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Repurposing the Former Isar 2 Nuclear Power Plant: “Wicked Problems” in a Regional Energy Transition

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Abstract

The nuclear phase-out in 2023 and Germany's climate targets raise the question of the repurposing of decommissioned nuclear power plants. This master’s thesis analyses the former nuclear power plant Isar 2 (KKI 2) in the context of regional energy transitions (RET). By addressing the “wicked problems” of such a regional transformation, the central question of this research is to be answered using a challenge-orientated approach (CORIS) and qualitative interviews with experts from planning, politics, the energy industry and research. The results show that, in particular, a subsequent energy utilisation of the KKI 2 site addresses regional challenges especially and can be realised in various implementation perspectives. KKI 2 offers infrastructural advantages, but repurposing ideas such as storage facilities or a hydrogen-ready gas-fired power plant require political, economic, social and environmental coordination.

Der Atomausstieg 2023 und die Klimaziele Deutschlands bringen die Frage nach der Nachnutzung stillgelegter Kernkraftwerke auf. Diese Forschungsarbeit untersucht das ehemalige Kernkraftwerk Isar 2 (KKI 2) im Kontext der regionalen Energiewende. Indem auf die “wicked problems” einer solchen regionalen Transformation eingegangen wird, soll mit einem herausforderungsorientierten Ansatz (CORIS) und qualitativen Interviews mit Experten aus Planung, Politik, Energiewirtschaft und Forschung, die zentrale Forschungsfrage beantwortet werden. Die Ergebnisse zeigen, dass besonders eine energetische Nachnutzung des KKI 2-Standorts regionale Challenges adressiert und in verschiedenen Umsetzungsperspektiven realisierbar ist. Das KKI 2 bietet infrastrukturelle Vorteile, doch Nachnutzungsideen wie Speicher oder ein wasserstoff-ready Gaskraftwerk erfordern politische, ökonomische, gesellschaftliche und umwelttechnische Abstimmung.

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List of abbreviations

AtG – Atomic Energy Act (germ.: Atomgesetz)

AtVfV – Nuclear Procedural Ordinance (germ.: Atomrechtliche Verfahrensverordnung)

BauGB – Federal Building Code (germ.: Baugesetzbuch)

BayLplG – Bavarian State Planning Act (germ.: Bayerisches Landesplanungsgesetz)

BZI – Spent Nuclear Fuel Storage Facility (germ.: Brennelemente-Zwischenlager Isar)

CCS – Carbon Capture and Storage

CCU – Carbon Capture and Utilisation

CHP – Combined Heat and Power

CO_2 – carbon dioxide

CORIS – Challenge-Oriented Innovation System

EEG – Renewable Energy Sources Act (germ.: Erneuerbare-Energien-Gesetz)

EnWG – Energy Industry Act (germ.: Energiewirtschaftsgesetz)

EU – European Union

GW – gigawatt

GWh – gigawatt hours

H_2 – hydrogen

KKI 2 – nuclear power plant Isar 2 (germ.: Kernkraftwerk Isar 2)

kW – kilowatt

kWh – kilowatt hours

LEP – Bavarian State Development Programme (germ.: Landesentwicklungsprogramm)

LNG – liquefied natural gas

MW – megawatt

PV – photovoltaics

RBZ – Residual Material Treatment Centre (germ.: Reststoffbehandlungszentrum)

RET – Regional Energy Transitions

TW – terawatt

TWh – terawatt hours

WTAZ – Hydrogen Technology User Centre (germ.: Wasserstoff-Technologie Anwenderzentrum

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1. Introduction

With the nuclear phase-out in April 2023 and the legally enshrined goal of climate neutrality by 2045, Germany faces a double challenge: the departure from fossil and nuclear energy and the development of resilient, innovation-based infrastructures (Bundesregierung, 2025). As a central component of Germany's climate strategy, the energy transition is not only a technical challenge at national level, but also an economic, social and environmental transformation process that is being implemented in specific regions (Coenen et al., 2021). These regional energy transitions (RET) focus on the specific potential and opportunities of a region and make the challenges and conflicts that are often masked at a higher level visible. Regions are therefore not just venues, but active shapers of these transitions (Coenen et al., 2021; Trippl et al., 2024a+b). A place-specific perspective is crucial to understanding the multi-layered nature of contemporary energy transitions (Coenen et al., 2021). One region that exemplifies this perspective is Lower Bavaria and with it comes a place of particular interest to RET: the former Isar 2 nuclear power plant (KKI 2). Since its shutdown in 2023, the site is being dismantled and is to be put to a new purpose towards the end of the next decade (PreussenElektra, 2021a+b).

The expansion of renewable energies is progressing dynamically, particularly in Lower Bavaria, but central infrastructures such as electricity grids and storage systems are lagging. At the same time, the requirements for planning security, social acceptance and the resilient design of transformation areas are increasing (Coenen et al., 2021; Munro, 2021). As a result, the question of how existing infrastructures, particularly decommissioned large power plant sites, can be strategically transferred to a sustainable energy future is becoming increasingly important. The Isar 2 site near Landshut is a prime example of this challenge. As one of the last German nuclear power plant sites in the grid related south, it has a high-quality energy infrastructure. The KKI 2 site is not only relevant in terms of infrastructure, but also has strong social, political and symbolic connotations, both as a symbol of the nuclear phase-out and as a potential beacon project for the energy transition. With its high-performance grid connection, ongoing exnovation and openness in terms of planning law (PreussenElektra, 2021a+b), KKI 2 is a particularly suitable case for analysing how subsequent uses can be designed not only technically, but also in terms of RET and it’s complex and multidimensional challenges (“wicked problems”) (Rittel & Weber, 1973). The question therefore arises as to what role KKI

2 can play in the future energy transition in the grid related south, which lags the north in terms of renewable energy potential.

The repurposing of post-nuclear infrastructures is a strategically important aspect of the energy transition, but one that has so far been under-examined in research. Transformation research has long focussed on innovation. Only more recent approaches such as the Challenge-Oriented Regional Innovation Systems (CORIS) approach have placed regional challenges and their management at the centre (Trippl et al., 2024a+b). This is where the nature of such complex and multidimensional challenges becomes apparent. At its core, CORIS deals with “wicked problems” (see Ritte & Webber, 1973) specifically with orchestrating which innovations should follow exnovation and how different “solutions” should be assessed.

This research paper takes up CORIS and the perspective of “wicked problems” in order to answer the central research question on which this work is based:

"How can the former Isar 2 nuclear power plant be repurposed in regional energy transitions to address territorial challenges?"

This research thus positions itself at the interface of transformation research, regional innovation policy and the debate on exnovation and the repurposing of large industrial sites. Although exnovation processes, such as the shutdown of nuclear power plants, have long been a reality in Germany, there has so far been a lack of systematic studies on the strategic reutilisation of such areas in terms of challenge-oriented regional development. This research therefore makes a twofold contribution: Firstly, the case of KKI 2 introduces a post-nuclear site into the discussion on RET that has hardly been considered to date. Secondly, the CORIS approach is applied to a new type of transformation site that is characterised by legal, political, social, economic and environmental complexity, thus extending it conceptually by applying it for the first time to a highly regulated post-nuclear exnovation site.

Methodologically, the work is based on qualitative expert interviews with key players from politics, administration, the energy industry and research who are directly involved in RET issues. In line with the CORIS approach, the research focuses on two processes in particular: the identification of regional challenges and the evaluation of potential innovation approaches in the context of the repurposing of the site. The results allow an initial assessment of how strategic repurposing ideas could be territorially effective without already mapping a real implementation process.

The thesis is therefore structured as follows: Chapter 2. introduces the theoretical framework of RET and the CORIS approach with the perspective of "wicked problems" at its core. Chapter 3. analyses the regional starting position and the theoretical background. Chapter 4. explains the methodological approach. Chapter 5. presents the results of the expert interviews, which are discussed in Chapter 6. and reflected upon regarding theoretical and practical implications. Based on this theoretical and empirical foundation, the aim of this thesis is to analyse the reutilisation ideas of the KKI 2 site in the context of RET and to work out their potential contribution to solving territorial challenges.

2. Theoretical conceptual perspectives

The regional approach to the energy transition is fundamental. "Regions are not simply passive sites where transitions unfold but are active players in shaping and steering these processes." (Coenen et al., 2021, p. 232). In the following, this importance will be further emphasised and the conceptual perspective of the CORIS approach will be explained. Simultaneously the importance and central position of the perspective of the "wicked problems" make their appearance and will be explained.

2.1 Overview on Regional Energy Transitions

There are numerous measures, policies and innovations around the world to accelerate the transition from resource-intensive energy production to emission-free and sustainable energy. However, while the significance for climate protection, energy security and the economy is being intensively discussed at global and national level, it is at the regional level that implementation is taking place. The regions are not only the venues for this transition, but also key players in the design and realisation of new energy systems (Coenen et al., 2021; Yang et al., 2024).

This chapter will describe how the regional has gained importance in the discussion about the energy transition and define RET. To this end, the development of the energy transition is first analysed historically and perspectives on the RET in Germany are presented.

2.1.1 The growing importance of the regional in the energy transition

The energy transition is a central component of global strategies to combat climate change and reduce greenhouse gas emissions. A key reason for this change is the urgent need to reduce greenhouse gas emissions in order to limit the negative consequences of global warming

(Ishola, 2024). The transition to renewable energy is therefore seen as a crucial step towards reducing emissions, conserving resources and achieving climate targets, such as those set out in the Paris Agreement (Yang et al., 2024).

In addition to environmental aspects, the energy transition also offers significant economic opportunities. It can promote economic growth and create new industries and jobs in the field of renewable energy technologies (Suitner et al., 2023). Regional energy initiatives in particular contribute to local value creation and can have a positive impact on economic development in rural or structurally weak regions (Suitner et al., 2023).

Technological progress is another driver of the energy transition. Innovations in photovoltaics (PV), wind energy and energy storage have made renewable energies increasingly competitive and efficient (Ishola, 2024). Advances in information and communication technologies as well as research and development in the field of renewable energies are also making a significant contribution to accelerating the energy transition (Pata et al., 2024).

In addition, the transition to sustainable energy systems is being driven by social and political pressure. Growing environmental awareness among the population and the influence of environmental movements have established renewable energies as an alternative to nuclear and fossil fuels (Laes et al., 2014). At the same time, political decisions and measures to reduce emissions as well as the expansion of renewable energies play a decisive role in the implementation of the energy transition (Chen et al., 2019).

The concept of the energy transition was formulated as early as the 1980s, when the German Academy of Sciences proposed a model focussing on moving away from fossil fuels and nuclear energy (Yang et al., 2024). This was in response to political and environmental crises, particularly the energy crises of the 1970s. In the following decades, rapid economic growth, which was heavily dependent on fossil fuels such as oil and coal, led to a significant increase in CO_2 emissions. This led to a growing awareness of the negative effects of climate change (Yang et al., 2024). Climate change increasingly developed into a global issue that influenced international politics. A key moment was the signing of the United Nations Framework Convention on Climate Change in 1992, which strengthened the vision of a global energy transition and increased the focus on renewable energy (Yang et al., 2024).

The energy transition describes the long-term, multidimensional and fundamental transformation process through which established socio-technical systems are shifting to more sustainable modes of production and consumption (Coenen et al., 2021). This involves not only technological changes, but also economic, social and political dimensions (Yang et al., 2024).

The aim is to reduce greenhouse gas emissions, increase the share of renewable energy in the energy mix and make the energy supply more sustainable.

Energy transitions are generally motivated by technological advances, economic factors, access to resources and the desire for better energy services (Ishola, 2024). Effective implementation involves not only increasing the share of renewable energy, but also promoting energy efficiency, improving energy access and reducing distribution losses (Pata et al., 2024). In the future, the focus should shift from a purely renewable to a comprehensive sustainable energy transition that takes equal account of economic growth, energy security, energy access and environmental sustainability (Yang et al., 2024).

