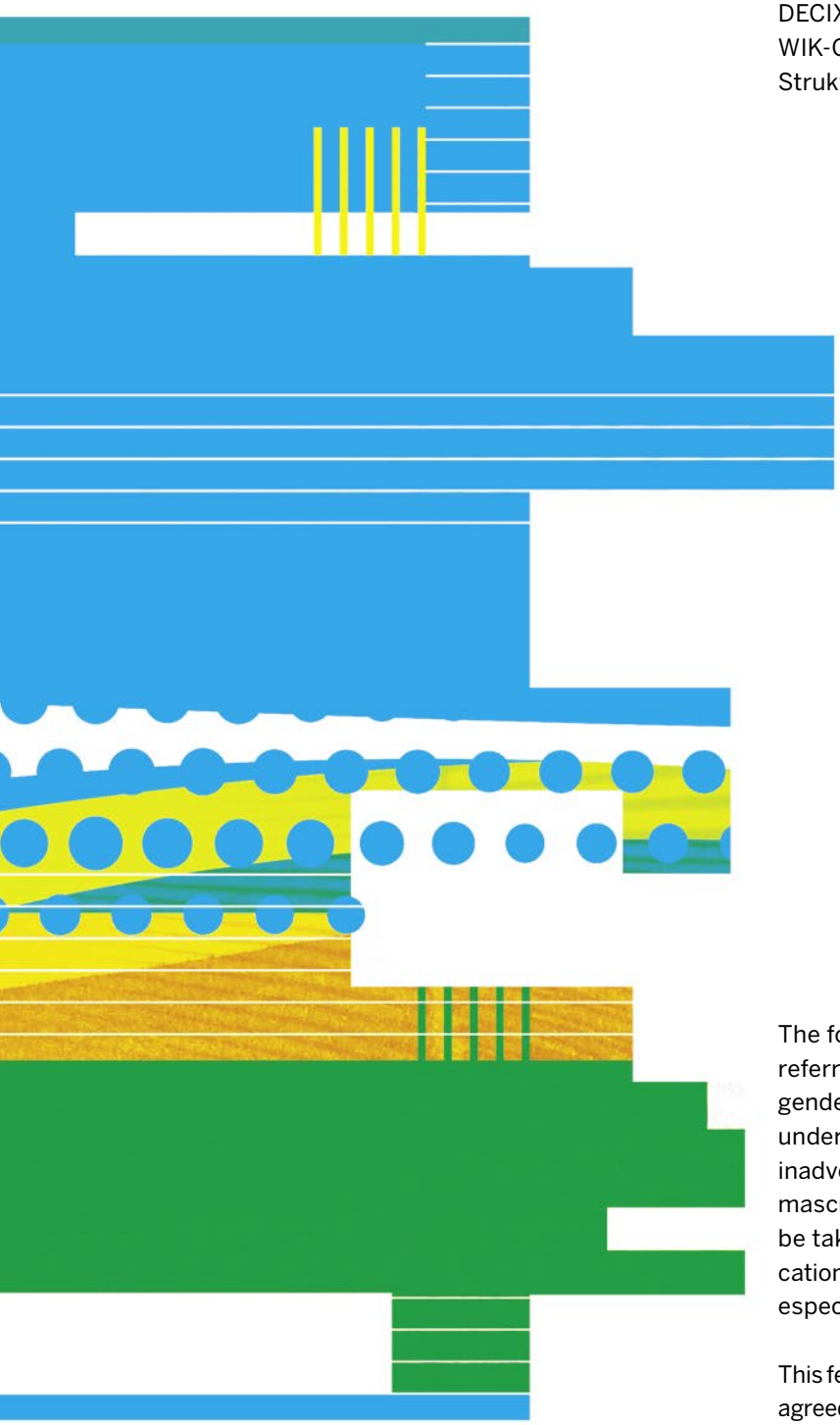
DE-CIX

Ministerium für Wirtschaft, Innovation,
Digitalisierung und Energie
des Landes Nordrhein-Westfalen

Feasibility Study
Data Infrastructures in Rhineland's Former Coal Mining Area

Summary



This study was prepared for the Ministry for Economic Affairs, Innovation, Digitalisation and Energy (MWIDE) of the State of North Rhine-Westphalia by a consortium of contractors under the content and project management of DECIX Management GmbH. The consortium of contractors comprises Deutsche Telekom Business Solutions GmbH, DECIX Management GmbH, Detecon International GmbH, WIK-Consult GmbH and Gesellschaft für Wirtschaftliche Strukturforschung (GWS) mbH.

DE CIX

DETECON CONSULTING

wik CONSULT

GWS SPECIALISTS IN EMPIRICAL ECONOMIC RESEARCH

The following text uses a gender-neutral language. When referring to persons in the abstract and in the singular, the gender-neutral singular 'they' shall be used, which shall be understood to include all gender identifications equally. If, inadvertently or for reasons of improved legibility, only the masculine pronoun or form of a word is used, this should be taken to refer also to persons of other gender identifications. We are committed to gender equality in all matters, especially with regard to equal opportunities.

Preamble

Dear reader

The coal mining areas in the Rhineland are faced with the challenges of the century – which we have preferred to embrace as the opportunity of the century. A region once dominated by brown coal is to be turned into the Rhinelands' 'Innovation Valley', a real-lab experience of modernisation, where future technologies are put to real-world scrutiny. A special role is set aside here for the digital infrastructure, given that any cutting-edge business location needs to rely on a powerful, safe and secure combination of digital technology and services.

It should be noted, however, that today's concept of 'building digital infrastructures' ought to cover a lot more than the traditional grid solutions for broadband services and mobile communication. Against the backdrop of the data-driven transformation of economy and, indeed, society, a proper data infrastructure is becoming more and more important. This study sheds light on the Rhinelands coal mining area's potential when it comes to situating data infrastructures, i.e., a hyperscale data centre with integrated data hub and digital future park. Look at the former lignite mining areas and it's Relevance Meets Opportunity. The structural changes are paving the way for technological advances and thus for the development of the requisite infrastructure.

The crucial role of data infrastructure is illustrated by the European cloud project, GAIA-X. Just suppose that in the 19th century the terms and conditions of rail operators had dictated that passengers hand over their luggage, to get it back only if they use the same train for the return journey. A crude picture, perhaps, but it pretty much sums up today's digital reality. The big providers of cloud services are based in the US or Asia, and their business model seems to be based on 'once you're in, we make it as hard as possible to get out again'. GAIA-X is designed to tailor services to the needs of businesses and individuals, without such a lock-in effect. GAIA-X is setting up a network of European cloud providers ready to do business in accordance with and in the spirit of European regulations and values.

So, data infrastructure is of immense relevance, and the study shows that the Rhinelands coal mining area is more than ready to deliver. The region is criss-crossed with fibre-optic cables which enable fast broadband connectivity and link the area with the international nodes in Frankfurt und Amsterdam. As the Number One centre of energy, the Rhinelands coal mining area stands for supply security and, going forward, the production of 'green' electrical power. Good news for some 60 million potential users in the region and within a radius of 250 kilometres.

