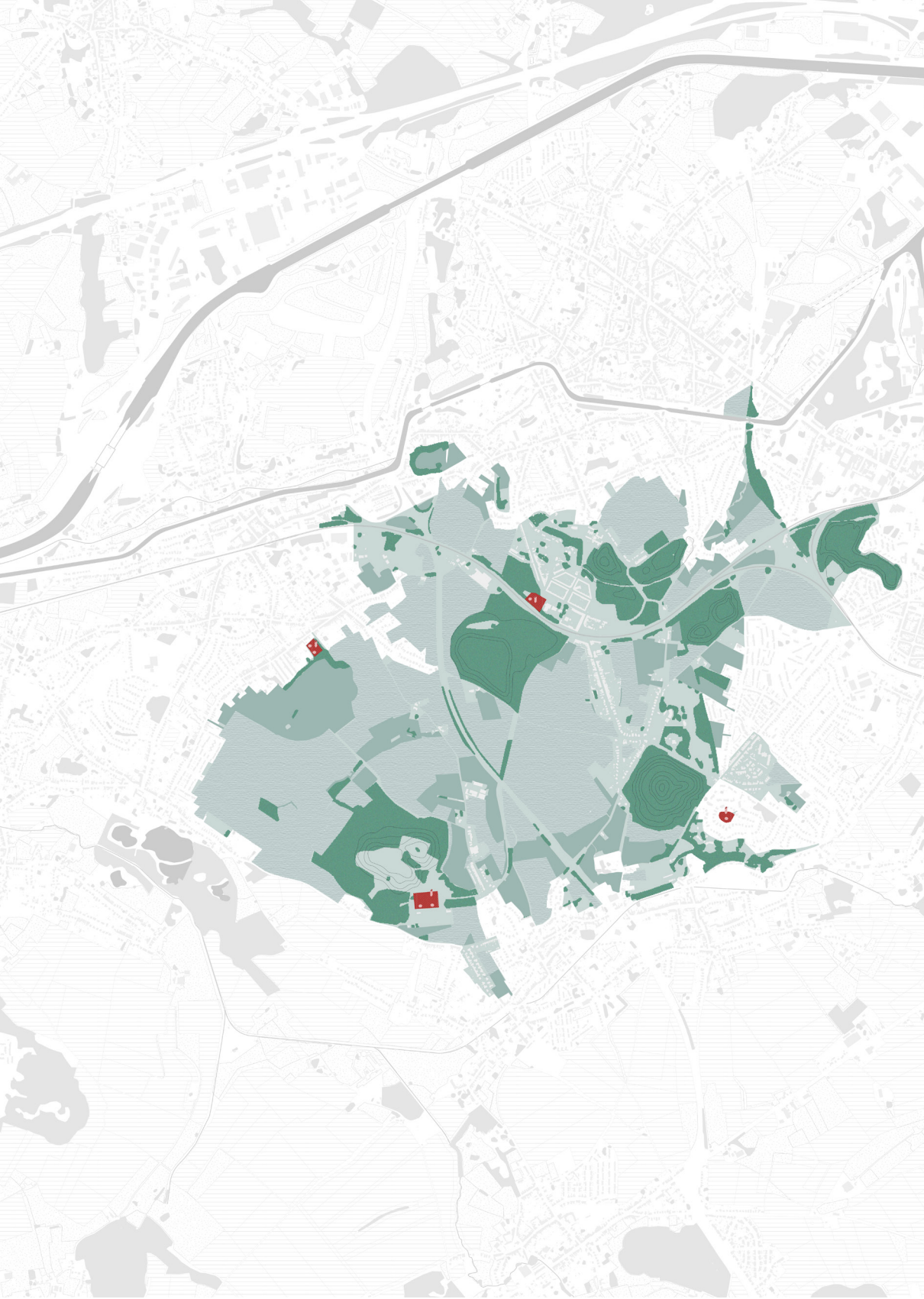
The first priority for the park is the community and the creation of new connections through sustainable mobility. This part is the logical continuation of the creation of the heating network. As a reminder, in the case of the Centre, geothermal energy will enable it to move towards energy self-sufficiency. Now that we know the strategic locations where this network needs to be installed, we need to rethink what happens on the surface. The aim is to completely rethink mobility in the park in order to ensure these new connections. The main aim is to make it easier for people living around the park to get around, thereby reducing commuting times and the carbon emissions produced by motorised vehicles. This new mobility network promises to promote soft mobility by creating new paths and introducing cycle lanes within the park. We'll come back to this point later in the brief. This network will also make it possible to set up production zones thanks to heat loss. The aim is to have as little heat loss as possible. As a result, we're going to try to reuse this heat by building productive greenhouses, which will make the most of grey energy.