A particularly illustrative case study is the German energy transition (Behnke & Hegele, 2024). It involves the comprehensive restructuring of the energy supply in the electricity, heating and transport sectors in a highly industrialised country. This far-reaching transformation is a cross-generational task whose fundamental framework conditions must be created today (Gawel et al., 2014). At the same time, the German energy transition highlights the challenges of such transformation processes, in particular the linking of regional industrial developments with overarching energy policy goals (Elshurafa et al., 2019).

Coenen et al. (2021) emphasise that the initial theorisation and empirical research on transitions largely ignored the spatial context of energy transitions. They themselves add a regional component to their definition of energy transitions and react to the steadily growing importance of the regional in the discussion of energy transitions. In the last decade, the volume of research recognising local and regional significance has risen sharply (see also Coutard & Rutherford, 2010; Mattes et al., 2015; Ruggiero et al., 2021; Yu & Gibbs, 2018).

Coenen et al. (2021) propose a framework that brings different approaches to regional energy transitions into dialogue and highlights the complexity of these interdependencies.

2.1.2 Perspectives on Regional Energy Transitions

According to Coenen et al. (2021), three non-exclusive perspectives can be distinguished to understand the influence of regions on the energy transition: Energy transitions in regions, energy transitions of regions and energy transitions by regions. This makes it possible to structure the diversity in the literature on regional energy transitions and understand their significance. Coenen et al. (2021) take inspiration from Hölscher & Frantzeskaki (2021), who distinguish three perspectives on urban transformations in, of and by cities. All approaches ask similar questions that address the foundations of regional energy transitions and their significance and implementation in space. These questions also seem useful for this thesis chapter in order to emphasise the importance of the regional in the energy transition.

The approach of energy transitions in regions focuses on how regions contextualise energy transitions. It analyses place-specific factors, processes and mechanisms that enable or hinder energy transitions. Regional industrial capabilities, institutions, political portfolios and resource endowments can be listed as decisive factors. However, market configurations, socio-economic conditions, networks and materiality are also cited as influencing factors. Regional cultures and consumption patterns that link negative expectations to the energy transition and limit the room for manoeuvre for political decision-makers and future expectations about the impact of the energy transition on regions that can influence current transition processes play a role (Coenen et al., 2021; Joshi & Agrawal, 2021). Esiri et al. (2024) also emphasise the role of regional resources in supporting the energy transition. Regions can effectively utilise their renewable energy potential, human capital and technological infrastructure to address specific regional energy challenges. This approach by Coenen et al. (2021) aims to add spatial sensitivity to non-spatial frameworks in energy transition research.

The energy transitions of regions approach assess the outcomes and impacts of energy transitions on regions. This includes the functions of regional supply systems, such as energy, transport, housing or food, and the effects on sector structure, employment, industrial structure and regional innovation systems (Coenen et al., 2021). The impact area of regions is important to consider. This approach addresses the potential positive and negative impacts of regional energy transitions that transcend regional boundaries and considers the importance of just transitions and other social scales (Coenen et al., 2021; Munro, 2021).

The approach of energy transitions by regions focuses on the agentic characteristics of regions in the governance of energy transitions. Regions are conceptualised as "agents of change" through their political powers and administrative capabilities (Coenen et al., 2021, p. 222). This requires the positioning of the region in a multi-level governance structure to describe the vertical and horizontal distribution of influence. Local energy supply companies usually position themselves as actors of this influence. Thus, the region can suffer a depoliticised form of governance, where technocratic governance determines development (Coenen et al., 2021; Juwet & Deruytter, 2021). The regional alignment between entrepreneurial activities and regional leadership can facilitate the energy transition but also harbours risks. Various papers address this entrepreneurial regional influence across borders and criticise the resulting imbalance in participation in the energy transition (Huang & Yu, 2021; Munro, 2021; Patchell & Hayter, 2021). However, the importance of policy frameworks and governance as well as cooperation between public, private and community actors can support the energy transition (Esiri et al., 2024).

To summarise, regions influence the energy transition in many ways. They provide the context in which energy transitions take place, are the place where the impacts are felt and can act as active shapers and drivers of change. In particular, it should be recognised that regional, national and global levels of the energy transition are closely interwoven (Chlebna & Mattes, 2024). The three perspectives are crucial for understanding RET. As Coenen et al. (2021) emphasise, it is important to understand the reciprocal relationships between regions and energy transitions: "interdependencies between 'regions shaping energy transitions' and 'energy transitions shaping regions'" (Coenen et al., 2021, p. 227).

The three perspectives emphasise the importance of the regional in the energy transition and at the same time highlight its complexity. This makes it more difficult to generalise statements about the importance of regional energy transitions. Although there is widespread agreement that localisation plays a decisive role in energy transitions, the relevant literature has so far provided little generalisable knowledge about the extent to which precisely this localisation influences successful change (Hansen and Coenen, 2015).

2.2 Introduction of the conceptual framework of CORIS

Tackling major societal challenges such as climate change and the energy transition or social and economic transformations require new approaches in regional innovation processes. While traditional Regional Innovation Systems (RIS) are primarily focussed on economic growth and technological development, CORIS aims to design targeted innovation processes to solve ecological and energy-related or social and economic problems.

This chapter analyses the theoretical development from RIS to CORIS, highlights the main differences and shows the necessity of the approach. It also analyses how CORIS is applied in practice, particularly in the regional energy transition, and the role of exnovation, innovation and repurposing as an initiative of the CORIS approach in this context.

2.2.1 From RIS to CORIS

Traditional research on RIS has primarily focussed on economic growth and the promotion of technological innovation. However, it is becoming increasingly apparent that such a focus is not sufficient to tackle major societal challenges such as climate change and the energy transition or social and economic transformations (Coenen & Morgan, 2020; Tödtling et al., 2022). Over time, more voices from academia have been raised to take research on regional studies and related fields further, beyond the dominant focus on "innovative growth models [that are] often divorced from the broader social and ecological context" (Donald & Gray, 2019, p. 297). They also argue in favour of a more progressive regional development agenda. One that focuses less on short-term economic growth and instead emphasises the importance of environmental and social sustainability (Evenhuis, 2017; Jeannerat & Crevosier, 2022; MacKinnon et al., 2022; Morgan, 2019). Against this backdrop, the CORIS approach was developed, which takes a broader perspective and focuses innovation systems more strongly on regional challenges (Trippl et al., 2024c).

A Regional Innovation System (RIS) refers to a network of companies, research institutions, political actors and intermediary organisations that exists in a region and increases innovation capacity through interaction and knowledge flows. This model was originally developed to explain and promote regional economic development (Tödtling et al., 2021). The concept of RIS emphasises that the innovative capacity of regions is shaped by the interactions between three elements: Actors, networks and institutions (Trippl et al., 2024d). Interactive learning between companies, research institutions and political actors is particularly important in this context, known as the triple helix (Asheim et al., 2019; Cooke et al., 1997; Tödtling & Trippl, 2005). RIS research has shown that regions vary greatly in terms of their RIS elements and their internal and external networking. In recent years, the RIS concept has been increasingly linked to the long-term economic restructuring of regions. The focus here is on industrial specialisation, institutional support and regional networks that enable new industrial developments or renew existing sectors (Isaksen & Trippl, 2016a+b).

CORIS expands the classic RIS concept by shifting the focus from purely economic goals and competitiveness to addressing territorial sustainability problems (Trippl et al., 2024a+b+d).

CORIS can be understood as those parts of RIS that have a challenge orientation (Tödtling et al., 2021). They demonstrate the ability of regions to tackle different and partly interconnected regional problems by developing challenge-orientated initiatives (Trippl et al., 2024d).

The need for the CORIS approach arises from the increasingly complex challenges that regions are facing. The inadequate management of pressing societal challenges requires an approach that expands the narrow focus on economic growth and places a focus on the multiple crises in order to effectively address these challenges (Tödtling et al., 2022; Trippl et al., 2024a+b+d).

The aforementioned expansion of the CORIS approach's understanding of innovation is also necessary. By recognising the role of diverse forms of innovation, social, user-related and institutional innovations in various areas of society as well as application innovations are considered in addition to technological innovations in the corporate sector (Tödtling et al., 2022; Trippl et al., 2024a+b). The negative effects of innovations are also considered (Coad et al. 2021; Soete, 2013).

Traditional RIS approaches often focus on the aforementioned triple helix, consisting of companies, research institutions and government agencies (Asheim et al., 2019; Cooke et al., 1997; Tödtling & Trippl, 2005). There is a need to bring in a broader range of actors that can play a crucial role in developing and applying innovative solutions to territorial challenges. These non-conventional actors include civil society groups, public actors, users and citizens. Established actors, such as policymakers or universities, can take on a new role and new actors can initiate challenge-orientated activities. The motivations for getting involved in the transformation process can be very different (Tödtling et al., 2022; Trippl, 2023; Trippl et al., 2024c). Hekkert et al. (2020) list motivations from expected economic gains (firms) to willingness to solve their own needs (users), and civic engagement to a normative stance regarding the challenge (NGOs).

Another necessity for the CORIS approach next to innovation is the consideration of exnovation and structural change. The need for an exit from unsustainable industries, technologies and practices is explicitly addressed in the CORIS approach. Exnovation is defined as the destabilisation of environmentally and socially damaging technologies and practices (David, 2017; Trippl, 2023; Trippl et al., 2023; Wesseling & Meijerhof, 2023). This is particularly important for regions that are characterised by old industries and need to undergo a structural change towards more sustainable economic practices (Baumgartinger_Seiringer et al., 2024).

The pressing challenges facing society, the economy and sustainability are unevenly distributed across the region. How global crises manifest themselves in space depends on the geographical contexts. The energy transition, for example, presents emission-intensive regions with different transition challenges than sparsely populated regions. Depending on their specific impact and capacity for innovation, regions can become central areas of experimentation and learning centres for transformative processes. They play a key role in overcoming global challenges, especially if successful approaches can be transferred beyond the region of origin and adapted to different regional contexts. Furthermore, the regional level is essential for the concrete implementation of political measures. This is not only due to the expertise available in areas such as transport, urban planning or housing, but also because the effects of overarching, centrally controlled strategies, as are often found in mission-oriented policy approaches, manifest themselves differently depending on regional circumstances (Uyarra et al., 2023). CORIS enables a regional view of development that focuses on the specific problems, needs and resources of a region (Trippl et al., 2024a+b+c).

Another necessity for the CORIS approach is the focus on overcoming pressing social challenges. Due to regional differences, historically evolved RIS must be reconfigured (Isaksen et al., 2022). Such a realignment is considered essential because the organisational and institutional support structures of a region, its research priorities, skills base and dominant policy approaches and practices are usually strongly linked to the economic and industrial structures of the past (Trippl et al., 2020). This means that historically evolved RIS are often inadequately geared to tackle territorial challenges, as they rarely have the necessary resources and capacities for challenge-orientated solutions (Markard et al., 2021; Trippl et al., 2024c).

CORIS responds to the increasingly complex challenges and impacts of multiple crises, such as climate change or pandemics (Tödtling et al., 2022; Trippl et al., 2024a+b+d). In view of these increasing shocks, there is a need for regions not only to react to crises and recover, but also to achieve regional resilience. This refers to the capacity of a region to "transit to a new sustainable path characterised by a more productive and equitable use of its physical, human and environmental resources" in response to sudden shocks and acute crises (Martin & Sunley, 2020, p. 15). CORIS supports this development by aiming to strengthen regional capacities to overcome challenges (Tödtling et al., 2022).

Ultimately, it can be said that the CORIS approach represents a necessary and consistent further development of the classic RIS concept in order to orientate regional innovation processes specifically towards overcoming social and environmental challenges. While RIS is traditionally focussed on economic growth and technological progress, CORIS expands this framework by focusing on sustainability goals, expanding the understanding of innovation, integrating new and previously neglected stakeholders, taking exnovation into account, regional context sensitivity, the framework for reconfiguration and supporting transformative resilience. CORIS thus offers not only a theoretical but also a practical orientation framework for shaping sustainable regional development.