This study can serve as a key component of our strategy to put the Rhinelands mining area on the map of leading digital regions. Presentation of the study goes hand in hand with an invitation for the digital industry, skilled personnel and potential investors to take a closer look at this region.

Professor Dr Andreas Pinkwart
Minister for Economic Affairs, Innovation, Digitalization and Energy of the State of North Rhine-Westphalia

Content

The complete study is available as free PDF document: www.wirtschaft.nrw/broschuerenservice


© DE-CIX/Adrian Vidak

Foreword

Being ready for the digital future

Digital technologies are permeating our world ever more strongly and rapidly – and there is no doubt that we are only at the very beginning of this process. The requirements for availability, performance and security of digital offerings are increasing rapidly. Powerful digital infrastructures, cloud solutions, data hubs and data centres form the backbone of this transformation.

The Rhenish mining district is a historically strong industrial region in the midst of digital transformation. This is the location of many large and small companies that will produce more and more data in the future – this development will be flanked by many other companies that are expected to settle in the Rhenish mining district. Up to 60 million users in a radius of 250 kilometres in and around the Rhenish coal-mining district are already increasingly demanding data infrastructures. In order to be able to supply these locally in the future, we have investigated in this study whether the Rhenish mining district has the prerequisites for the settlement of corresponding data infrastructures, whether it makes sense to settle these in the Rhenish mining district, and how this can succeed.

GAIA-X provides data on location

These regional infrastructures are immensely important for the further digitalisation of the region, which is historically shaped by the extraction, conversion and refinement of lignite. The following pages identify three infrastructure components that the region needs in order to become one of the most innovative regions in Europe: A hyperscale data centre, a data hub – also known as an Internet Exchange – and a digital park.

The closer the companies are to the infrastructure components, the faster the data transmission. This plays an important role for more and more application scenarios. Short latency times – the technical term – are a basic requirement for many future-oriented technologies. These include autonomous driving, the Internet of Things, the increasing use of cloud applications, artificial intelligence and blockchain, as well as the developments of Industry 4.0.

The district meets all the requirements of a high-tech region

We also need the aforementioned infrastructures so that our economy can develop in a digitally sovereign manner, without being dependent on globally operating Internet corporations. This is why we are currently supporting an infrastructure ecosystem according to EU standards and rules in the form of GAIA-X. The federated concept creates space for self-determination, which we in Europe appreciate very much.

The digital ecosystem will play an increasingly important role in the future. To survive herewhat is needed above all are smart partnerships. In order to successfully shape our future, one of the seven capacities which we need both today and in the future is sovereignty. The Rhenish mining district has all the prerequisites to be a location for the aforementioned infrastructure components, thus increasing our digital sovereignty – in order to survive in the new ecosystem.

In a nutshell: The region is ideally situated geographically between two important world-class Internet Exchanges. Many medium-sized companies of international standing are based here, and these are increasingly demanding data infrastructures in the course of their digital transformation. The power supply is excellent for the operation of the required infrastructures. The conditions and potential for locating a hyperscale data centre with a data hub and connected digital park in this region are given.

This study provides investors from all over the world with the information they need to recognise the potential of the Rhenish mining district.

Best regards

Your

Harald A. Summa
CEO, DE-CIX Management GmbH

1 Introduction

Introduction to 'Feasibility Study: Data Infrastructures in Rhineland's former Coal Mining Area'

This 'Feasibility Study on Data Infrastructures in Rhineland's Former Coal Mining Area' was commissioned by the Ministry for Economic Affairs, Innovation, Digitalisation and Energy of the State of North Rhine-Westphalia, against the backdrop of impending structural change in the region.

This feasibility study investigates the issue whether and, as the case may be, where Rhineland's former Coal Mining Area provides the conditions and the potential for a Hyperscale Data Centre with an integrated Data Hub and associated Digital Future Park.

Background: data infrastructures as the basis for structural change

Rhineland's former Coal Mining Area comprises Düren county, Euskirchen county, Heinsberg county, Rhein-Erft county, Rhein-Kreis-Neuss county, Aachen City Region and the city of Mönchengladbach. In the west, Rhineland's former Coal Mining Area is bounded by the border with the Netherlands and Belgium. In the east, it borders on the Rhine, connecting Rhineland's former Coal Mining Area with the million-strong city of Cologne, the state capital of North Rhine-Westphalia, Dusseldorf, and the former federal capital, Bonn. The identity, economy and culture in Rhineland's former Coal Mining Area have been marked by lignite extraction, power generation and refinement, and now faces a profound transformation.

There are opportunities in Rhineland's former Coal Mining Area, in particular where the technologies of the future are used and rethought. Digital transformation, thought by many experts to have a transformative potential comparable to that of the Industrial Revolution, poses great challenges to the economy and to society. However, this development just as well offers tremendous opportunities and may contribute to the development of new business models and the creation of added value and employment.

'In Rhineland's former Coal Mining Area, there is a unique opportunity, through structural change, to implement projects related to issues of the future such as climate change mitigation and adaptation, digitalization and sustainable economic activity in practice, for the benefit of the people.' This is how the Economic and Structural Program for Rhineland's former Coal Mining Area, in which the region sets out its strategic guidelines for the process of transformation, summarises the issue at hand. The regular funding program is being preceded already by two funding program lines, in which early projects are being started, including projects in the area of digitalization. Many more projects are to follow, supported by federal subsidies and development grants for maintaining and expanding employment and value creation in the former lignite mining areas.[1]

The infrastructural basis of digital transformation is of crucial importance here. It is apparent already now that the quantities of data being processed will continue to grow in the future. At the same time, the speed of data transmission plays an important part for more and more applications. Low latency – which is the technical term – is a prerequisite for many technological trends, be it autonomous vehicles, the Internet of Things, the increasing use of cloud applications, artificial intelligence and blockchains, and the development of 'Industry 4.0'. Furthermore, digital sovereignty plays a more and more important part.

Companies frequently do care where their data are stored. It is to meet this desire for data sovereignty that the project is also associated with the federal government's 'GAIAX' initiative.

Low latency requires short distances for the quantities of data to be transmitted. The Internet – similarly to electricity and the water supply – is location-dependent. It is not 'just there' but is transmitted via data lines, without which digital technologies simply do not work.

1 The Economic and Structural Program can be found here on two pages [in German]: www.rheinisches-revier.de/media/191212_abstract_wsp_formatiert.pdf

Focus of the study: Hyperscale Data Centre, Data Hub, Digital Future Park

This study examines the issue of the infrastructural requirements for low latency. Its focus is studying the feasibility of a 'data infrastructure' project with three components:

- Data storage: a place where large quantities of data can be stored locally – referred to as the 'Hyperscale Data Centre' in the study;
- Data distribution: a 'Data Hub'[2] for the interregional distribution of data located in such a Hyperscale Data Centre; and
- Use of data: a business park in the vicinity of the Hyperscale Data Centre and Data Hub where companies with data-driven business models benefiting from low latency can be established – referred to as the 'Digital Future Park' in the study.