LEGEND

Slag heap
Meadow
Connectivity

Agriculture



LEGEND

Slag heap
Hub
Meadow

Agriculture

— 1 km

— 2 km

— 3 km

— 4 km

— 5 km

— 6 km

— 7 km

The second priority is to create new meeting points to boost the economy, the community and tourism. These focal points are the characteristic elements of heat production, namely the geothermal power station, as well as the various mining shafts, which are currently blocked, but which provide a large amount of heat storage. Thanks to these central elements, users will have landmark locations throughout the mine. At these points, a number of information panels will be set up near the shafts to boost tourism and enhance the presence of the mining infrastructure. In addition, an observation tower will allow visitors to admire the hilly park from an elevated vantage point, as well as serving as a landmark in the area.

1 km

2 km

3 km

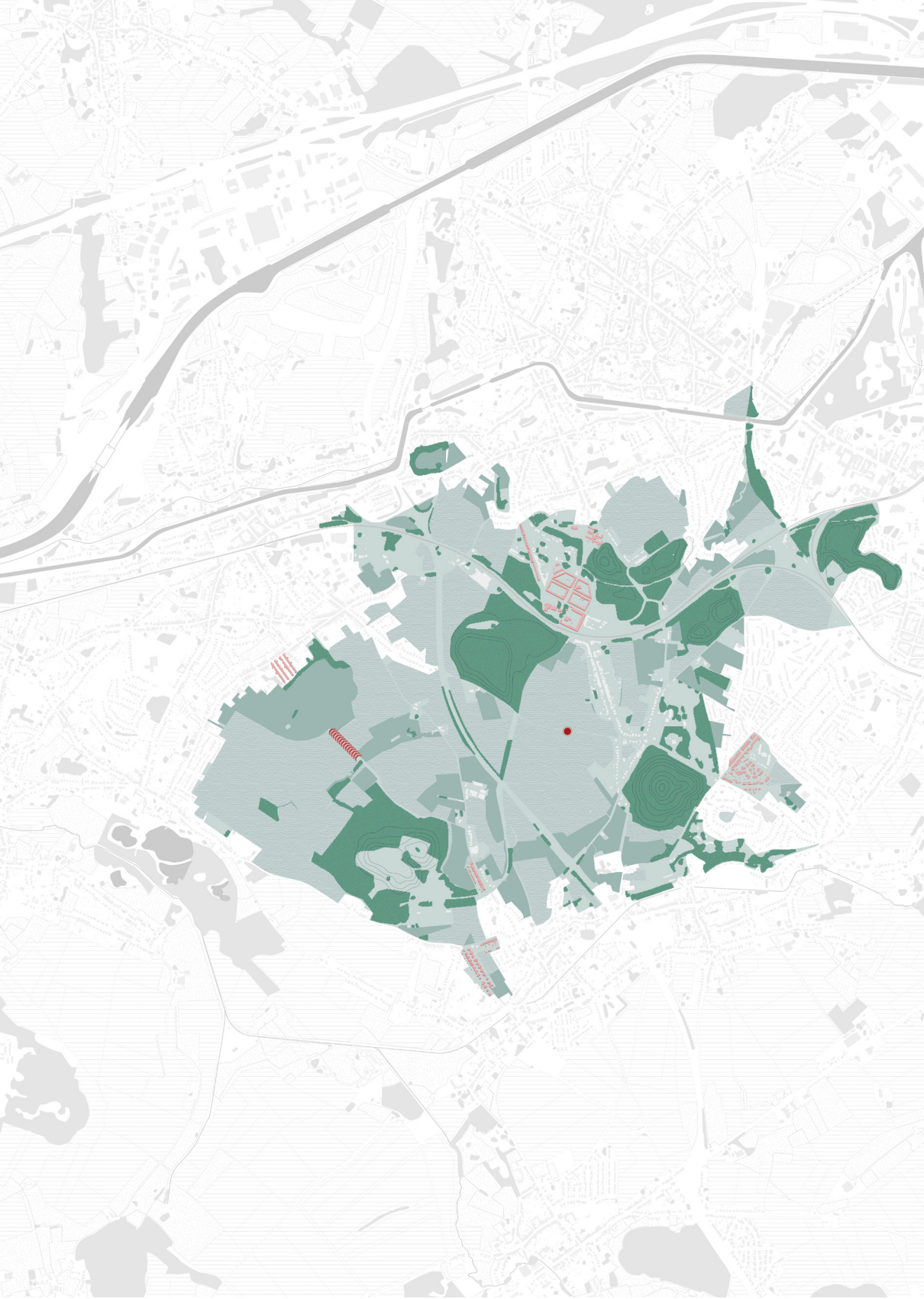
The third priority is to recognise the heritage and landscape of mining. Since the site is rich in heritage, the aim is to share it with local residents and users. A remembrance trail is the perfect way for outsiders to immerse themselves in the landscape shaped by the mining industry. The idea behind the trail is to show how the industry has left its mark on the area we know today. Thanks to this walk, users will be able to understand the consequences for the area, as well as the risks associated with mining in particular. In addition to this exercise in memory, users will be able to understand the energy issues and how the project is taking action to offset this over-consumption of energy. They will also be able to follow the path of heat thanks to this interactive walk.