2.2.2 Core processes of the CORIS approach

Now that the CORIS approach has been introduced and its necessity clarified, CORIS will be described as a practical orientation framework. Trippl et al. (2024a+b) identify four central processes that are essential for CORIS:

1. Identification of challenges and resources: This first process step involves the joint identification of territorial sustainability challenges with other stakeholders, the delineation of problem causes and the selection of the most important regional needs or problems. This involves exploring how the region's resource base needs to be modified to accelerate innovation-based territorial transformations
2. Development, application and diffusion of innovation: This process comprises the development, testing and implementation of innovative solutions to overcome identified challenges. This also includes the scaling of these approaches within the region and their transfer to other regions with comparable problems. The term "solutions" is interpreted broadly and includes technological, social and institutional innovations as well as their synergetic combination.
3. Delocking and exnovation: A central aspect of the CORIS approach is not only the search for and support of socially desirable innovations, but also the exit from unsustainable industries or those that can be categorised as exnovation. In addition to industries, this also includes technologies, institutions, networks and practices (Heyen et al. 2017). Managing the process of exnovation is of fundamental importance if the transformation of the regional system is to be 'just' (Heffron, 2021; Heyen et al., 2017; Newell & Mulvaney, 2013). In such processes, there is a risk that stakeholder groups with established interests and strong anchoring in the status quo will hinder change processes or actively work against transformation initiatives (Baumgartinger-Seiringer, 2022). The process of exnovation in favour of environmentally friendly solutions and "green" economic activities (Trippl et al., 2020) can open new opportunities. The targeted promotion of this transformation potential is becoming a central task of regional innovation and economic policy.
4. Orchestration: The three core processes mentioned above require the coordination of different stakeholder groups, which often have different motivations and abilities to help shape innovation-based territorial transformations. As already described, the involvement of new actors can lead to conflicts of interest and have negative consequences for transformation processes because of innovations (Coad et al., 2021). However, orchestration offers the opportunity to better anticipate these conflicts of interest and negative consequences and to use social conflicts for creative and constructive processes. Benner (2020) looks at the practice of regional innovation and economic policy and concludes that networking (e.g. cluster initiatives) and participatory policy development processes (e.g. smart specialisation) can be used to

develop shared visions, moderate conflicts of interest and combat negative consequences. Mastering policy coordination processes is also part of orchestration. This concerns both cooperation at the horizontal level of regional innovation and economic policy with departments responsible for labour market policy, environmental policy or spatial planning, for example, as well as vertical coordination with the national and supranational policy level (Pontikakis et al., 2022).

At this point, it is also important to ask at which administrative level the CORIS approach can usefully serve as an orientation for regional innovation and economic policy. Because this depends on capacities, powers and competences at different political levels, the question cannot be answered directly (Trippl et al., 2024a+b). If the answer to the question of the administrative level depends on the identification of the specific problem or solution strategy, the subsidiarity principle seems logical. For example, Wanzenböck & Frenken (2020) argue that social challenges should (primarily) be addressed by the administrative level that is most likely to be affected.

2.3 Linking "wicked problems" and CORIS as a conceptual framework

In the centre of the CORIS stand the challenges of a region. Due to their multidimensional and complex nature, solutions to such challenges cannot be clearly identified and must be further differentiated and discussed. The perspective of "wicked problems" by Rittel & Webber (1973) is particularly relevant to the problem statement of this research and is closely related to the CORIS approach. The concept of "wicked problems" will be discussed in more detail below, as it is extremely advantageous for making the empirical approach of this research coherent and for orchestrating which innovations come after exnovation. Finally, it supports the research of how "solutions", as described in chapter 2.2.2, are to be evaluated.

The challenges in the repurposing of the former Isar 2 nuclear power plant can be described as so-called "wicked problems" and "tame problems" in the sense of Rittel & Webber (1973). "Wicked problems" are characterised by the fact that they cannot be clearly defined, cannot be completely solved and are highly context- and interest-driven. Solutions are not objectively right or wrong, but are always associated with consequences, judgements and compromises. "Tame problems" are usually technically describable, workable with specialised knowledge and (theoretically) conclusively solvable (Rittel & Webber, 1973). In the case of this research, all regional challenges can be categorised as “wicked problems”, even if some challenges are technically describable, workable with specialist knowledge and (theoretically) conclusive. Overall, all challenges are dependent on perspectives and interests, politically and socially charged and multidimensional. Depending on their subsequent use, some challenges are solution-orientated, and others are too complex and therefore “wicked”. Even seemingly technical challenges are part of a larger, complex and conflict-laden problem system and should therefore be viewed as “wicked problems” in a broader sense. The solutions to “wicked problems”, once implemented, "will generate waves of consequences over an extend" (Rittel & Webber, 1973, p. 15). With “tame problems”, on the other hand, "one can determine on the spot how good a solution-attempt has been" (Rittel & Webber, 1973, p. 15).

It becomes clear that the concept of wicked problems in the case study of the reuse of KKI2 is inevitably linked to the CORIS approach and the case of RET. This view can be further substantiated by considering other related approaches to transformative (regional) innovation systems and policies. These approaches deal intensively with “wicked problems” (see Benner, 2025; Flanagan et al., 2023; Hekkert et al., 2020). In the case of this research work, it is very well illustrated how the “wicked problems” of different, highly complex options can be dealt with at the interface of innovation and exnovation in regional transitions, thus the CORIS perspective.

3. Context

In this chapter, the topic of the reutilisation of the former nuclear power plant in Lower Bavaria will be further contextualised. The basis for this is provided by relevant literature, which was primarily provided by stakeholders that are relevant for the topic, such as the KKI 2 owner and operator PreussenElektra or various ministries. The Bavarian State Government's Energy-Atlas[1] also plays an important role, providing an interactive map that can significantly support the topic of this work on RET with differentiated data.

Firstly, the area of the KKI 2 site and the region, on which the repurposing of the site has an impact, are geographically classified and further described in the chapter. An important part of the region are the stakeholders who are affected by the repurposing of the site. However, these will be presented alongside the territorial challenges in chapter 5., in order to avoid duplication in this work. In this chapter, the history of the nuclear phase-out as a fundamental part of the energy transition in Germany will be described and finally the Isar 2 nuclear power

[1] Germ.: Energie-Atlas

plant will be discussed in more detail. The history of KKI 2 and the official plans for dismantling, together with the official plans for utilisation during dismantling, form a frame for understanding the starting point for the ideas for a repurposing.

3.1 Literature-based background on the region

KKI 2 is located on the left bank of the Isar at river kilometre 61 west of the Niederaichbach barrage in the district of Ohu on the territory of the market town of Essenbach, which belongs to the district of Landshut in the administrative district of Lower Bavaria (EON, 2003; EON, 2011; Google, 2025; StMUV, 2024).

The area of the site within the demonstration fence (operating site) is 893,645 m^2 (excluding the spent nuclear fuel storage facility (BZI)) (PreussenElektra, 2021b). In general, it should be noted for this chapter that all relevant information for contextualisation is addressed, although the most important points are discussed in more detail in later chapters. A further formulation of the buildings and facilities follows, for example, in chapter 3.3. There are also accessible infrastructure areas on the site, such as power grids, transport links and natural resources, which can be used or processed for sustainable subsequent use. This category applies in particular to the region, for the sole reason that infrastructure areas extend beyond the boundaries of the KKI 2 site. The question of which buildings, facilities or infrastructure areas will remain after the dismantling of KKI 2, and potential reutilisation will also be discussed in later chapters.

The official PreussenElektra paper uses a 10 km radius in its definitions of the geographical regulation of the region. Within this area, the effects of reutilisation are directly noticeable, as economic, social and ecological changes during subsequent use can have an impact on the local population, infrastructure and local institutions (PreussenElektra, 2021b). However, a radius of 10 kilometres around KKI 2 is also selected as the area of investigation for the protected resource of humans, in particular human health. The unfavourable point for emissions of radioactive substances is also located within this area (PreussenElektra, 2021a). The requirements of the Bavarian State Ministry of the Environment and Consumer Protection and Environmental Resources Management can thus be met by ensuring that all impacts relevant to the assessment are reliably recorded with this delimitation (Becker & Mraz, 2021).

The affected region includes various municipalities in the vicinity of the KKI 2 site. It is important to list these because they could experience new economic impetus, infrastructure developments and social changes because of repurposing. Table 1 provides an overview of all municipalities that are wholly or partially within a 10 km radius (as of 31 December 2019). It is not necessary to differentiate this further because the impact a reutilisation could have on the region would not stop sharply at the 10 km limit.

Municipality	Direction	Distance from KKI 2 in km	Total population
Bayerbach near Ergoldsbach	N	11,0	1.929
Postau	NNE	5,4	1.629
Weng	NNE	8,2	1.443
Ergoldsbach	NNW	11,6	10.050
Niederaichbach	E	1,7	4.008
Niederviehbach	E	6,3	2.642
Loiching	E	10,3	3.606
Wörth a. d. Isar	ENE	3,9	3.030
Kröning	SSE	7,8	2.059
Adlkofen	SSW	7,3	4.407
Essenbach	WSW	5,5	11.999
Ergolding	WSW	10,6	12.720
Landshut	WSW	13,0	73.411
Total			132.933

Table 1: Municipalities within or partially within a 10 km radius of the KKI 2 site (as of 31 December 2019) (Source: adapted and expanded from PreussenElektra (2021b), p. 27, own translation).

When defining the region, it is important to mention economic and industrial infrastructure because it can be revitalised or further developed as part of the subsequent use. Kieselhorst (2017) mentions that nuclear power plants are often sited in rural areas at a distance from human agglomerations, suggesting that industrial infrastructure may not be the most defining feature of the immediate surroundings. In the case of KKI 2 and the region within a 10 km radius, this is partly true. For example, there are companies from various sectors in and around Essenbach and especially in Landshut (PreussenElektra, 2021a). However, the primary economic focus is on agriculture and forestry. A more differentiated look shows that in and around Essenbach and especially in Landshut there are companies in the electrical, metal, and mechanical engineering, food and beverage, communications/data processing and wood and textile processing sectors (PreussenElektra, 2021a).

In addition to these sectors, transport routes and the energy infrastructure are important parts of the economic and industrial infrastructure. The A92 federal motorway runs approximately 1 km north of the KKI 2 site, as do several federal, state and district roads. There is also a connection from KKI 2 to the state road 2074 (formerly B11) between Wörth and Landshut (Google, 2025; PreussenElektra, 2021b). The railway infrastructure is also quite well developed with two railway lines running through the 10 km radius. These include the Landshut-Plattling line, which passes KKI 2 at approx. 700 metres and offers a siding to the plant site. The Munich-Landshut-Regensburg line runs to the west at approx. 8 km. The nearest railway station is Wörth a. d. Isar at approx. 3 km to the north-east and the nearest railway station with shunting operations is in Landshut (Google, 2025; PreussenElektra, 2021b). The river Isar is not navigable and therefore there are no waterways within a 10 km radius. As there are no plans to make the river navigable, waterways will not be the subject of this research when considering the repurposing of KKI 2. There are no civil or military airfields within a 10 km radius and the airport near Munich is only about 46 km away (PreussenElektra, 2021b). Just like waterways, airways are not relevant to this work and can therefore be ignored.

The energy infrastructure is fundamental to this research and is particularly well developed in the 10 km radius around KKI 2 and is illustrated in Figure 2 in electricity, gas and other lines. A complex network of energy infrastructure runs through the 10 km area. In general, it can be said that the region around the KKI 2 site is well developed in terms of energy, particularly regarding the electricity infrastructure. KKI 2 has three grid connections. The main grid connection (400 kV), the reserve grid connection (110 kV) and a third underground grid connection (20 kV) are operated by the transmission system operator TenneT TSO GmbH, which is responsible for the extra-high voltage grid in the Bavarian region (Becker & Mraz, 2021). In addition to TenneT TSO GmbH, 50Hertz Transmission GmbH, Amprion GmbH and TransnetBW GmbH are the largest transmission system operators in Germany (Bundesnetzagentur, 2020). A gas pipeline runs roughly parallel to the A92 federal motorway and is located approx. 1 km north of the KKI 2 site (PreussenElektra, 2021a). About 5 km west of KKI 2, another pipeline branches off from the gas pipeline and then runs northwards (PreussenElektra, 2021a). The operator of this gas pipeline is Bayernets (Bayernets, 2025). In addition to the electricity and gas network, there is also a petrochemical pipeline about 15 km away to the south-west (PreussenElektra, 2021a+b). It is recommended that the Energie-Atlas

(2025) itself be accessed online in order to provide a concrete visualisation of the energy infrastructure.