- Rhineland's former Coal Mining Area provides two crucial benefits for such a project. First, it is ideally situated geographically, between Frankfurt and Amsterdam, two important 'global Internet exchange points'. There are more than 60 million potential users reachable within a 250-kilometre radius, who could benefit from a data hub in Rhineland's former Coal Mining Area. Secondly, as already noted at the beginning, Rhineland's former Coal Mining Area is facing structural change anyway, to which digital transformation can make an important contribution. The development of various future topics projected in Rhineland's former Coal Mining Area (such as the energy system of the future, climate-friendly manufacturing methods, innovative mobility and the circular economy) can benefit significantly from data infrastructure as the basis of digital technologies.

The two essential questions investigated in this study are these:

- Does it make sense to establish a Hyperscale Data Centre with an integrated Data Hub and associated Digital Future Park in Rhineland's former Coal Mining Area?
- If so: Which sites would be ideal and what steps need to be taken?

2 Another, more common term is 'Internet exchange point'. For this study, we have decided to use the term 'Data Hub' (the meaning of which will be explained in detail in Chapter 2). The two terms have some differences in meaning, which will also be explained in Chapter 2.

2 Object, structure and methodology of the study

The target audience of this study is policy-makers, business development programs at local, state and federal level, as well as decision-makers in trade and industry. Potential investors, those responsible for location marketing, representatives of the press and media as well as civil society are also addressed. This study is intended as a guide for them, providing an overview and enabling them to make their own assessment of the topics and options for action discussed.

This study was prepared for the Ministry for Economic Affairs, Innovation, Digitalisation and Energy (MWIDE) of the State of North Rhine-Westphalia by a consortium of contractors under the content and project management of DECIX Management GmbH. The consortium of contractors comprises Deutsche Telekom Business Solutions GmbH, DECIX Management GmbH, Detecon International GmbH, WIK-Consult GmbH and Gesellschaft für Wirtschaftliche Strukturforschung (GWS) mbH.

In the course of this study, during the period from January to December 2020, the contractor investigated, following the Delphi method, how these data infrastructures can pave the way towards the economic development of the region. Important prerequisites for this include suitable land, available fiber-optic connections and a stable power supply.

Figure 1 shows a diagram of the interactions of data infrastructures. A Hyperscale Data Centre with an integrated Data Hub functions in this context as the linchpin of digital progress. This is where the data are stored and processed. The Data Hub is the connecting element, organising and executing rapid data transmission, like an airport, regionally, nationally and internationally. Other large Internet exchange points (i.e. data hubs) such as Amsterdam, Frankfurt, Paris and Stockholm can be reached directly, without detours, from Rhineland's former Coal Mining Area. Data streams – for instance, to and from cloud computing providers – are handled and controlled by such data hubs.

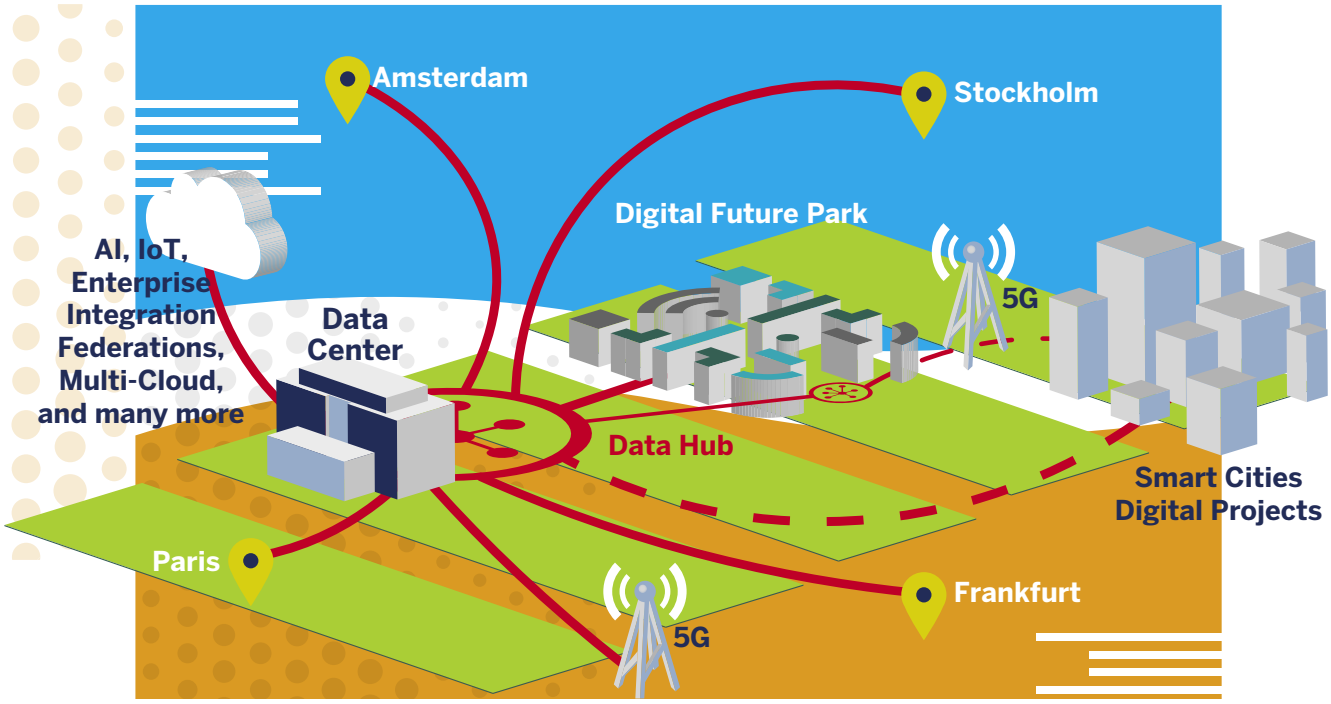


Figure 1: Data infrastructures

Applications from the areas of 5G mobile communications, the Internet of Things (IoT), autonomous vehicles and artificial intelligence all benefit from locally available data hubs. Data hubs are also suitable for connecting to and directly interconnecting company networks. The function of a data hub is data distribution.

In this project, the Digital Future Park is intended to function as a further point of attraction for data-centred companies and as an innovation site. The Digital Future Park will be a business park with a direct connection to a data hub, thus offering companies all the associated benefits. The function of the Digital Future Park is to create a space (specifically: a business park) for using data.

In brief: Hyperscale Data Centres are very large data centres providing a reliable, scalable basis for the secure storage of large quantities of data. A local Data Hub, required for the rapid distribution of large quantities of data, ensures short distances and fast data connections. The Data Hub, in turn, thrives on the dynamism of the Hyperscale Data Centre, as a constant demand for new connections is generated by the Hyperscale Data Centre. Finally, the Digital Future Park will provide a space where jobs will be created in innovative, digital, data-driven industries that require communication in real time and will benefit regionally from direct connectivity to the Data Hub.