4 km

5 km

6 km

7 km



LEGEND

Slag heap

Meadow

Heritage interest

Agriculture



Fig. 33 - Entrance to the Quesnoy mine on the outskirts of the park, 2024

These three issues can already be seen in the project's three main territorial features: the facades, the entrances and the interior of the park. Although the park is delimited, it is important to rethink all the elements relating to the project.

The park's façades raise questions about how the park is linked to its surroundings. The aim of the park's boundaries is not to fragment the landscape any further than it is at present. On the contrary, its aim is to provide the best possible link between this resource area and its surrounding context. What's more, there is a real concern about accessibility on the site at the moment, due to the partitioning of the villages over the course of history. Indeed, after the deindustrialisation of the site and the abandonment of the mining sites, all external connections were cut off.

A number of places of interest outside the site will be connected to enable users and residents to take advantage of the various facilities available in the area. Places such as parks, sports facilities and places of worship will be highlighted and signposted to give park users access to a wider area. As a result, it is no longer just the park that benefits from the site's opportunities, but the whole of the surrounding villages. The village centres will also benefit from easier access, as the project will promote connections between these villages via the park.

In parallel with these connections, the heating network has been installed specifically to bypass the park. As a result, each entrance is connected to the heating network, improving the accessibility that the site previously had with its series of cavaliers.

The entrances play a very important role. They form the transition between the outside and inside of the park. These access points are strategically located at the various mining cones. The mining dwellings are located on the periphery of the park, providing a landmark when we arrive on site.

This access through the housing estates gives users a glimpse of the first elements of the project, namely the conversion of the streets into cycle lanes and the renovation of the workers' houses as a model for energy consumption.

These entrances are like monuments in their own right. In fact, each coron is made up of a number of mining infrastructures such as slag heaps and mine headframes. At the same time, users will be directed directly to the new economic centres, allowing them to enter the project straight away.



Fig. 34 - Vision of a future cycle route, 2024



Fig. 35 - The cavaliers transformed into footpaths, 2024

Inside the park, everything is arranged in a linear way. The main aim is to incorporate geothermal energy to revitalise the surface. This will remind users of the energy production of yesteryear, but this time it will be sustainable.