In addition to the economic aspects in the region, the social aspects are just as important. In this section, we will briefly outline the key facts. Lower Bavaria has a population of 1.25 million, which currently accounts for around 10% of Bavaria's population. The demographic trends vary from region to region. For the district of Landshut, an increase of 11.8% is expected by 2040 and the average age of people in Lower Bavaria is expected to rise from 44.4 years (2025) to 46.4 years (2040). In 2043, there will be 44 people aged 65 and over for every 100 people of potentially working age. In 2023, this ratio was around 35 to 100 people. If the increase in the retirement age is considered, there will be around 39 people of working age aged 67 and over for every 100 people of working age in 2043 (BLS, 2025; Regierung von Niederbayern, 2025). However, the employment figures also show a positive trend and that commuting across municipal boundaries is not uncommon in the region (BLS, 2024; Regierung von Niederbayern, 2025), which runs counter to an ageing population and the issue of a functioning pension system, for example.

Economic and social developments and backgrounds of the region are considered in regional planning and in projects such as the subject of this research. Plans and programmes that are likely to have a significant environmental impact must be subject to an environmental assessment in accordance with the ER Directive 2001/42/EC of the European Parliament and the Bavarian State Planning Act (BayLplG) (RPL, 2018+2025). The next paragraph will therefore focus on the environmental aspects in the region and raise them to the level of stakeholders.

The idea of considering nature as a stakeholder is an innovative approach and relates to the growing concept in the discourse around sustainability that recognises nature as a distinct entity that has rights, or at least interests, that should be considered in decision-making processes. Boyd (2017) supports this concept and forms the basis for recognising nature as an equal stakeholder. There are several nature and water conservation areas and a bird sanctuary within a 10 km radius of KKI 2 (PreussenElektra, 2021a+b). There are also five Natura 2000 sites in the region. There are also two nature conservation areas, various biotopes, landscape conservation areas, natural monuments and a protected landscape feature as well as national parks, national nature monuments, biosphere reserves and nature parks (PreussenElektra, 2021a, p. 9). It is recommended that the Energie-Atlas (2025) itself be accessed online in order to provide a concrete visualisation of the protected areas and priority/reserved areas.

The region of the 10 km area around the KKI 2 site is the primary area, as it represents the direct economic, social and economic impacts of repurposing. However, the impact of subsequent use will also extend beyond this radius, as the changes associated with subsequent use are of a regional nature and therefore potentially have a greater impact on neighbouring areas. In some cases, the impact region should therefore be considered beyond the 10 km area, for example to capture regional policies, political strategies or governance processes or more distant affected stakeholders on a broader level. This extension can nevertheless be limited. For example, KKI 2 has a marginal impact on Austria and, consequently, repurposing is likely to have little effect. The nearest Austrian border is approx. 60 km away (PreussenElektra, 2021b).

This means that the nearest cities with a population of more than 100,000 are particularly relevant. As commuter areas and especially in the context of RET, large cities are particularly affected. In addition to Landshut, the nearest cities affected are Regensburg (to the north, approx. 47 km away), Ingolstadt (to the west, approx. 64 km away) and Munich (to the south-west, approx. 75 km away) (Google, 2025; PreussenElektra, 2021b).

It should be noted that the exact definition of the area and the region depends on the planned project objectives, the legal framework and the ecological aspects of the repurposing, which will be examined in detail in the further course of the research for this thesis. The region on which the after-use of KKI 2 has an impact is now defined both geographically and economically, socially and ecologically. It is characterised not only by its physical proximity to KKI 2, but also by the interactions and synergies that subsequent use could generate in the various areas of the economy, society and the environment.

In summary, it can be said that the 10 km radius around KKI 2 has a mixed economic structure characterised by agriculture and forestry, various commercial and industrial sectors and a well-developed transport and energy infrastructure. The proximity to the greater Munich, Landshut and Regensburg areas and the good transport connections play an important role for activities in the region and its future development. Nature plays a role as a stakeholder and is considered by regional planning.

3.2. Nuclear power phase-out

Germany's nuclear phase-out was decided three days after the nuclear disaster in Fukushima and is an elementary component of the German energy transition (Kunz & Weigt, 2014). The last nuclear power plants were shut down in April 2023, shifting energy generation to other sources. As a pioneer, Germany has phased out nuclear energy and, in line with the idea of climate neutrality, wants to obtain energy only from renewable sources in the long term. By 2045, greenhouse gas emissions are to be reduced by 65% compared to 1990 levels and net zero emissions are to be achieved (Pata et al., 2024). This goal of climate neutrality is anchored in the German climate protection plan, the most important component of which is the implementation of the energy transition (Pata et al., 2024). In the first quarter of 2025, 119.4 billion kWh of electricity were produced in Germany (Destatis, 2025a). Not only was less energy generated than in the same quarter of the previous year, but more electricity was generated from fossil fuels (Destatis, 2025a). In the first quarter of 2024, the share of fossil energy generation was 41.5% and now stands at 50.5% (Destatis, 2025a). For the first time since the first quarter of 2023, the share of electricity generation from conventional energy sources is higher than that from renewable energies (Destatis, 2025a). In order to meet the defined climate targets, renewables must be expanded to increase the 57.1% of electricity generation from renewable energy sources in 2024 (BMWK, 2024) to 80% by 2030 (UBA, 2023).

As of 2024, the primary sources of renewable energy in Germany are onshore wind (22.7% of renewable energy), PV (14.9% of renewable energy), biomass (9.8% of renewable energy), offshore wind (5.2% of renewable energy) and hydropower (4.5% of renewable energy) (BMWK, 2024). In order to achieve the German target of 215 GW of PV capacity by 2030, the grid related south of Germany, which has less potential for wind energy than the north, must perform particularly well. The Energie-Atlas (2025) for Bavaria provides very specific insights into the generation of renewable energies and their consumption. In total, around 42 billion kWh of electricity were produced from renewable energies in Bavaria in 2023, which is more than two thirds of the total electricity produced in Bavaria (Energie-Atlas, 2025). Of this, around 38% is PV, 28% hydropower, 20% biomass and 14% wind energy (Energie-Atlas, 2025). The expansion of renewable energies in Bavaria is essential to achieve the planned goal of climate neutrality by 2040 (FfE, 2024). And in the east, i.e. Lower Bavaria, PV are being used more intensively than ever before. Here, the lower wind potential and the associated high costs of wind generation are leading to a lower expansion of wind turbines (FfE, 2024). Electricity generation from solar energy in particular is being expanded. The FfE (2024) forecasts that 147 TWh of renewable electricity will be generated in Bavaria, 100 TWh of which will be realised through PV (FfE, 2024, p. 121, figures 8-10). The exact electricity generation and consumption per administrative district, municipality, administrative district, etc. can be determined in detail using the Energie-Atlas of Bavaria. In the municipality of Essenbach, for example, where KKI 2 is located, 70.4% are produced with hydropower, 24%

with solar and 5.5% from biomass as of 2023 (Energie-Atlas, 2025). In order not to go beyond the scope of this paper, no deepening will follow. However, I recommend visiting the digital Energie-Atlas of Bavaria, which provides very detailed information on availability, potential, projects, etc. relating to the energy transition. Overall, a lot of renewable energy is happening and being developed in the region. Nationwide decisions are being implemented through state and regional planning, thus driving forward the energy transition. In Germany, nuclear power can be considered an exnovation and is no longer part of the German energy strategy (Jungjohann, 2020). The focus is on projecting renewable energies. Because the exnovation does not simply disappear, it is necessary to clarify what happens to former nuclear energy infrastructure within the RET. This is precisely where the research in this master's thesis comes in and the next step is to take a closer look at the KKI 2.

3.3 KKI 2 site

In this chapter, the specific location of KKI 2 and KKI 2 as part of the nuclear phase-out itself will be discussed in more detail. The Isar 1 nuclear power plant is also located on the KKI 2 site. After the Fukushima accident, KKI 1 was finally shut down and has been dismantled since 2017 (Becker & Mraz, 2021; PreussenElektra, 2019). Both reactors are legally, technically and planning-wise independent plants and can be considered separately from each other (PreussenElektra, 2019). In contrast to this, the current public, economic and political discussion on the repurposing of the plant for energy purposes relates to the Isar 2 site.

KKI 2 went into commercial operation in 1988 as a pressurised water reactor from the manufacturer KWU of the Konvoi design (Becker & Mraz, 2021; StMUV, 2024). The operator PreussenElektra GmbH owns 75% of the nuclear power plant and Stadtwerke München GmbH 25% (Becker, 2022; PreussenElektra, 2021a+b). The gross electrical output was 1,485 MW and the net output was 1,410 MW (PreussenElektra, 2021b). Overall, KKI 2 was the world champion ten times in terms of annual electricity generation of all 430 nuclear power plants worldwide, including six years in a row until 2004 (PreussenElektra, 2021a). By June 2011, the Isar 2 nuclear power plant had generated around 265 billion kWh of electrical energy (EON, 2011) and by September 2018 it was the third nuclear power plant worldwide (the two more powerful nuclear power plants were also German) to generate 350 billion kWh of electricity (PreussenElektra, 2019). A total of 400 billion kWh of electricity was produced by KKI 2 (StMUV, 2024). In 2017, it therefore contributed around 12% to covering Bavaria's electricity demand and thus compensated for the fluctuating feed-in of renewable energies to stabilise the grid (PreussenElektra, 2019). Together with the last two nuclear power plants in Germany, KKI 2 produced 34.7 TWh in 2022, which corresponded to six percent of gross electricity generation. In 2023, this figure had already fallen to 7.2 TWh and 1.4% of gross electricity generation (Destatis, 2025b). In total, PreussenElektra invested over 300 million euros in modernising and optimising the safety of the nuclear power plant in order to bring it up to the current state of science and technology (PreussenElektra, 2019). National and international inspections have repeatedly confirmed the very high safety level of KKI 2 worldwide (PreussenElektra, 2019).

In accordance with the 13th amendment to the Atomic Energy Act, the authorisation for power operation expired on 31 December 2022 (PreussenElektra, 2021a) and power operation was discontinued on 15 April 2023 at 23:52 after an extension (StMUV, 2024; Wimmers et al., 2023). The nuclear power plant will be dismantled in several phases and is expected to take 14 years until it is released from nuclear supervision, with completion in 2037 (Becker & Mraz, 2021; PreussenElektra, 2021a). Most of the total mass (782,500 tonnes) are buildings and non-nuclear systems. Less than 1% of the total mass must be disposed of as radioactive waste (PreussenElektra, 2021b). Overall, it can be said that approx. 3,200 tonnes of waste can be expected to be disposed of for a pressurised water reactor (Thierfeld & Schartmann, 2009).

The dismantling of KKI 2 can be divided into three phases. Firstly, the decommissioning and dismantling of the nuclear power plant will be prepared in the post-operational phase (PreussenElektra, 2019). Here, the nuclear fuel elements still in the plant are transported to the BZI (PreussenElektra, 2021a). Actual dismantling begins one year after shutdown (PreussenElektra, 2021b). In dismantling phase 1, higher radioactively contaminated plant components are dismantled as early as possible, such as the reactor pressure vessel internals, the decontamination of the primary circuit and the dismantling of pressurised storage tanks, ventilation and wastewater treatment plants and cable routes (PreussenElektra, 2021b). The second dismantling phase does not begin until all fuel assemblies and special fuel rods have been removed from the plant. The reactor vessel and the biological shield are dismantled here, which overlaps with dismantling phase 1 (Becker & Mraz, 2021; PreussenElektra, 2021b; StMUV, 2024). The official documents relating to dismantling go into further detail on dismantling techniques and methods as well as material and waste management, which will not be discussed further in this paper.