3 Data infrastructures: potentials in Rhineland's former Coal Mining Area

The first question to be answered now is whether it really makes sense to implement such a project specifically in Rhineland's former Coal Mining Area, i.e. to establish a Hyperscale Data Centre with an integrated Data Hub and an attached Digital Future Park. To answer this question, this study investigates the geographic location of Rhineland's former Coal Mining Area, the developments accompanying digital transformation, and the very specific economic structure in Rhineland's former Coal Mining Area.

Beneficial geographic location of Rhineland's former Coal Mining Area

Two significant data routes cross through Rhineland's former Coal Mining Area: west to east and north to south. Its geographical location and this particularity – in addition to the large number of potential users described above – make Rhineland's former Coal Mining Area especially attractive for establishing data infrastructures. The fact that two date routes cross through the region calls for a closer look and investigation of the specific potential for establishing data infrastructures:

- West to east: with its hubs at Dublin and Frankfurt, the first data pathway runs from west to east, including the international data centre conurbations of London and Amsterdam. Rhineland's former Coal Mining Area is crossed by the lines from Aachen to Cologne and from Amsterdam to Dusseldorf.
- North to south: the other data pathway connects the Scandinavian data centre infrastructures of the German industry, European institutions and American content providers via Stockholm and Dusseldorf with Frankfurt and Paris.

There are further geographical advantages to Rhineland's former Coal Mining Area: the region is embedded in a string of European conurbations often referred to as the 'Blue Banana' by economic geographers. From here, more than 60 million potential users within a radius of 250km can be reached in a round-trip time (RTT[3]) of less than 20 milliseconds, or 100 million within a radius of 400km in a round-trip time (RTT) of less than 40 milliseconds, while the region itself has a population of 2.4 million. The region benefits from a good multimodal transport infrastructure: it is criss-crossed by motorways and rail networks, Cologne/Bonn and Dusseldorf have international airports as well as high-speed rail links. Metropolises such as Brussels, Amsterdam and Antwerp are less than two hours away, Dusseldorf and Cologne less than one hour.

By the way: nearby Dusseldorf is not only an international trading centre of worldwide renown and a media and broadcasting location with a vibrant investor community but, since Prussian times, it has also been the second telecommunications centre for international telecommunications services in Germany, after Frankfurt.

3 RTT: The round-trip time is the period in milliseconds (ms) needed by a data packet to travel from one point on the Internet to another and back again.

Switch GRAND RAPIDS „The Pyramid Campus“, Michigan, USA

Digital transformation meets vibrant ecosystem in structural change

With the projected phasing out of lignite mining for generating electricity, an economic era is coming to an end in Rhineland's former Coal Mining Area. A far-reaching process of transformation is about to begin. Developing new data infrastructures will give Rhineland's former Coal Mining Area the opportunity to make use of this necessary structural change, while taking due account of the issues of sustainability and combating climate change. More than that, this infrastructure would help to promote the technologies of the future, develop business models, secure employment and contribute to the future growth of the national economy.

Disruptive developments around changing markets ('platform economics' is a keyword here), digital technology trends, the development towards cloud and edge computing and the GAIAX initiative make it clear that data traffic, and the quantities of data exchanged, will increase and will become more regional and local. This means two things are becoming more and more important: first, control over data and the knowledge where the data are being stored; secondly, the speed of the data connections and, related to that, as direct as possible a link to the companies providing services. These two points (local data storage and data sovereignty, as well as direct, fast data connections) are ensured by the data infrastructures investigated in this study.

Issues of the future such as artificial intelligence, 5G, the Internet of Things, blockchains and autonomous vehicles are actively being promoted in the region. Globally leading research and development are at home in Rhineland's former Coal Mining Area: there is a strong presence of research and education in Rhineland's former Coal Mining Area, with a number of universities at Aachen and the Jülich research centre (Forschungszentrum Jülich).

With respect to power supply, Rhineland's former Coal Mining Area provides a high security of supply and system stability. This is regarded as a guarantee for the ability to develop data infrastructures. Looking at the mere numbers, power cuts are among the lowest in the world at around 10 minutes per year, not including short-term disturbances in the grid (e.g. power-line flicker).[4] Where they do occur, power cuts are usually local.

Rhineland's former Coal Mining Area is home to nearly 100,000 businesses.[5] In 2019, the total gross value added was 76 billion euros,[6] amounting to about 12.3 per cent of the value added in North Rhine-Westphalia and about 2.6 per cent of the value added in all of Germany.

4 Cf. www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Versorgungssicherheit/Versorgungsunterbrechungen/Auswertung_Strom/Versorgungsunterbrech_Strom_node.html

5 Source: Landesdatenbank NRW [NRW state database], 'Rechtliche Einheiten' [legal entities], 2018

6 At 40,439 euros per employee, wages are slightly below the average for North Rhine-Westphalia (42,032 euros) and Germany (41,716 euros). Productivity is also slightly below average, at a GDP of 72,784 euros per employee.

The overall discourse and talks with various stakeholders suggest the following conclusion: there is demand in the region; the relevant technologies are supported by the structural funding going to Rhineland's former Coal Mining Area. The regional economy welcomes the establishment of data infrastructures and the expectation it brings to attracting model digital companies to the region. One other point is to be highlighted in this conclusion: data infrastructures require an enormous amount of energy, and Rhineland's former Coal Mining Area is particularly suited for supplying this energy. Given its traditional strength in energy supply and also an above-average reliability in the security of supply (minimal power cuts, a high security of supply by global comparison), supplemented by the now strongly accelerated development towards a supply from renewable energy sources, Rhineland's former Coal Mining Area is all but ideally suited as a location for data infrastructures in this respect as well.

To sum up: The region is situated in a geostrategically advantageous location. For one thing, a large number of users can be reached directly. For another, Rhineland's former Coal Mining Area is situated on two important data routes, from west to east and from north to south. Added to this are the general trend within digitalization, which favors a decentralization of data infrastructures, and the particular economic structure in Rhineland's former Coal Mining Area (especially as concerns energy supply). The question, therefore, of whether Rhineland's former Coal Mining Area is suitable in principle for establishing data infrastructures there, must be answered with a clear 'yes'.

Benefits of Rhineland's former Coal Mining Area:

A beneficial geographic location with sustainable prospects

- → A reach of at least 60 million potential users within a 250-km radius, plus further applications such as IoT, autonomous vehicles, etc.
- → Existing investments in network infrastructure provide a beneficial location along two important European Internet data routes
- → A diverse supply of land for large business premises in proximity to the metropolitan regions of Dusseldorf and Cologne
- → A high security of power supply already exists and will in future be ensured by renewable energies.