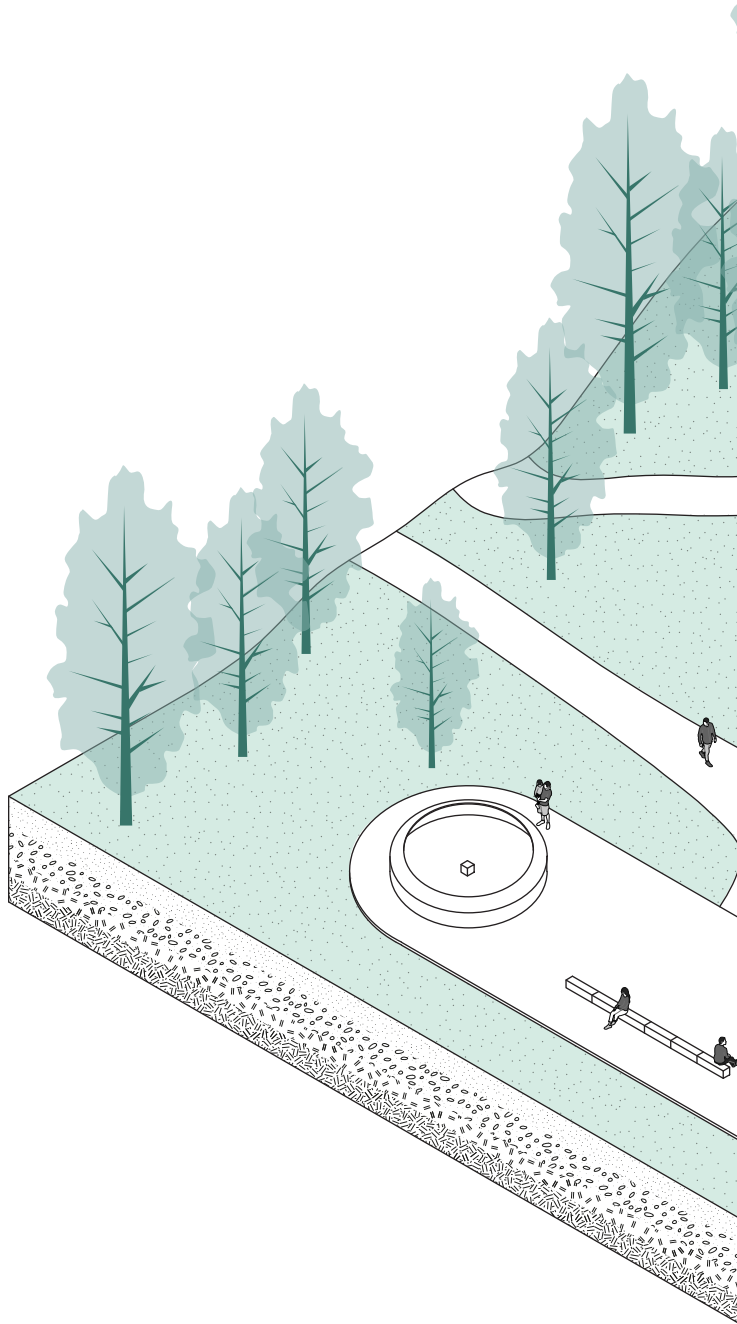
Once inside the park, we'll be taking users on a journey through the mining past, through the rehabilitation of various infrastructures such as the extraction shafts, the workers' houses and the cavaliers, and through an understanding of the territorial issues to which we are all invited to pay attention. The vast expanse of the park means that the site qualifies as a park. It was therefore important to define the boundaries of this park to prevent the loss of the fertile land, which is immeasurably rich. In addition, there will be a certain amount of freedom for nature to keep the park as natural as possible. It will help to bring together people who are currently closed off due to economic decline.