Of far greater importance are the interim uses of KKI 2 while the dismantling work is being carried out. Buffer storage areas will be set up inside and outside the controlled area to temporarily store dismantled materials, prepare them for further transport or create batches for external treatment (PreussenElektra, 2021a+b; StMUV, 2024). In addition, a residual material treatment centre (RBZ) will be set up for KKI 2 in existing controlled area buildings in order to handle facilities and equipment for processing radioactive residual materials and waste in a targeted manner (PreussenElektra, 2021b). Existing facilities in the plant and on site will continue to be used as far as they are suitable. The BZI has been in operation since 2007 and is licensed until 2047 (Becker & Mraz, 2021). As an interim storage facility for spent fuel elements, it remains to be seen what will happen to the nuclear waste after the end of operation. The repository is planned for low- and intermediate-level radioactive waste, which represents 95% of the waste volume in Germany (PreussenElektra, 2019). The German government assumes that a repository for highly radioactive, heat-generating waste will be available in 2030 (Präger, 2025). In March 2025, seven Castor containers with German nuclear waste were transported from England to KKI 2 (GNS, 2025). Until 2005, it was common practice for some of the spent fuel elements in German nuclear power plants to be transported to corresponding facilities in England and France for reprocessing. However, the nuclear power plant operators were contractually obliged to take back the waste from the reprocessing of their fuel elements abroad (GNS, 2025).

How much and what will be left at the site at the end of the dismantling work has not yet been decided. The "greenfield"[2] option was realised at the Niederaichbach nuclear power plant, which was the first European nuclear power plant to be completely dismantled between 1987 and 1995 and was located on the KKI 2 site (Brandt & Dame, 2019; Thierfeldt & Schartmann, 2009). As a synonym for the unrestricted subsequent use of the site in accordance with general building law, this is the strategy generally pursued by politics and industry, as has been proven several times in the past (Brandt & Dame, 2019). The "greenfield" strategy excludes buildings that store radioactive waste, such as the BZI (PreussenElektra, 2019). After release from nuclear monitoring, the buildings and site that are no longer contaminated can be demolished or put to a new use in accordance with general building law (PreussenElektra, 2021b). This also fits in with the KKI 2 case study, whereby the utilisation of the site is already being changed by certain interim uses. For example, a battery storage project with a capacity of 50 MW and 100 MW storage capacity is already being realised in the first expansion stage (Pichlmaier, 2024). A lot can still change until the dismantling work is completed. In conclusion, however, the "greenfield" strategy for complete decommissioning as the primary goal in Germany regarding KKI 2 can be understood to mean that everything will be

[2] Germ.: Grüne-Wiese

demolished except for radioactive waste storage facilities and potentially reusable buildings (PreussenElektra, 2019).

For decommissioning and dismantling and repurposing, several legal principles must be observed, which should be mentioned briefly. Firstly, the Atomic Energy Act (AtG), which regulates the decommissioning and dismantling of nuclear power plants in a binding manner. It obliges the operator PreussenElektra to dismantle the plant immediately and stipulates that repurposing is only possible once dismantling has been completed and the site has been cleared. Decommissioning therefore takes legal priority over any other use as stated in the AtG §7 and AtVfV. As a basis for land use and development plans, the Federal Building Code (BauGB) stipulates that subsequent use must be compatible with the intended structural purpose (e.g. special energy area). In addition, the subsequent use must be in line with regional planning objectives (e.g. energy priority area, grid infrastructure) (RPL, 2025). The Bavarian State Development Programme (LEP) is also important, as it defines the basic principles of spatial development and organisation, provides guidelines for spatial development for regional planning and coordinates spatially relevant sectoral planning. In addition, the energy policy strategies of the Free State of Bavaria, such as the Bavarian Energy Plan 2040 (StMWi, 2024a+b), which are addressed in later chapters, must also be considered. In order not to go beyond the scope of this paper and because the focus is not on the policies, the legal framework will not be discussed further insofar as it does not contribute to answering the research question.

4. Methodology

This chapter presents the methods on which this work is based in a transparent and comprehensible manner. In a first step, the research question is presented, and the empirical procedure is described to answer the research question.

4.1 Research question

The starting point is the central research question: "How can the former Isar 2 nuclear power plant be repurposed in regional energy transitions to address territorial challenges?"
In order to answer this research question, a qualitative-explorative research design was chosen. In this research, I am investigating a relatively under-researched field, which I want to explore through qualitative enquiry. The empirical procedure, the selection of interview partners, the transcription process and the qualitative content analysis are described below.

The word "address" is central to this research. "To address a challenge" is a common expression that can encompass both tackling (to tackle, to face) and solving (to resolve, to mitigate) a problem. The Cambridge Dictionary (2025) defines "to address" as: "[T]o give attention to or deal with a matter or problem." This meaning implies cognitive engagement, strategic approach and active influence. It is therefore more than "solving" and includes recognising, classifying and reacting to complex framework conditions.

In this work, the term "address" is therefore divided into two aspects. On the one hand, it describes the extent to which reutilisation ideas can solve specific regional challenges, and on the other hand, it reflects the way in which regional challenges influence the implementation of reutilisation ideas as context-specific restrictions.

The first core process of the CORIS approach is the identification of challenges and resources (Trippl et al., 2024a). Within this core process, it is described that to drive innovation-based territorial transformation, it will often be important to explore how the region's resource base needs to be modified. In order to understand this, it is necessary to analyse which implementation perspectives exist for the approaches to solving the challenges. According to Trippl et al. (2024a+b), this resource base consists of natural resources, infrastructural and material assets, technologies, competences, institutions, etc. For the work of this research, it means that the realisation perspectives of different after-use ideas are evaluated. The next step, which should not be part of this work, would be to explore modification, as addressed in Trippl et al. (2024a+b).

4.2 Identification of guiding questions derived from the conceptual framework

The guiding questions for the interviews were derived from the central concept of the CORIS approach with the perspective of "wicked problems" and identified for the empirical analysis of this research. The objective was to use interviews to specifically record the perspectives of experts who could contribute to answering the research question. The guiding questions were kept quite general and not tailored to the individual focal points of the interview partners. The guiding questions are divided into four thematic blocks:

1. **Territorial challenges of repurposing**

- Which regional challenges could be specifically addressed by different repurposing ideas of the KKI 2 site? (e.g. economic, social, political, ecological, infrastructural)
- Which structural factors in the region (e.g. economic specialisation, institutional framework conditions, policies) influence the feasibility of different reutilisation options?

2. **Stakeholder landscape: supporters and opponents of subsequent use**
    - Which actors are in favour of (or opposed to) different reutilisation ideas?
    - To what extent do political, economic or civil society actors influence the decision-making processes for reutilisation ideas?
    - What role do intermediaries (e.g. cluster organisations, economic development agencies) play in mediating between different stakeholder groups?
3. **Potential effects of repurposing on the region**
    - What economic effects can be expected from different reutilisation scenarios? Are there already data or empirical values from similar projects?
    - What social consequences could result from the reutilisation of the site? What are the opportunities and risks in terms of e.g. employment, participation and regional identity?
    - How could the repurposing of the KKI 2 site affect the region's ecological sustainability goals? (e.g. reduction of emissions, environmental consequences of the remediation of contaminated sites)
4. **Implementation prospects and challenges**
    - What political or legal framework conditions need to be adapted or created for successful reutilisation?
    - What financial and infrastructural conditions influence the feasibility of the planned repurposing? Which funding programmes or investment models would be conceivable?
    - What strategies can help to reduce social resistance to certain reutilisation ideas and increase local acceptance?
    - What role does the nature as a stakeholder play?

4.3 Interview design

Interviews with experts from various relevant areas of RET form the core of this master's thesis. A qualitative, semi-structured interview design with an interview length of 30 - 45 minutes was chosen in order to capture the subjective perspectives, individual experiences and complex contexts. For this study and the results of this research, it is essential that the interviews "get to talk". It was therefore important from the outset that the interview design neither restricted the interviewees in their statements nor pushed them too much in one direction, but at the same time also provided a direction and guaranteed that the results of the individual interviews could be compared with each other. For this reason, the interviews centred on open-ended guiding questions, which allowed for a flexible course of discussion and at the same time ensured that all relevant topics were addressed. In addition, this guaranteed that the experts' individual expertise and areas of specialisation were recorded and assigned particular importance. Ultimately, this also made it possible for the results of the interviews to represent the core of the master's thesis in a complex and authentic way and to "speak". The guiding questions were derived from the conceptual framework (see chapter 4.2) and thus divided into thematic categories.

4.4 Selection and categories of interview partners

On the base of the categories of the guiding questions, groups of content were separated. Those new categories were compared with the literature to find thematic guidance in finding suitable interview partners. In accordance with the research design, the content focus of the work and the interview design, the following seven categories were identified:

- Project development in RET
- Regional planning and development
- Energy grid and energy market
- Energy storage
- Energy suppliers and system integration
- Politics and administration
- Science and research in RET

These categories reflect the thematic categories of research. The regional aspect is also important for the research. When selecting the interview partners, care was taken to ensure that they had a regional connection. The genres differ in terms of the urgency of a regional reference. For example, in the regional planning and development category, it is more important to have an expert with a regionally specific focus as an interviewee than in the energy storage category. In the case of this research, this requirement was met. Each category that required a regionally specific expert was filled with an interviewee from the Landshut region. Overall, only experts from Germany were chosen in order to maintain comparability and thematic relevance, particularly in discussions about politics, policies and national or regional strategies.

In addition to the content-related and regional aspects that justify the selection of interview partners, the stakeholders who are affected by the repurposing of the former KKI 2 site also play a role. I define stakeholders according to Freeman (1984) as "any group or individual who can affect or is affected by the achievement of the organisation's objectives" (individuals or groups who are affected in some way by the decisions of a company or project) (Freeman, 1984, p. 46). This definition is the basis for many modern concepts and can be further differentiated with Mitchell et al. (1997) for the case of this work. This study introduces a model that identifies stakeholders based on their power, legitimacy and urgency, which helps to prioritise stakeholders and assess their influence on the project. In addition to Freeman (1984), the definition by Mitchell et al. (1997) should also be added for this research to prioritise the stakeholders and filter out the most important ones from the large number of actors involved.

This results in a broad mix of stakeholders ranging from politicians to professionals in agriculture or civil society. For the research design of this study, however, only the opinions of those who have an expert opinion in the decision on the repurposing of the site are important. An expert from local politics or a spatial planner from the region concerned, for example, also has in-depth knowledge of the opinions, wishes and intentions of those working in agriculture or civil society. Furthermore, the selection of interview partners and their suggestions for further interview partners covered the necessary breadth. This will be discussed in more detail in the following sections of this chapter. Ultimately, the selection of interview partners can be justified as follows: Firstly, the interview partners have sound expert knowledge of the identified thematic categories based on the literature and conceptual framework. Secondly, they fulfil the regional approach and can provide region-specific statements on energy transitions. By selecting the seven interview partners according to the seven categories, all stakeholders are considered regarding their expertise and the design of this qualitative research.

The interview partners will not be listed for reasons of anonymity. However, categories can be listed to which the interview partners are assigned. These categories are listed below without revealing the name, employer and position. The list is presented in table 2 in the chronological order in which the interviews were conducted:

Interview - number	Date 2025	Conducted by	Face-to-face (F) or phone/digital (D)	Interview duration	Category of expertise	Sector
1	01.04.	author	D	49:14:00	Expert for energy technology research and storage	Public sector / politics
2	07.04.	author	D	46:54:00	Expert for regional spatial planning	Public sector / Spatial planning
3	10.04.	author	D	41:22:00	Scientific expert for energy system analyses	Science / Energy research
4	11.04.	author	D	44:33:00	Scientific expert for system integration of renewable energies	Science / Energy research
5	14.04.	author	D	45:57:00	Industry expert for energy and climate strategies	Trade association / Technology and industry

6	18.04.	author	F	53:57:00	Expert for regional energy consulting	Public sector / Energy consulting
7	30.04.	author	D	25:04:00	Project developer in the energy sector	Private sector / project development

Table 2: List of interviews conducted in chronological order (Source: author's elaboration (2025)).