A region for digital innovation with successful growth and further potential

- → Prospective returns for investors
- → Various federal and state funding programs on the basis of the InvKG [Act on investments in coal-mining regions]
- → An economic structure built on medium-sized enterprises with many internationally active 'hidden champions'
- → A dynamic start-up region with digital products and services
- → Established technological trends are already visible (autonomous vehicles, blockchains, digital energy, 5G, IoT, hydrogen technology, bio-based industry, etc.)
- → Major investments in mobility and rail infrastructure

Regional diversity promotes long-term growth

- → Multilingual professionals are available; the proximity to international borders provides access to an international pool of professionals
- → Internationally recognised research and higher education institutions in the region
- → Model region for the climate-friendly transformation of manufacturing sites
- → A modern and climate-neutral energy and manufacturing region by 2040

Figure 2: Beneficial location on two important European data routes

Figure 3: Potential areas for a hyperscale data center

4 Feasibility and localization

Having determined that it makes sense in principle to establish a Hyperscale Data Centre with an integrated Data Hub and attached Digital Future Park in Rhineland's former Coal Mining Area, it will now be investigated whether the conditions for this are indeed in place and, if so, at what specific locations.

To determine suitable locations, a set of criteria/conditions that such a location must meet was developed. In the main, these are available land, a suitable fiber-optic connection, a suitable connection to the electricity supply and geographic proximity to relevant businesses and universities. The precise specifications of the selection criteria of possible areas of land for (1) the Hyperscale Data Centre with an integrated Data Hub and (2) a Digital Future Park are set out in the Appendix.

In carrying out a step-by-step analyzis, the first step concerns the establishment of a Hyperscale Data Centre with an integrated Data Hub. In the design of this study, the Data Hub is integrated into the Hyperscale Data Centre and will therefore not be analyzed separately in this chapter. The Hyperscale Data Centre is intended to function as a catalyst for the establishment of a Digital Future Park in a second step.

45 parcels of land meeting a minimum requirement of an area of 10 hectares (ha) were investigated. Both the number and the quality of the sites are well placed by international comparison.

Localization of the Hyperscale Data Centre with Data Hub

As a Hyperscale Data Centre requires a great deal of land, there are fewer sites suitable for this. By applying the selection criteria, the available potential sites are narrowed down to three plots of land favofavorablerable for establishing a Hyperscale Data Centre with an integrated Data Hub, located in two counties:

- → Rhein-Kreis Neuss county (Rommerskirchen, Dormagen-Nievenheim)
- → Rhein-Erft county (Bergheim-Paffendorf)

The existing power distribution grid structures at these three sites allow a suitably supported electricity supply, which will be upgradeable at all three sites. The fiber-optic backbone structures in Rhineland's former Coal Mining Area allow for multiple redundancy of connections of the sites identified for incoming and outgoing data traffic.

Localization of a Digital Future Park

The decisive selection criterion for a Digital Future Park is an estimate of the termination length of the fiber-optic connection to the Hyperscale Data Centre under real-time latency conditions. Put another way: the most important selection criterion for a site's potential to accommodate a Digital Future Park is its proximity to the Hyperscale Data Centre with its integrated Data Hub. Any site not within a radius of 30 kilometres around one of the three potential sites for the Hyperscale Data Centre was excluded as a potential site. In this context, it must also be noted that existing innovation parks can be developed into Digital Future Parks by expanding and extending them. The following possible combinations were identified:

Hyperscale Data Centre with Data Hub in:		
Rommerskirchen (Rhein-Kreis Neuss) Potential locations for a Digital Future Park in:	**Dormagen-Nievenheim (Rhein-Kreis Neuss)** Potential locations for a Digital Future Park in:	**Bergheim-Paffendorf (Rhein-Erft-Kreis)** Potential locations for a Digital Future Park in:
→ Bedburg	→ Bedburg	→ Bedburg
→ Bergheim Quadrath-Ichendorf	→ Bergheim Quadrath-Ichendorf	→ Bergheim Quadrath-Ichendorf
→ Bergheim-Niederaußem	→ Bergheim-Niederaußem	→ Bergheim-Niederaußem
→ Bergheim-Paffendorf	→ Bergheim-Paffendorf	→ Dormagen-Nievenheim
→ Dormagen-Nievenheim	→ Elsdorf	→ Düren
→ Düren	→ Frechen	→ Düren/Niederzier
→ Düren/Niederzier	→ Grevenbroich-Frimmersdorf	→ Elsdorf
→ Elsdorf	→ Grevenbroich-Neurath	→ Erftstadt/Hürth
→ Erftstadt/Hürth	→ Grevenbroich/Jüchen	→ Eschweiler
→ Frechen	→ Hürth	→ Frechen
→ Grevenbroich-Frimmersdorf	→ Kerpen-Sindorf	→ Geilenkirchen-Lindern
→ Grevenbroich-Neurath	→ Kerpen-Sindorf/Elsdorf	→ Grevenbroich-Frimmersdorf
→ Grevenbroich/Jüchen	→ Meerbusch-Osterath	→ Grevenbroich-Neurath
→ Hürth	→ Neuss	→ Grevenbroich/Jüchen
→ Jülich	→ Pulheim-Brauweiler	→ Hürth
→ Kerpen	→ Rommerskirchen	→ Jülich
→ Kerpen-Sindorf		→ Kerpen
→ Kerpen-Sindorf/Elsdorf		→ Kerpen-Sindorf
→ Meerbusch-Osterath		→ Kerpen-Sindorf/Elsdorf
→ Merzenich		→ Merzenich
→ Neuss		→ Neuss
→ Niederzier		→ Niederzier
→ Pulheim-Brauweiler		→ Pulheim-Brauweiler
		→ Rommerskirchen

5 Consequences of data infrastructures on the economy of the region

The development of new infrastructures (Hyperscale Data Centre and Digital Future Park) will provide an opportunity to make use of the necessary structural change in Rhineland's former Coal Mining Area for North Rhine-Westphalia generally to increase its added value and competence in the area of digitalization. This means that employment can be secured and an economic contribution to future growth can be made.

The economic analyzis provides qualitative and quantitative assessments of (a) effects on employment in Rhineland's former Coal Mining Area and (b) effects on the gross domestic product (GDP) of the following infrastructure projects:

1. Development and operation of a Hyperscale Data Centre with an integrated Data Hub in Rhineland's former Coal Mining Area

1. Development of at least one Digital Future Park in Rhineland's former Coal Mining Area

The data basis for the analyzis is an input–output analyzis (IOT). On the national level, the Federal Statistical Office makes available the IOT as part of its national accounts. For individual states or lower regional units such as Rhineland's former Coal Mining Area, there are no current IOTs from official sources. For this reason, a table for North Rhine-Westphalia developed in 2018 in the course of a MWIDE study on 'The economic significance of industry-oriented services in North Rhine-Westphalia'[7] was used in this study.

On the basis of DE-CIX Management GmbH's market experience, an analyzis of comparable national and international projects, and a model profile comparison with international, innovative digital regions, conditions and assumptions regarding a Hyperscale Data Centre and Digital Future Park were determined and validated. These assumptions were then translated into economic effects by means of an input–output analyzis. This shows the effects the structural components will have on the gross domestic product (GDP) and on employment both nationally and in North Rhine-Westphalia.