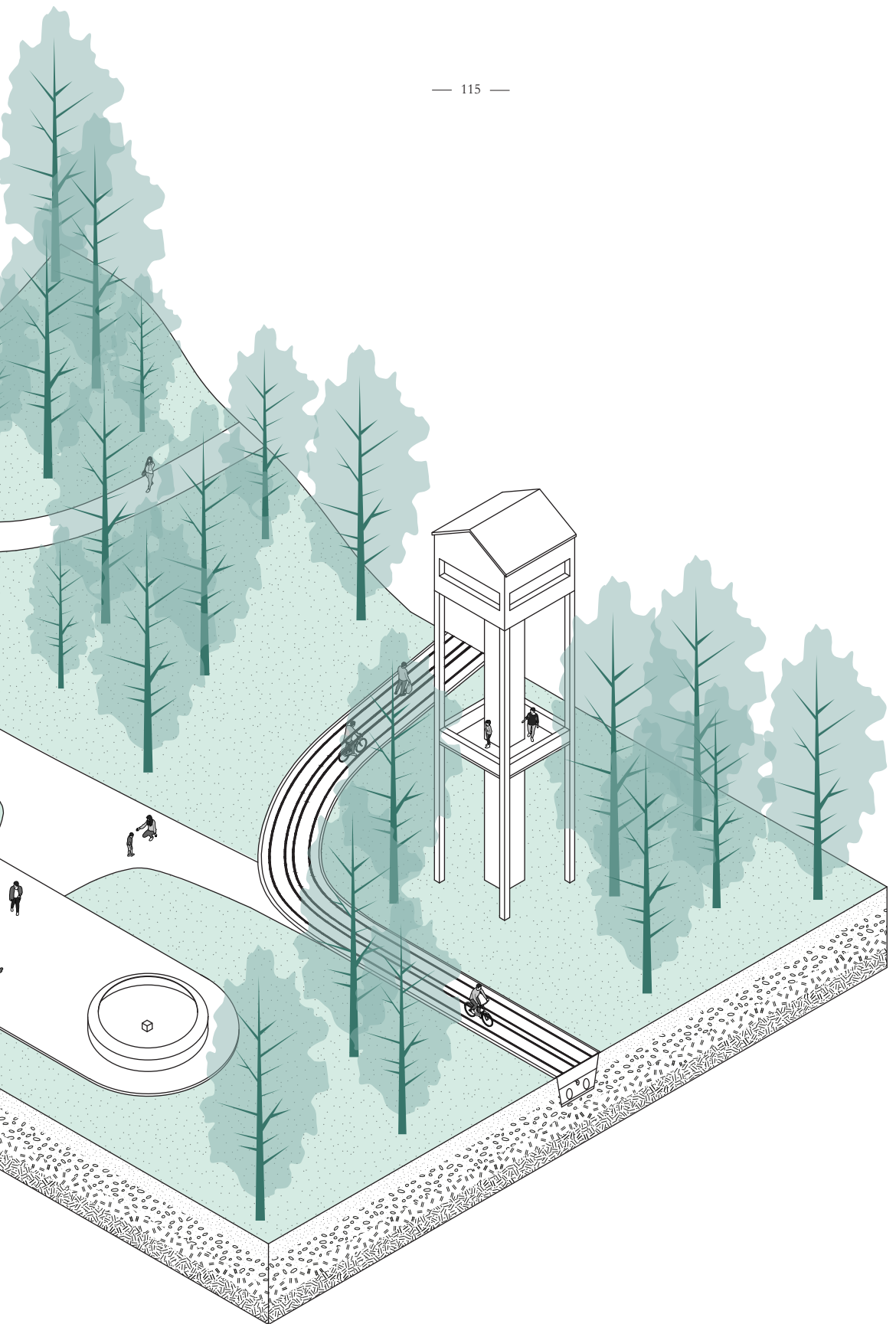
We're convinced that the dual approach of rehabilitating the existing building, in addition to its basic function of producing energy, and allowing nature to play its part will make this park a new focal point for the residents who are particularly attached to the area. This ecological and economic renewal will help to improve current living conditions.