The interviews were conducted as follows: Based on the thematic categories of the guiding questionnaire and the research for the theoretical-conceptual background, over 50 people were researched as potential interview partners. In a first step, the candidates who seemed most promising in the own estimation were contacted. After a certain amount of time to give the potential interviewees time to respond, further people from different backgrounds were contacted. In most cases, the company e-mail was used. Contacting the general company email and LinkedIn was less successful than the official and direct enquiry. Requests for an interview were made by email, explaining the topic, research question, objective, duration and the issue of anonymity. Attached to this request was a document with information about the interview and the guiding questions as well as informed consent. Overall, it can be stated that the enquiry was always met with great interest and in all cases a response was received agreeing to an interview. The signed declaration of consent was returned quickly and reliably. In the process of requesting interviews, the willingness to forward the enquiry to other experts was noticeable. Due to the topicality and importance of the topic of this master's thesis, better interview partners were found according to the snowball principle. The person who was contacted first agreed to an interview in all cases, but in many cases other contacts were recommended who were even closer to the topic, either thematically or regionally specific. In the end, interviews were conducted with experts who had been recommended by experts. Even if the research resulted in good interview partners, the quality of the interview partners was raised even further. This can be proven not least by the results of the interviews. The general selection of interview partners was based on availability, subject specialisation, professional experience and professional position.

In total, more than seven interviews could have been conducted. However, due to the scope of a master's thesis and the coverage of the thematic categories, empirical research was stopped at seven interviews. Further reasoning is explained in chapter 6.4.2. The interviews conducted cover the thematic categories and the results are comprehensive and leave hardly any gaps. At this point, however, it should be mentioned that further topics have emerged because of the interviews conducted and potential interview partners that have emerged. The operator of the former Isar 2 nuclear power plant, PreussenElektra, should be emphasised here. As a potential interview partner right from the start, PreussenElektra is very suitable for an interview. Unfortunately, no interview could be secured after more than five enquiries. The interviews with other experts made it clear once again that PreussenElektra plays a very important role as a stakeholder. In conclusion, it can therefore be said that although the stakeholder PreussenElektra can be outlined in its intentions, plans, etc., no official statements can be identified in this work apart from the publicly available literature.

4.5 Conducting the interviews

The interviews were mostly conducted in German by telephone or in a Microsoft Teams meeting. One interview was conducted in person because the interviewee was in Vienna on business. The interviews were recorded using audio recording only.

The order in which the interviews were conducted was based on the participants' commitments. However, it should be mentioned at this point that potential interviewees with a general view of the subsequent use of the former KKI 2 site were approached first. For example, the first interview was with the expert for energy research, technology and storage, who is both a regional expert and a government decision-maker. This allowed the guidelines to be validated and slightly adapted. In the subsequent interviews, the choice of the first interview partner proved to be a good one, as a broad range of thematic and regionally specific expertise supported the design of the interview, the time limit and the content of the guiding questions. All three points could be adopted in the subsequent interviews and did not have to be changed. This ensures the comparability of the results. Only the time for the individual open research questions was varied depending on the expertise of the interviewee. The target of 30 - 45 minutes was adhered to in each interview.

4.6 Preparation and implementation of the analysis

Once an interview was completed, it was transcribed. The immediate transcription made it possible to focus the subsequent interviews more precisely and to emphasise topics in the open guiding questions if this was necessary. The transcription was carried out using Microsoft Word. The accent of the experts from the Lower Bavaria region proved to be a challenge. Such linguistic peculiarities were not considered. The content of the interview was used as a guide. Overall, the transcript was prepared to the best of my knowledge and belief. Ambiguities were marked and audible intonations and pauses were only considered in cases relevant to the content. The entire process was based on the simplified rules according to Dresing & Pehl (2018) and Kuckartz & Rädiker (2022).

In preparation for the analysis, the results of the individual interviews were divided into blocks that followed the thematic categories of the guiding questions. As the interviews followed these categories anyway, this categorisation is possible and necessary for reasons of efficiency and clarity. This procedure corresponds to an initial structuring of the content but does not represent coding in the strict sense.

The analysis of the research is based on a combined deductive-inductive approach. This method according to White & Marsh (2006) is particularly suitable for systematically analysing communicative texts. Unlike quantitative content analysis, qualitative content analysis is based on a hermeneutic-interpretative understanding of research and is open to new, unanticipated content. The research design of this work is intended to give the experts the opportunity to express new topics and ideas in the interviews. The guiding questionnaire, which was deductively derived from the literature and the conceptual framework, served as the starting point. During the analysis, the thematic blocks identified were iteratively adapted and expanded in order to work out categories that were listed by experts in the interviews. This inductive part corresponds to the principle of the "hermeneutic loop" described by Krippendorff (2004, pp. 87-88). In the research of this thesis, this means that the topics of the first interview represent new categories. These categories are compared with the themes from the second interview. After all interviews have been reflected on and compared in this way, there are common categories at the end that guarantee comparability. In the case of this work, these categories are very much orientated towards the guiding questions. The categories deductively derived from the literature and the conceptual framework of the guiding questionnaire are extended by the inductively developed categories from the interviews. The new, inductively identified themes lead to a step-by-step reinterpretation of the earlier coding. In this way, connections are made between the statements in the respective interviews. In this way, ideas for subsequent use can be better analysed and discussed and the interviews can be put in relation to each other. This process is accompanied by a constant examination of the interpretations of the statements and the reference to the individual interviews.

The following can be taken as a simple example for understanding and ensuring transparency: Through the first deductive coding based on literature and conceptual framework, the thematic category "energetic reutilisation" was identified as the reutilisation of the KKI 2 site. This idea was confirmed by the interviews and expanded to include emergent categories. An example of this would be "subsequent use as energy storage". This category was not originally explicitly envisaged, which is why the sub-category "subsequent use as energy storage" was added inductively. This example shows the iterative nature of the analysis and illustrates how the hermeneutic loop was used to differentiate existing categories through new findings from the interviews. In this way, the core of this work, which aims to let the interviews "speak", is also preserved.

5. Results

Following the qualitative content analysis according to White & Marsh (2006), the results are not presented interview by interview, but thematically or category by category. The guiding questions and the topics, which were recorded according to the principle of the hermeneutic loop, form the content structure. In addition to the methodological background, themes and patterns that emerge across several interviews and are of particular importance for the research in this thesis can be recorded in this way. It also allows chapter 6. to better address the similarities, tensions and contrasts between different people and opinions on the same categories. Chapter 5. concentrates on the statements in the individual interviews. In some cases, relevant literature is consulted in order to understand the statements. The focus here is on grey literature (reports, policy documents, company publications, etc.).

5.1 Ideas for repurposing

For the site of the former KKI 2, as defined in chapter 4., various ideas for repurposing were mentioned by the experts in the interviews. Table 6 in the appendix gives an overview of the ideas of reutilisation and which ideas where mentioned in which interviews.

The storage of energy at the site is discussed as a central possibility and necessity (Interviews 1-7). Storage in batteries is mentioned most frequently, and the option of large-scale battery storage is discussed in particular (Interviews 1-7). **Repurposing: battery storage**

In connection with the question of long-term storage, most experts mention the technology of storage in the form of hydrogen (Interviews 1-6). **Repurposing: hydrogen storage**

Other storage options are also mentioned, although these are less discussed and categorised as less likely. The idea of a compressed air storage facility is mentioned, but is considered questionable (Interviews 5, 6). **Repurposing: Compressed air storage**

Mentioned as an efficient form of storage, the pumped storage power plant is another option. The specific idea of raising the reservoir which was used for cooling during nuclear times in order to generate storage energy is discussed (Interviews 2, 5). **Repurposing: Pumped storage power plant**

Due to the energy infrastructure, the option of energy conversion or repurposing as a power plant is frequently mentioned. According to some experts, a gas-based reserve power plant that is potentially hydrogen-ready could be considered for various reasons (Interviews 1, 3-6). The idea is that these power plants could be converted to hydrogen operated in the medium term (Interview 5). Gas-fired power plants are also regarded as storage facilities in the system, as they can utilise hydrogen that was previously generated from electricity (Interview 6). Interview 4 lists further possibilities for "combined cycle power plants", such as the idea of operating a gas turbine at the site. Initially with CCS natural gas and later with hydrogen (Interview 4) **Repurposing: Gas-fired power plant/standby power plant**

Hydrogen production is also linked to this. The production of hydrogen at the site using an electrolyser is seen as promising and the requirements and challenges are discussed (Interviews 1, 3, 4). **Repurposing: Hydrogen production**

A further utilisation of the site as a power plant is the idea of a waste-to-energy plant. Waste incineration for energy generation is mentioned as an alternative type of power plant (Interview 5). **Repurposing: Waste-to-energy plant**

The option of combining different subsequent uses is an idea for subsequent use that is mentioned several times. Combinations between energy generation, storage and consumption are discussed in the interviews (Interviews 3-5, 7). **Repurposing: Combined solution**

In addition to the storage and production of electricity, other technical utilisations are mentioned and discussed in the interviews. Although the possibility of energy-intensive industries settling here was mentioned, it was considered rather unlikely (Interview 3). **Repurposing: Energy-intensive industry**

Utilisation as a server farm is discussed as a comparable use. A data centre would be an energy-intensive use and therefore an option (Interview 4, 5). **Repurposing: Server farm**

The use of CO_2, i.e. carbon capture and utilisation (CCU), is mentioned in the context of potential new facilities on the site. Carbon capture and storage (CCS) is seen as a potentially important role for industry and is discussed as an optional repurposing of the KKI 2 site (Interview 5, 6). **Repurposing: CCS/CCU**

The idea of a research site for nuclear fusion comes from the political side (Kuntschner, 2025; Göttler, 2025) and is addressed in the interviews (Interviews 1, 4, 5). **Repurposing: Nuclear fusion research**

Other concepts and non-energy-related uses from the political sphere, such as using KKI 2 as an industrial monument (Kuntschner, 2025), were also discussed (Interview 2, 5). The interview partner of Interview 2 himself visited KKI 2 during the own school days and finds the idea of an industrial monument not so far-fetched. Such a use for sightseeing and educational purposes is justified (Interview 2). **Repurposing: Industrial monument**

The option of repurposing of the site for local recreation is discussed by Interview 2. Considerations regarding the organisation of recreational opportunities relate to the impact region within a 10 km radius of the site (Interview 2). **Repurposing: Local recreation**

5.2 Territorial challenges of the ideas for repurposing

The area in which the effects of after-use are directly noticeable is defined in chapter 3.1. In the interviews, the impact region is projected onto this area and in some cases extended. The thematic context indicates whether the area, the region of Lower Bavaria or the whole of Germany is affected by challenges.

Challenges listed here were only discussed in the interviews. In addition, the challenges listed are supported by additional literature where necessary and explained in more detail to ensure comprehensiveness. The regional challenges are categorised into economic, social and environmental challenges. This structure makes sense, as several challenges apply to different reutilisation ideas. The challenges are listed in this chapter and contextualised in chapter 6.. Table 7 in the appendix gives an overview of the challenges and gives information about which challenges was mentioned in which interviews.

In chapter 5.4, the ideas for subsequent use are listed as solutions to the challenges, as expressed by the interviewees.

The challenges in the repurposing of the former Isar 2 nuclear power plant can be described as so-called "wicked problems" and "tame problems" in the sense of Rittel & Webber (1973). As already explained in chapter 2.3 this research circles around the perspective of “wicked problems” as all regional challenges can be categorised as “wicked problems”, even if some challenges are technically describable, workable with specialist knowledge and (theoretically) conclusive (Rittel & Webber, 1973). As already introduced, the regional challenges mentioned by the interviewees are categorised as “wicked” in the light of the problem logic described by Rittel & Webber (1973), as the reuse ideas as solutions cannot be directly assessed as good or bad, but solutions can generate consequences that are not fully foreseeable.

5.2.1 Economic challenges

Economic challenges are of fundamental importance for the subsequent use of KKI 2. This chapter also lists energy-related challenges that were mentioned by the experts and can generally be categorised as "economic challenges".