The level of investment required for establishing the data infrastructures is estimated at 1.9 billion euros. Two thirds of this investment will go to companies in North Rhine-Westphalia. Overall, the construction of the infrastructures will secure employment in the order of 13,300 jobs during the implementation phase, 50 per cent of which will be in North Rhine-Westphalia. According to model calculations, the permanent effect on employment will be in the order of 5,130 new jobs. Of these, 3,450 new jobs will be in North Rhine-Westphalia.

In the Digital Future Park itself, 2,030 new jobs are expected, while 50 direct jobs are expected in the Hyperscale Data Centre with its integrated Data Hub. It must be noted, however, that the 2,030 jobs in the Digital Future Park will causally depend on the provision of the Hyperscale Data Centre with integrated Data Hub. They will only be created if the Digital Future Park is actually connected to the Data Hub, that is to say, if the required 'digital supply' is ensured.

As regards demand stimuli and effects on the gross domestic product, calculations show a total annual effect of 734 million euros (875 million euros) on the GDP in North-Rhine Westphalia (Germany) on complete implementation of the projects and establishment of the companies. In North Rhine-Westphalia, the largest beneficiary will be the energy sector, with around 65 million euros, followed by media and IT with 36 million euros, manufacturing with 23 million euros and business services with 18 million euros.

The geographic distribution of purchasing power is investigated by means of a commuter analyzis. The starting point for this analyzis is the establishment of the Hyperscale Data Centre in the Rhein-Erft county or Rhein-Kreis-Neuss county. The data is used to show the effects the structural projects might have on commuter flows and consumption flows for these two counties as examples. Considering current linkages and interdependencies, a total of 54 per cent of the incomes from employments subject to social security contributions will remain in the counties considered. Overall, it may be assumed that at least three quarters of employees commuting to the new sites will come from within a radius of 50 km from the county in which the structural components will be situated. Hence, a large part of the effects induced will be on that area.

7 Koch, A., Jäger, A., König, T., Kronenberg, T., Lerch, C., Reiner, M., Többen & Weidner (2019), Wirtschaftliche Bedeutung industrieorientierter Dienstleistungen in Nordrhein-Westfalen. A study on behalf of the Ministry for Economy, Innovation, Digitalisation and Energy of the State of North Rhine-Westphalia.

6 Conclusions and parameters for implementation

The primary objective in implementing this project is to create sustainable added value for Rhineland's former Coal Mining Area. In this context, developing a Hyperscale Data Centre (which would entail the establishment of a hyperscaler) will, on its own, initially only provide the digital economy of a region with a certain proportion of the added value that is to be expected from the overall project (the establishment of all three data infrastructure components). The permanent effects entailed by the Hyperscale Data Centre alone will consist mainly in annual reinvestments and ongoing operating costs, an added value in the hundreds of millions directly attributable to the development, and continuing business tax income once the establishment becomes profitable. Other than one-off effects surrounding the initial investment, a relatively small number of new direct jobs is to be expected.

The actual benefit to the regional economy will arise mainly from integrating a fast-growing, at least regionally, and perhaps nationally significant Data Hub into the Hyperscale Data Centre. That benefit will be significantly enhanced by connecting the Data Hub with a business park used by companies with data-based business models. Connecting further users, such as applications from the area of 'smart services', will supplement this beneficial effect on the economy. This context will be supplemented by the following relationships:

- In deciding to establish a Hyperscale Data Centre, it is absolutely necessary that there should also be a Data Hub on site. This Data Hub will ensure the necessary scalable data distribution for the hyperscaler and its customers.
- It is expected that the Data Hub will enhance the national and international visibility of the region along with the site and, provided that things develop in a positive manner, will attract business within the digital economy.
- As a Data Hub will operate with the aim of generating profit, it will require a sufficient number of customers directly connected to it. Furthermore, a continuing increase in user numbers will be required so that these customers can continuously be offered added value. This will secure the investments in a hyperscaler, as this increase in user numbers will also lead to an increase in customers for the hyperscaler.
- Companies in the Digital Future Park will use the hyperscaler to store data locally and, combined with possible further sites within IT security schemes, securely. The Data Hub will be required to exchange data in real time with the lowest possible latency.

The following parameters should be considered in order to be able to make full use of the potential of the project for the benefit of Rhineland's former Coal Mining Area:

Data Center interxion FRA15, Frankfurt, Germany

Different owners for the three data infrastructure components

The owners of the three data infrastructure components, i.e. (1) the Hyperscale Data Centre, (2) the Data Hub integrated within it, and (3) the Digital Future Park, should be different entities. Each of these three elements has its own prerequisites; potential investors should not be from the same group. Ownership of more than one data infrastructure component by a single actor should be avoided.

Shaping the relationships between the data infrastructure components

The relationships between the three data infrastructure components should be deliberately designed in such a way that they both produce added value for the owners and have a beneficial effect on the regional digital economy in Rhineland's former Coal Mining Area. Such well-functioning governance, i.e. shaping the relationships between specific ownership structures and the operations of the individual elements, is a decisive success factor for the overall project.

Securing digital sovereignty: taking into account considerations from GAIA-X

Given the increasing significance of data-driven business models, it is becoming more and more important for companies to retain control of their data. When using cloud technologies, in particular, such control also means knowing where the data are located physically. Therefore, the implementation of the project described in this study should involve adequate consideration being given to data security and digital sovereignty. In doing so, given the current state of knowledge, it is reasonable to draw on the objectives and considerations of the GAIA-X project initiated by the Federal Ministry for Economic Affairs.

Safeguarding the interests of the regional economy

The regional (digital) economy in Rhineland's former Coal Mining Area should be involved in the development of the overall project in an appropriate manner. This includes taking into account any existing and/or emerging projects with a topical connection to this project, and giving consideration to established businesses in Rhineland's former Coal Mining Area. This approach has already been deliberately followed in the course of preparing this study. It was for this consideration that many companies and other actors in the region were included in the conversation as an essential part of the methodology used in preparing this study.

Rhineland's former Coal Mining Area as a model and pilot region for structural change: considering the energy system of the future, innovative mobility, climate-friendly manufacturing methods and the circular economy

Rhineland's former Coal Mining Area is to become a model region for the climate-friendly transformation of an industrial site. To that end, the required technologies – in the areas of e.g. the energy system of the future, climate-friendly manufacturing methods, innovative mobility or the circular economy – are to be developed and brought into wide use in Rhineland's former Coal Mining Area and marketed globally. Digital technologies and artificial intelligence can help push these topics and facilitate significant progress. The most crucial prerequisite for this, though, is the existence of high-performance data infrastructures. Establishing a Hyperscale Data Centre, a Data Hub, and a Digital Future Park can make an important contribution here.