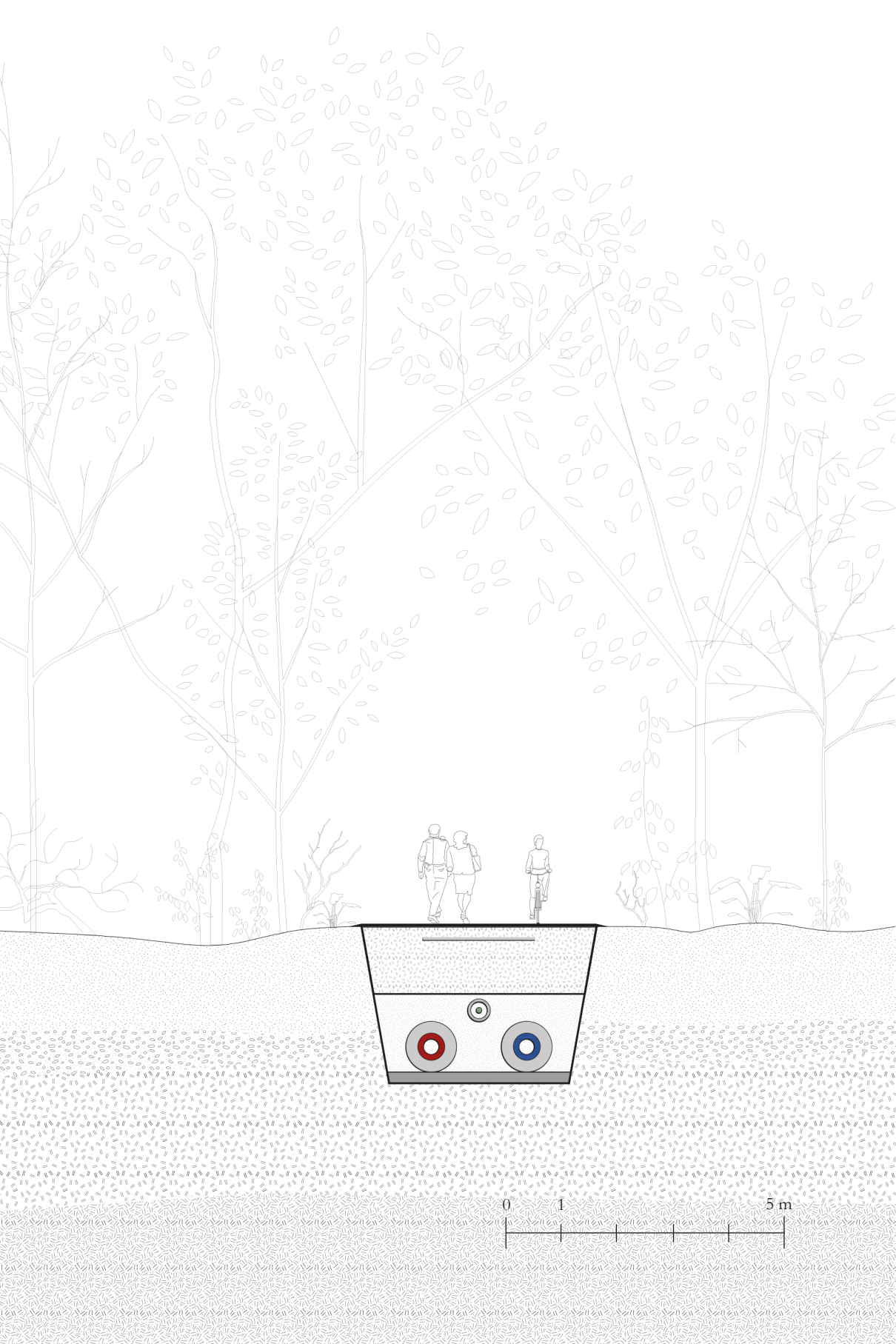
The four new hubs at the old mining shafts are the starting point for the project. This is where the walk begins, as it is the point of interaction between what happens underground and on the surface. We wanted this walk down memory lane to be a total experience for all users. So we set up a circuit enabling users to understand the journey of coal through the different stages, passing through the various mining infrastructures.

Here, a platform encircles the shafts, allowing them to be highlighted. Previously, the shafts were simply marked out with a stone containing information. The project provides a panel explaining the new geothermal project, as well as the various information and historical elements linked to the collieries.

We decided to leave the slag heaps in their natural state. After collecting various testimonies from local residents, we realised that they had already made the site their own. So, with the same idea in mind as the Contrat de Bassin Minier, we classified the different slag heaps according to how they were used by the local people. In other words, the Saint-Emmanuel and







Albert 1er slag heaps will be used for walking, while the Quesnoy slag heap will be used by cyclists for recreational purposes. What's more, as they are veritable monuments to biodiversity, we thought it best to leave them as they are so as not to disturb the flora and fauna.

Over the course of history, another form of slag heap has been created, that of levelled slag heaps. As we saw earlier, some slag heaps are at risk of erosion. As a result, some spoil heaps have been razed to the ground or simply flattened. This is the case for several small slag heaps in the park, but above all for one of the main slag heaps. Basically, four slag heaps overlooked the vast expanses of the park. However, the slag heap belonging to the Saint-Alphonse colliery has been razed, leaving its mark on the landscape. What was once a high heap of waste has become a wide meadow. As a result, we decided to demarcate the surface of the slag heap so that we could continue to read it in the landscape. This demarcation takes the form of barriers.