5.2.1.1 Summer/midday energy surplus and winter/night deficit

Bavaria has a high potential for PV, and a high proportion of electricity is already generated from PV, water and biomass (calculated 106% in the whole of Lower Bavaria on paper) (Interview 2). The problem is the nature of solar energy, which generates far too much energy at midday on sunny days, according to Interview 2. Currently, the electricity from PV systems must be regularly curtailed to prevent the grid from being overloaded (Interview 2). Interview 4 describes the problem as "1 in 7". The PV peaks in summer are seven times as high as the region actually needs. These gigantic peaks often cannot be utilised and are therefore lost. At the same time, there is a deficit in winter or at night (Interview 5). This imbalance represents a fundamental challenge for the energy grid. **Challenge: Dominance of PV and seasonal/daily imbalance**

Storage is needed to balance out the PV peak and bridge the deficit (Interview 4). Interview 3 cites Bavaria's renewable energy potential as a reason for the inadequate expansion of modern technologies such as hydrogen, which could be used as a storage option for surplus energy. Pumped storage power plants, which are considered one of the most effective forms of large-scale storage, "de facto" do not exist in Bavaria, according to Interview 2. As far as battery storage is concerned, there is a strong expansion in Bavaria, especially due to the high proportion of PV (Interview 1). However, they are primarily suitable as short-term storage for a few hours. Long-term storage, especially for bridging seasonal deficits, is lacking, according to Interview 1. Interview 4 estimates the required short-term storage capacity in Bavaria at around one third to one half of the PV capacity. In addition, large-scale storage systems are still an expensive option, which limits their use (Interview 6). Interview 6 argues that as many as necessary should be built, but as few as possible. The clear challenge for the region is therefore the utilisation of surplus energy. **Challenge: Utilisation of surplus energy**

5.2.1.2 Potential for renewable energies

The renewable energy potential describes the theoretical, technically or economically usable amount of energy that can be obtained from renewable sources. The realisable potential is important here, which describes the proportion that can be tapped, considering acceptance, spatial planning, spatial resistance, grid connection, etc. (Kleinschmitt et al., 2022). Based on the renewable energy potential of a region, locations that are the most lucrative are demanded first in the market economy model. In the example of wind energy, for example, higher yields can be expected in northern Germany (Interview 2). According to Interview 5, there are "de facto hardly any wind turbines" in Bavaria, which has an impact on the renewable energy potential. In the case of energy generation from PV systems, Lower Bavaria shows quite high potential with large peaks. However, Interview 7 emphasises that the use of arable land for PV systems or wind turbines is a very emotional discussion with farmers and agricultural policymakers. The existence of surplus energy also indicates a problem with the utilisation and distribution of potential, which lowers the renewable energy potential (Interviews 1, 2). The region also has a lower potential in terms of new technologies. The potential for renewable energies in southern Germany/Bavaria is "progressing a little more slowly" than in the regions (north/northeast) where large-scale electrolysis is primarily located (Interview 3). This is not least due to the north-south grid connections, which are not yet sufficiently developed (Interview 3). Interview 3 goes on to explain that gas and hydrogen power plants will only become relevant in southern Germany, as demand for electricity is currently high here and the expansion of renewable energies is slower. Interview 6 emphasises the importance of renewable energies. He assumes that in 2045 there will be a demand for around 1000 - 1100 TWh of electricity per year, whereby almost 1000 TWh will be covered by wind and solar energy, while the rest (70-100 TWh) will be provided by gas-fired power plants, ideally with hydrogen. The challenge for Bavaria is to keep pace with the north, which has a high renewable energy potential. **Challenge: Limited renewable energy potential**

5.2.1.1 Grid connection and grid expansion

As already mentioned, the north-south grid connections are not yet sufficiently developed (Interview 3). In the context of RET, the challenge of grid connection and grid expansion is of central importance, as it concerns the integration of new energy infrastructures into the existing system. In principle, the electricity grid at the KKI 2 site is very well connected, as it was designed for the "old days" (Interview 5) of centralised power plants that transported energy from one point to the outside. However, this is not necessarily the same as taking energy from the distribution grid, for example from decentralised energy sources such as PV systems, and storing it on site. The grid must change a lot to accommodate new energy concepts, and it is not yet developed enough for the required transformations. Interview 5 cites this as one of the two major challenges alongside the market. **Challenge: Alignment of the grid with the past**

The existing infrastructure is a major advantage for subsequent energy utilisation. However, it is also clear that adjustments are necessary for the new utilisation (Interview 3, 5). The challenge is to make this old infrastructure usable for modern purposes while minimising the necessary investments and at the same time ensuring the availability of the existing infrastructure. **Challenge: Utilising the existing infrastructure**

Another challenge facing the region is the availability of different grid types. Even though the general expansion of the electricity grid in the defined 10 km radius of Interview 5 was described as "great", the gas grid is not very well developed. According to Interview 6, the hydrogen core network, which is relevant for repurposing ideas that have to do with either the production or use of hydrogen, does not yet exist in the region or in Germany as a whole. The same applies to CCS and CCU. Corresponding pipelines would have to be built from scratch, as they transport CO_2 in liquid form and cannot utilise the existing gas network (Interview 5, 6). **Challenge: Availability of the specific grid types**

In connection with the availability of the grid for electricity, gas, H_2 and CO_2, the role of the grid operators in the challenges for the region must be listed. The construction of H_2 and CO_2 as well as the expansion of the electricity and gas grid must be carried out in cooperation with the grid operators. In the case of the electricity grid, the grid operator Tennet is crucial for the transmission grid and Bayernets for the gas grid (Interview 3). Grid operators must grant authorisation for grid feed-in services. The cost factor of an underutilised grid also plays a role in the decisions for the grid operators. According to Interview 4, maintaining the GW connections at former power plant sites is a difficult decision for large transmission system operators if there is no clear political perspective and financing for maintaining them. He also adds the challenge for the grid operators of site selection. For the focus region of this research, the district of Landshut, this means that the grid operators would only be in favour of the site, particularly in the case of the storage facility reutilisation idea, if a storage facility at this location could solve problems in the grid, i.e. where bottlenecks exist. This conflicts with private investors who want to build storage facilities where they can make money. The decision-making authority of the grid operators and their reluctance to maintain existing connections without clear political and financial commitments is a major obstacle. Grid serviceability from the grid operators' perspective can therefore be counted as a regional challenge. **Challenge: Decision-making authority of the grid operators**

If we look at the grid operators and their decision-making authority, which is influenced by financial and political decisions, the connection with politics and political authorisations becomes clear. Grid expansion and ideas for repurposing require a clear political framework. Uncomplicated authorisations are a primary prerequisite, which is currently not the case (Interview 5). According to Interview 4, the political regulations are currently not attractive for investment. Even if the government of Bavaria is now in favour of a certain expansion of wind power, the installation of above-ground power lines is very restricted by policies (Interview 6). Interview 5 cites the example that approval procedures for grid expansion can take 10 years. The lack of a political perspective, the lack of a legal framework and lengthy authorisation procedures as well as the political requirements for grid expansion hinder investments and make it difficult to plan projects within the regional energy transitions. **Challenge: Restrictions due to political perspectives and authorisation procedures**

Based on the interviews 1, 2, 4, 5, the conflicts of interest of the stakeholders who would be affected by the repurposing of KKI 2 are a regional challenge. Several actors with different goals and priorities are involved, which makes planning and implementation more difficult. Chapter 5.3 deals with the stakeholders and explains which ideas are supported and who would oppose ideas. This multitude of stakeholders with their sometimes-conflicting interests, from the need to operate a stable network, to the desire for returns on investment and political objectives, to local concerns and the desire for participation, creates a complex environment and poses a significant regional challenge. **Challenge: Conflicts of interest between affected stakeholders**

5.2.1.2 Energy transition

The energy transition must be mastered as a whole, for which climate-neutral technologies are needed in order to achieve the climate protection targets by 2045, which requires considerable effort (Interview 1). According to Interview 5, the Renewable Energy Sources Act (EEG) has already ensured that renewable energies have been massively expanded, albeit at a corresponding cost. What the EEG does not include is a practical transition to an energy market that really does consist primarily of renewable energies. The interviewee from interview 5 sees the challenge for Germany, and therefore also for the focus region of this work, in the fact that the EEG has a 20-year after-effect. **Challenge: Effects of the EEG**

The energy transition promotes renewable energies and actively pushes fossil fuels into the background. The loss of fossil-fuelled power plants has created a supply gap that cannot be covered quickly enough with renewables (Interview 1). The Federal Network Agency[3] has identified a supply gap of 21 GW of capacity that is needed to guarantee security of supply, starting from the end of this year (Interview 1). There is not only a lack of time, but also a lack of legislation (Interview 6). This perspective is being spun by experts at federal level, as the grid cannot be viewed regionally. Grid stability and security of supply are challenges that need to be addressed across all regions. **Challenge: Supply gap due to the loss of fossil fuels**

5.2.1.3 Market conditions and economic risk

The economic market and framework conditions and the associated risks are a fundamental challenge for the subsequent energy utilisation of the site. As already mentioned, Interview 5 cites the market alongside the grid as one of the two major challenges that are not yet sufficiently advanced. The electricity market is currently such that the operators of gas-fired power plants are rather unhappy (Interview 5). Regarding the RET, energy producers are not satisfied with the energy market in terms of money (Interviews 1, 5). A market for new energy technologies such as hydrogen or reserve power plants that is not fully functional or mature creates uncertainty for investors and makes projects in the region economically difficult. **Challenge: Unattractive market conditions**

At the same time, the industrial situation in Germany is currently poor (Interview 6). There is a risk of deindustrialisation, which is why cheaper electricity urgently needs to be produced. The need to provide energy at competitive prices puts pressure on economic viability, not least in the focus region of this study, and influences the selection of favoured technologies within the RET. There is also a lack of a mechanism to achieve favourable electricity prices, despite the high proportion of renewable energy. Interview 5 reports on the optimism at the time that renewable electricity would become so cheap that fossil fuels would be forced out of the market. Today, according to Interview 5, 50-60% of the electricity in the system is produced

[3] Germ.: Bundesnetzagentur

by renewable energies, but the price of electricity has only increased. Interview 5 poses the question of how Germany can move away from this system. **Challenge: Danger of deindustrialisation and the need for cheap electricity production**

The economic risks for investments in RET projects extend beyond the market for specific technologies. Policies banning CO_2 emissions from 2040 onwards from energy producers can harbour business risks. Especially if no CCS infrastructure is available (Interview 5). The economic risk of producing electricity at a reasonable price is also a challenge and, according to Interview 5, is currently difficult to assess. Interview 6 adds to this challenge by considering the costs of a storage facility. Above-ground hydrogen storage facilities are also too expensive for large-scale use and an isolated solution for hydrogen, i.e. where production, storage and consumption take place on site without a core network, is probably not economically viable according to Interview 3. The economic viability of the various repurposing options varies and often depends on external factors. Market development, regulatory framework conditions, costs of all kinds and the uncertainty of the development of these issues represent a significant investment risk for specific technologies in the region. **Challenge: Economic risks of specific technologies**

It is clear that investments are only made in regions where the conditions are attractive (Berlemann & Tilgner, 2006; FHNW, 2024). The impact region around KKI 2, like the rest of Germany, is characterised by private investors who belong to the liberalised market (Interview 6). Interview 6 and Interview 2 emphasise the renewable energy potential in the north of Germany. Locations with high profitability (e.g. northern Germany for wind power due to higher wind speeds) are in demand first in the market economy model. Lower Bavaria, on the other hand, has a lower renewable energy potential and therefore has different and in some cases weaker locational advantages for projects within the energy transitions. The attractiveness of the location for private investors depends on many factors. Overall, the regional attractiveness for investment in energy transitions can be defined as a challenge. **Challenge: Regional attractiveness for investment in energy transition**

5.2.1.4 Costs and financing

Firstly, it must be noted that a region has limited financial resources. Projects in the RET are cost-intensive and always associated with risk. For projects to be realised, national or even international financing is often required if the financial possibilities of a region are exceeded (Interviews 5, 7). **Challenge: Financial possibilities of the region**

Regarding chapter 5.2.1, the economic challenge of expanding the infrastructure should be mentioned. Interview 5 and Interview 6 both emphasise the huge amount of money and the insane effort involved in expanding the entire infrastructure in terms of electricity, gas, H_2 and CO_2 and connecting new locations to the grids. The costs for necessary adjustments and the integration of new technologies must be considered (Interviews 3, 5). The sheer size of the investments required to expand the energy networks and create new infrastructures exceeds the financial possibilities of a region alone (Interview 5). **Challenge: High costs for the expansion of existing and new infrastructure**