At the same time, the structural-change strategy has its own requirements regarding the specific design of the project. For instance, in view of the high energy consumption of data centres, the energy supply schemes implemented should be climate-friendly and save on resources, such as by the use of renewable energies, or suitable recovery of the waste heat produced. The requirements of civil society regarding the aesthetics of the infrastructures to be developed should also be considered, for instance by giving the projected buildings an attractive architectural design.

In this way, the undertaking can become a visible showcase project and make an important contribution to shaping structural change. Given existing plans for transformation, Rhineland's former Coal Mining Area offers optimum parameters for an appropriate implementation.

Data infrastructure elements to be considered separately

In planning the implementation phases, it will be important to be aware of the reciprocal synergy effects outlined above. To reduce complexity, it will nevertheless be helpful to consider the three data infrastructure elements separately in their respective particularities and prerequisites. Implementation need not necessarily be planned as a joined-up mega-project; decoupling the different projects is a viable option.

Conclusion: Rhineland's former Coal Mining Area as a digital region

This study has investigated whether it makes sense to establish the three data infrastructure elements – Hyperscale Data Centre, Data Hub, and Digital Future Park – in Rhineland's former Coal Mining Area and, if so, where this would be possible. To answer these questions, comprehensive research was carried out and numerous discussions were held with more than a hundred experts and companies. The result is presented in this publication: it offers a deep insight into the often invisible infrastructural basis of digital transformation, the potential of Rhineland's former Coal Mining Area to take part in this digital transformation and the steps necessary to exploit that potential for the benefit of the region.

The result of this study can be put simply: Rhineland's former Coal Mining Area has the full potential for establishing the three data infrastructure components. An important point to note is this: an open Data Hub design will particularly support regional developments in the further arrangements for existing and planned funding projects and other regional initiatives.

Data center Green Mountain DC1-Stavanger, Norway

This study may now serve as a basis for possible developments. It is intended as a point of reference for policy-makers, economic stimuli at the local and state levels and decision-makers in trade and industry, to enable them to gain a better understanding of data infrastructures and the 'digital potential' of this structurally changing region at the heart of Europe. Not least, this study may also serve to familiarize the interested public with this topic.

One important target audience for realising this potential shall be named at the very end of this study: investors from all over the world, who are hereby provided with the information they need to recognise the potential of Rhineland's former Coal Mining Area. The publication of this study comes with the following hope and expectation: this study is suitable for making Rhineland's former Coal Mining Area, with its particularly favorable geostrategic location, internationally visible as a site for a Hyperscale Data Centre, a Data Hub and a Digital Future Park.

7. Appendix

7.1 Hyperscale Data Centre: selection criteria

Figure 4: Selection criteria for establishing a Hyperscale Data Centre

Category	Criteria
Localization	→ The usable plots of land are not immediately adjacent to, or situated with-in, residential areas. Plots of at least 15 ha are preferred, including SEVESO II/III areas with a reliable power grid, fiber-optic network and wa-ter supply (industrial quality). → Easy access is ensured, inter alia by public transport, road links; exclusion of risk/hazardous situation that may impede development, including by natural events. → Option: Existence of conversion areas ready for subsequent use after 2023, as transformers or redundant power grid connections, inter alia, can continue to be used (risk reduction, cost savings).
Digital ecosystems/ data-centred use	→ There is an immediate, digitalization-friendly business environment, in par-ticular for operating data centres. → Reachability of more than 60 million users within a 250-km radius or more than 100 million users within a 400-km radius is ensured, not including IoT or IIoT users. → Data centre specialists are available within a 30-km radius. → There is scope for local uses of the Data Centre, including a varied spec-trum of users in data-centred companies and institutions, within a radius of 50 km. → Option: Additionally, as an option, greenhouses may be erected in imme-diate proximity to the Data Centre to exploit obvious energetic synergy potentials.
Reliable power supply	→ There is a capacity for a reliable, immediate grid connection of not less than 150 MVA, which should ideally be connected to 2 substations via a ring line (or similar redundancy), of which one substation is no more than 4 km away and has sufficient connection capacity. The lowest level of connection is 110 kV, supported by an alternative high-voltage supply at 220 kV or 380 kV. Power consumption will be more than 600 GWh per annum. → Access to and short-term capability of development of renewable energies is possible to an available target level of not less than 300 MVA after 2025 ('be green', not 'buy green').
Redundant fiber-optic links	→ There are at least two long-haul fiber-optic link providers available which in aggregate implement 3 pathways, without loops or intersections, each having at least 20 usable fiber pairs, for connection to the network; the maximum distance to the trunk line from the potential development site is 5 km.
Data Hub	→ A provider for a Data Hub (i.e. an Internet exchange point provider) is available and able to implement a large number of enterprise-level inter-connection services using a non-discriminatory, distributed platform design. Note: Obviously, this does not apply to any of the sites, there being no data hub in Rhineland's former Coal Mining Area. The study design as-sumes that such a data hub will be constructed within the Hyperscale Data Centre. Therefore, in what follows, it will be implicitly assumed that a Data Hub will be 'automatically' included in the development.

7.2 Digital Future Park: selection criteria

Figure 5: Site-specific selection criteria for establishing a Digital Future Park

Category	Criteria
Localization	→ The usable plots of land are in business parks and have an area of at least 10 ha. → Easy access is ensured, inter alia by public transport, road links. → Furthermore, there are open spaces for operating the park's own energy supply (production and storage), such as photovoltaics, wind power or hydrogen plants, or agricultural testing areas. → The development will be within a 30-km radius of the Hyperscale Data Centre site so as to achieve a latency (RTD) of < 2 ms.
Digital ecosystems/ data-centred use	→ There is an immediate, digitalization-friendly business environment. → Digital specialists and managers are available within a 30-km radius. → There is already a varied spectrum of users in data-centred companies and institutions within a 30-km radius of a potential site. → Actors may be both from business and from research and education, administration and society
Reliable power supply	→ There is a capacity for a reliable, immediate grid connection of not less than 6 MVA, which should ideally be connected to 2 substations via a ring line (or similar redundancy), of which one substation is no more than 4 km away and has sufficient connection capacity. → Access to and short-term capability of development of renewable energies is possible to a target level after 2025 ('be green', not 'buy green'). → The power supply for latency-sensitive users, including 5G and auton-mous vehicles and e-mobility, is ensured. → Infrastructures can be operated for a modular, local edge data centre with a performance capacity of 1 MVA.
Redundant fiber-optic links	→ Several fiber-optic transition chutes for connection to several long-haul trunk lines are available. → There are structured redundant ductwork systems for flexible connection of all areas/buildings within the park.
Data Hub	→ The connection to an Internet exchange point can be made directly from the Digital Future Park.