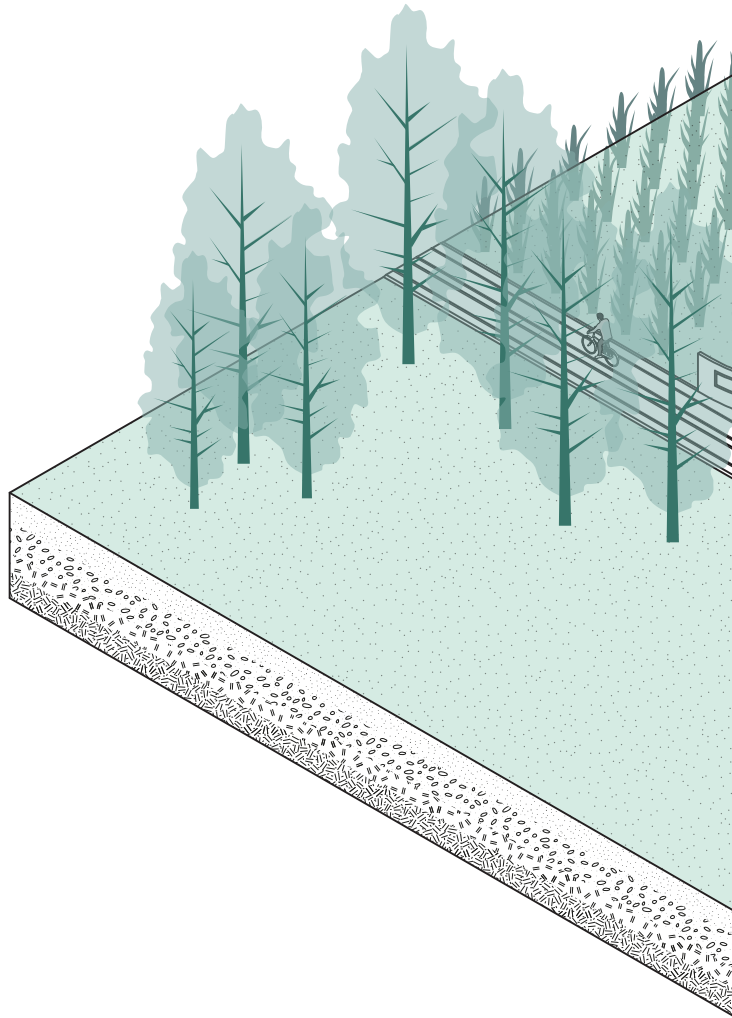
As explained above, the workers' houses will be the first to be renovated using geothermal energy. Their appearance will not change in order to preserve their heritage value. However, they will act as a model for the future of housing.