Imprint

Publisher

Ministry for Economic Affairs, Innovation, Digitalisation and Energy (MWIDE) of the State of North Rhine-Westphalia

Berger Allee 25
40213 Düsseldorf
Tel.: +49 (0) 211/61772-0
Fax: +49 (0) 211/61772-777
Internet: www.wirtschaft.nrw

Steering Committee

Client
Ministry for Economic Affairs, Innovation, Digitalisation and Energy
Dr. Michael Henze
(Head of Department V, Digitalisation and Economic Development),
Christian Dinnus
(Head of Department VB2, Digital Economy 'DWNRW', Digital Business Models)

Implementation and realization partner
DE-CIX Management GmbH
Harald A. Summa (Managing Director)

Region Rheinisches Revier:
Ralph Sterck
(Managing Director Zukunftsagentur Rheinisches Revier, represented by Boris Linden / Benjamin Casper),
Dirk Brügge
(District node chairman infrastructure and mobility)

Contact person for content-related questions

Department VB2 Digital Economy (DWNRW),
Digital Business Models
Sebastian Ley
digitalewirtschaft@mwide.nrw.de

Contractor

Deutsche Telekom Business Solutions GmbH

Implementation and realization partner

DE-CIX Management GmbH

Project management

Gerd J. Simon (DE-CIX Management GmbH)

Author and editor

DE-CIX Management GmbH
Gerd J. Simon,
Alexander Frese

Design and Layout

Hansen Kommunikation Collier GmbH

Photo credits

According to the information.

Study contributions

DE-CIX Management GmbH
Dr. Falk von Bornstaedt,
Bernd Spiess

eco – Verband der Internetwirtschaft e.V.
René Bernard,
Roland Broch

WIK-Consult GmbH
Dr. Cara Schwarz-Schilling,
Dr. Bernd Sörries

Gesellschaft für Wirtschaftliche Strukturforschung (GWS)
Dr. Johannes Többen,
Philip Ulrich,
Dr. Marc Wolter

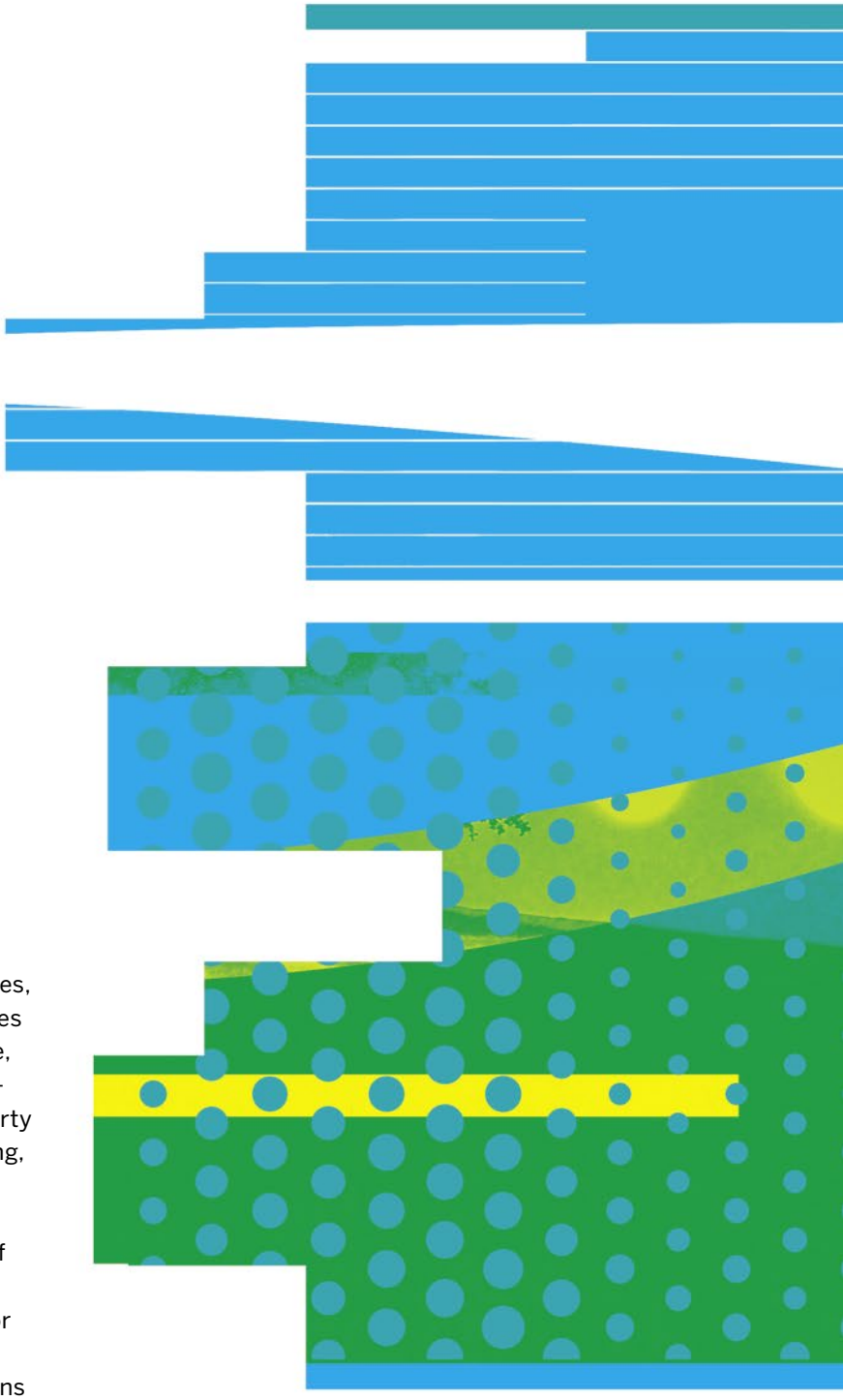
Further contributions from:
Detecon International GmbH
Dr. Markus Steingröver,
Dr. Mathias Schweigel,
Roman Antun Saakel

Architekturbüro planquadrat Elfers Geskes Krämer PartG mbB
Martin Geskes

Studio Scholz-Bauer:
Andreas Bauer,
Gregor Scholz

The publication can be accessed as a PDF document on the website of the Ministry of Economic Affairs, Innovation,Digitalization and Energy of the State of North Rhine-Westphalia at www.wirtschaft.nrw/broschuerenservice.

1st edition: April 2021 / MWIDE21-004



Please note:

This publication is published as part of the public relations work of the state government of North Rhine-Westphalia. It may not be used by political parties, candidates or election workers for canvassing purposes during an election campaign. This also applies to state, federal and local elections and to the election of members of the European Parliament. Its distribution at party information stands during election events and inserting, printing or affixing it to party-political information or advertising material in particular is deemed improper use. Its distribution to third parties for the purposes of political canvassing is also prohibited. The use of this publication by any party or supporting organization for the sole purpose of informing its own members shall remain unaffected. Irrespective of when, by what means and in what number this publication reached the recipient, it may not be used in a way that could be misconstrued as the state government‘s partisanship in favor of individual political groups, even without reference to a forthcoming election.

April 2021 / MWIDE21-004

DE-CIX

Ministerium für Wirtschaft, Innovation,
Digitalisierung und Energie
des Landes Nordrhein-Westfalen