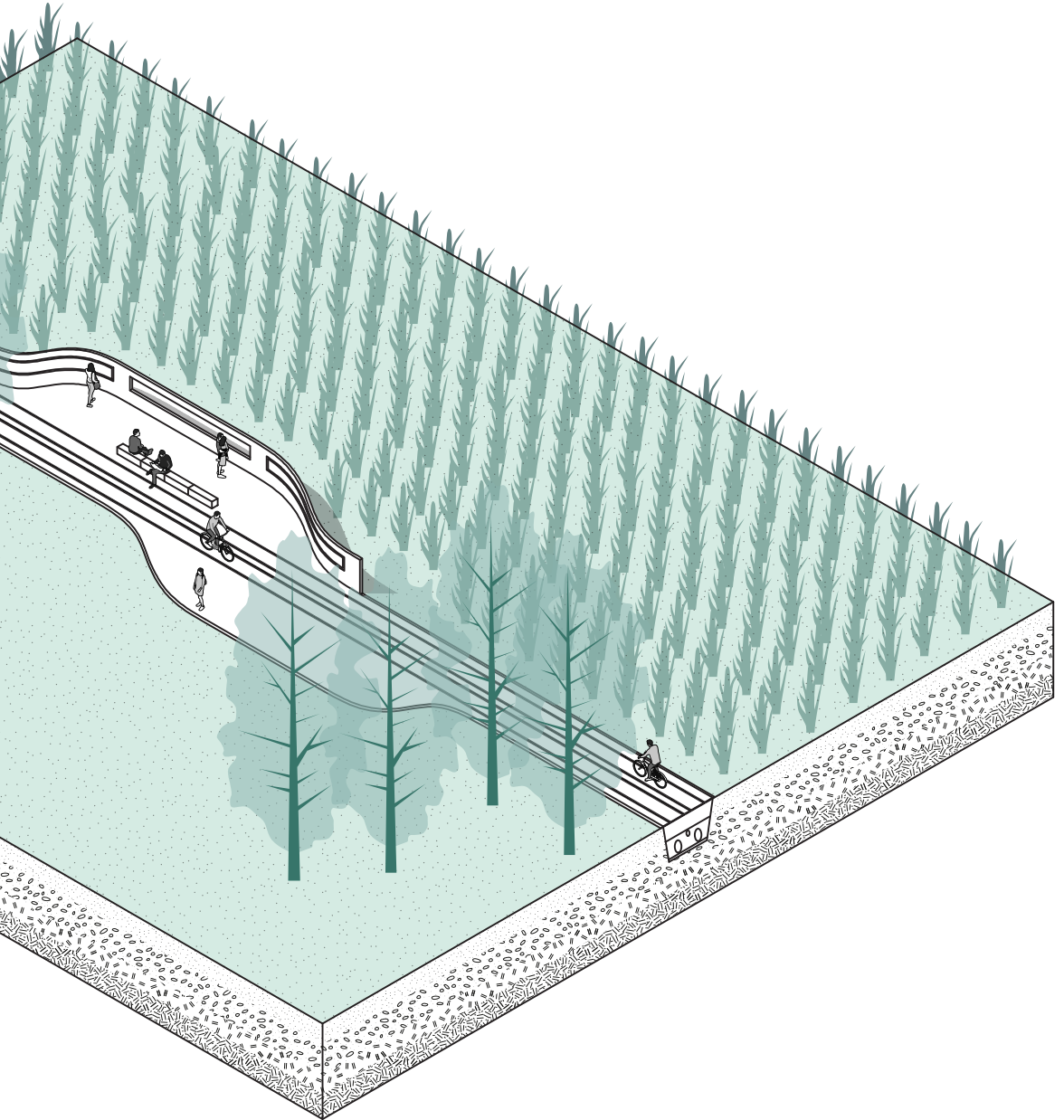
The creation, reuse and renovation of flows remains the most important development of the project on its surface. Indeed, the aim of the new connections is to reuse the old railways as a soft mobility circuit. As a result, we are recreating the cavaliers that used to exist using a path with a smooth surface so that it can be accessed by the widest possible public, including cyclists and PRMs. As a reminder, this pathway will form the heating and electricity network for the homes around the park. The function of the flows therefore has a double meaning, namely the distribution of heat and a new form of sustainable mobility. Some sections will have an interesting added value, such as the installation of a greenhouse or breaks during the walk.

With regard to the greenhouse, as explained above, it makes use of the losses resulting from the transport of heat, which are equivalent to around 0.5 degrees Celsius per kilometre travelled. In this way, we reduce the impact of grey energy by using it. Thanks to these production centres, the landscape becomes more productive. What's

more, it creates significant links between local residents. These greenhouses will be located on new tree-free stretches of land.

The breaks will involve the creation of a wider area in which to take time to observe the landscape. An installation depicting the situation in the Golden Age will be installed so that users can immerse themselves in the history of the site. In this way, walkers and cyclists can choose their own route. These paths will be designed so that people can only pass through the park or enjoy it as a recreational and informative stroll.





As far as the renovation of the roads is concerned, it will be as straightforward as possible. Although we have not discussed the impact of public transport and traffic flows in general at the end of this brief, we are nonetheless opting for a reduction in car use for the road sections located in the park, with the exception of the N55, which divides the park into two distinct parts. In this way, the streets become cycle-friendly and encourage soft mobility.

4.3 CONCLUSION

By studying the case of the Centre, we have understood how an infrastructure such as geothermal energy can considerably change the landscape on the surface. Although the geothermal power station is not visible, it does allow us to take advantage of the work to revitalise and establish new objectives for each area.

Thanks to the various developments, we are reusing and rehabilitating the Centre region's glorious mining past to take advantage of it to improve societal, economic and environmental issues. In the end, it is the decline and its artificiality that have given birth to the project by reusing and reinterpreting all the infrastructure.

The infrastructure landscape as we know it hides incredible opportunities to maximise it. The contribution of renewed energy, mobility and public facilities will enable this area to guarantee its sustainability. Every region hides opportunities that allow it to rise from the ashes.

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