Interview 4 clearly emphasises that grid operators must be able to justify the financing of maintaining grid connections. Without a clear political perspective, they will back down. In cases of repurposing as storage facilities, for example, it is desirable to reduce the construction cost subsidies for storage investors to zero if possible. If a connection is available, it should be made available at cost price. The financing of the maintenance and utilisation of grid connections, which are so important for subsequent use, is unclear and depends heavily on political decisions. The level of construction cost subsidies to be borne by the investor is a critical factor for the economic viability of a reutilisation project and can be seen as a challenge (Interviews 1, 4). **Challenge: Project financing and construction cost subsidies**

5.2.1.5 Approval and planning processes

The planning and realisation of projects within the RET is heavily dependent on approval processes. These lengthy and complex processes represent a significant obstacle to the rapid realisation of subsequent use processes. Interview 5 emphasises that uncomplicated approvals are a primary prerequisite for the implementation of facilities and therefore for the realisation of some after-use ideas. These are currently not in place and there is a lack of an urgent legal framework for the construction of the required power plants. Interview 1 expressly confirms that authorisations take longer than the actual construction. Without fast and uncomplicated approval procedures and a clear political and legal framework, projects cannot be realised in a timely manner, which reduces planning security for investors and delays necessary developments (Interviews 4, 5). **Challenge: Lack of quick authorisations and clear framework conditions**

Hesitation on the part of politicians and a lack of prioritisation of regional policy and national issues on the part of the federal government represent a key challenge. Just as the transmission system operators back out of obtaining connections as long as there is no clear political perspective (Interview 4), the Atomic Energy Act makes short-term utilisation difficult (Interview 4). According to Interview 4, an amendment to the Atomic Energy Act or the Nuclear Decommissioning Act would be needed to prioritise subsequent use. There is a lack of a progressive further development concept that addresses and analyses all alternative uses. Political regulations are currently not attractive for investment (Interview 5). Political uncertainty and a lack of direction at federal and state level are blocking or slowing down processes considerably. **Challenge: Political hesitation and lack of prioritisation**

The question of responsibility is closely linked to this. It must be clarified how the location of KKI 2 is to be prioritised in the individual planning levels. Interview 1 discusses the planning levels of regional planning, urban land-use planning and land-use planning. The municipal and regional level has the decision-making power when it comes to determining utilisation. Interview 2 emphasises that planning sovereignty lies in principle with the municipality and sees the municipal and regional levels as having primary decision-making power as to how this location should be used (Interview 2). Regional planning can make determinations in order to secure the location. In addition to these planning levels, the grid operators also have decision-making authority, as does the operator and landowner of KKI 2, PreussenElektra, which has control over the schedule (Interviews 1, 4, 5). Coordinating and determining the utilisation at different planning levels are necessary steps that can take time and present potential obstacles. **Challenge: Planning at different levels**

As described in chapter 3., the dismantling process of the nuclear power plant is expected to last until 2037. The repurposing depends on whether the dismantling proceeds quickly or whether the site remains a construction site for a long time (Interviews 3, 6). According to Interview 6, there is a risk of a "crazy loss of time"[4] if dismantling takes over 15 years and is not dovetailed with the construction of a new plant. Interview 3 points out that the deconstruction and repurposing work could interfere with each other. Some of the neighbouring properties are not available, as they may have to be used for the demolition work (Interview 4). The dismantling schedule is an external factor that strongly influences the availability of the site, and the time coordination of reuse projects and brings with it potential delays and therefore a regional challenge for the realisation of reuse ideas. **Challenge: connection with dismantling schedule**

[4] Germ.: verrückter Zeitverlust

5.2.2 Social challenges

Social challenges are of fundamental importance for the subsequent use of KKI 2. This chapter also lists energy-related challenges that were mentioned by the experts and can generally be categorised as "social challenges".

5.2.2.1 Social acceptance and protests

Interview 1 and Interview 7 in particular consider social acceptance to be very important for the realisation of projects. Interview 5 emphasises that the social process regarding the subsequent use of the KKI 2 site is relatively difficult, as there are always different groups that are in favour or against. "You will never make everyone happy." (Interview 5). Interview 2 gives the example that the expansion of the necessary infrastructure, such as large power lines and transformer stations, is already leading to citizens' movements and resistance from local communities. It is a challenge for politicians and spatial planners to involve society in the realisation of energy infrastructure projects, to prepare them for this and to gain their support (Interview 2). Protests can arise, particularly with projects that have a visual and physical impact on the landscape (Interview 6). **Challenge: Acceptance by communities and residents**

Interview 3 mentions that special technologies are more readily accepted than others. He emphasises that the KKI 2 site can be conducive to certain subsequent uses because industry or energy plants are already in place. However, the communities around the site of the former nuclear power plant are grateful that nuclear power is no longer being produced (Interview 6), although they have benefited from the nuclear power plant for decades, e.g. in terms of business tax (Interview 2). This has to do with the safety factor, which could make repurposing more difficult if the safety factor is not satisfactory. **Challenge: Safety aspects of industrial repurposing**

5.2.2.2 Regional value creation and participation

Acceptance of a repurposing is higher if the region benefits noticeably, be it through more or cheaper electricity, jobs or other benefits (Interview 5). Interview 5 argues that it can be a challenge to convince the population of the benefits of repurposing if the region has the feeling that it will not benefit from the repurposing. Added value for the region could be created in the form of jobs (Interview 1). Particularly due to the poor situation of industry and the threat of deindustrialisation in Germany with enormous job losses, subsequent use is important in terms of cost-effective energy production and job creation (Interview 6). Next to the economic aspect the social one of regional value creation is important, as it supports or hinders the realisation of reutilisation ideas. **Challenge: Regional value creation**

The acceptance of a certain repurposing is often also linked to the issue of participation. The right to have a say and the participation of the public, municipalities and citizens is important for the acceptance of repurposing in the region (Interview 1, 4). **Challenge: Participation and involvement of the public, municipalities and citizens**

The social desire for regional value creation and participation can be an obstacle, particularly when implementing new technologies such as battery storage. The technology for battery storage, for example, does not currently come from Germany, but from Asia, which means that the region does not benefit from the technology development itself, but only from craft businesses. Regional competitiveness in a national and international context is a regional challenge (Interview 1). **Challenge: Regional technology development**

5.2.2.3 Regional image

The region would like to have regional added value. Asian technology, for example, would stand in the way of this (Interview 1). Local politics would also like to focus essentially on the image the region would like to have (Interview 5). About the ideas for the repurposing of the former nuclear power plant site, decisions must be made regarding a green image and industrial friendliness (Interview 5). The visual presence of a repurposing also plays a role in the regional image (Interview 7). Interview 4 says that Bavaria's philosophy is that the electricity supply can still be provided regionally, even in Bavaria, without disengaging from the Energy Union and the national energy grid.

Challenge: Regional image

5.2.2.4 Area conflicts/battle for space

In the interview with Interview 2, the "battle for space"[5] between the rapidly growing area for PV and the need to secure the regional food supply was discussed in detail. Interview 2 mentions the fact that the expansion of energy infrastructure requires space, which leads to social conflicts when space is limited. New transformer stations for the expansion of wind power, for example, require areas of up to 25 hectares and plans for large-scale battery storage facilities of up to 20 hectares (Interview 2). In order to realise the energy targets of the federal government and local authorities, routes must be found for new large power lines. Routing them through fields and plots of land is a major challenge and requires large areas of land, not

[5] Germ.: Kampf um Raum

least for the construction work (Interview 6). In addition, the area immediately surrounding the site is already densely populated and is bordered by the Isar river, the motorway, a village and a planned federal road (Interview 2). **Challenge: Land use conflicts**

5.2.2.5 Jobs and attractiveness for the population

As already mentioned, the acceptance of repurposing is increased if the region benefits from jobs (Interview 5). Various reutilisation ideas influence the need for different professions. According to Interview 1, the development of regional technologies for battery storage, for example, could create local jobs. The impact of different after-uses on the demographics of the neighbouring towns and the attraction of young people is unclear (Interview 6). However, the creation of jobs for the local population is not unimportant for acceptance and the required value creation in the region. The phenomenon of rural exodus is a challenge in the region. **Challenge: Attractiveness of the region for (young) workers**

5.2.2.6 Peripheral location

Due to its use as a nuclear power plant, the location of KKI 2 is quite peripheral. The location can also have an influence on repurposing ideas and can be listed as a regional challenge (Interview 6). **Challenge: Peripheral location**

5.2.2.7 Dealing with nuclear waste

Dealing with radioactive material is a challenge for alternative uses. Interview 5 mentions the risk that a relatively large amount of radioactive waste will have to be temporarily stored in Germany without having a final storage option. Now, Castor containers are being temporarily stored at the KKI 2 site during dismantling work. According to the Federal Office for the Safety of Nuclear Waste Management, the operation of the interim storage facility at the KKI 2 site is authorised until 2047. Of the 152 cask spaces, 95 are currently occupied. However, it is assumed that only 124 cask spaces will be required because of the premature end of nuclear energy utilisation (BASE, 2025). The question of a final repository in Germany has still not been resolved (Interview 3) and it is not yet certain what will happen to the radioactive material and nuclear waste. The search for a final repository in Germany is a very difficult and time-delayed political process (Interview 2). Although the interim storage of nuclear waste is necessary, it is not popular and there is no enthusiasm for it to remain at the KKI 2 site for decades. Designation as an interim storage facility poses a challenge that can block other developments, especially due to social discontent (Interview 2). **Challenge: Dealing with nuclear waste**

In the case of KKI 2, it is also unclear how long it will take to decontaminate the site (Interview 5) if radiation is present when dismantling is completed. In the event of radiation, the region faces several challenges, which makes repurposing of the site more difficult. Interview 3 emphasises that they themselves would not want to work at a site that is exposed to radiation in any way. Personally, you don't want to work at a site where there is a question of a threshold value (Interview 6). The presence of (even marginal) radiation can affect the sense of security of potential users (companies, employees) and reduce the attractiveness of the location (Interview 6). **Challenge: Radiation as a social challenge**

5.2.3 Environmental challenges

Environmental challenges are of fundamental importance for the subsequent use of KKI 2. This chapter also lists energy-related challenges that were mentioned by the experts and can generally be categorised as "environmental challenges".

5.2.3.1 Climate-neutral technologies and climate targets

As already mentioned, the energy transition must be mastered, for which technologies are needed to achieve the climate protection targets by 2045 (Interview 1). The German government has made climate protection one of its central tasks. The core of national climate policy is the Climate Protection Act, which sets legally binding climate targets. Germany aims to be greenhouse gas-neutral by 2045 (Bundesregierung, 2025). Interview 6 cites the supply gap caused by the loss of fossil-fuelled power plants, which cannot be covered quickly enough with renewable technologies. Various ideas exist to close the gap, such as the use of reserve power plants. The challenge is to utilise these power plants in a climate-neutral way in the medium term. Interview 6 estimates a date of eight years after commissioning with hydrogen. The challenge of the infrastructure for H_2 and CO_2 has already been mentioned, and the geological challenges will follow in the next chapter. The environmental challenges for the region include renewable technologies, which are not yet advanced enough to guarantee security of supply, and meeting climate targets, which clashes with the current supply situation. As national sustainability strategies are implemented in regions, these are particularly affected by the challenges (see chapter 2.1). **Challenge: Climate targets**

5.2.3.2 Geological conditions

Geological conditions refer to the nature of the subsurface at the specific location and in the region, which influence certain utilisation options. The special nature of the subsurface poses several challenges for the repurposing of the site (Interviews 2, 5). Subsequent uses that require the subsoil are difficult to realise at the site, as there are no old mines and no geological conditions (Interview 2). Interview 6 mentions the role of the raw material situation, particularly in the realisation of new technologies. In the interviewee's opinion, it makes no sense to use technologies for which there is a finite raw material potential, especially as the energy transition process will take longer (Interview 6) **Challenge: Geological conditions**

5.2.3.3 Topography

The topography in Lower Bavaria, especially in the Isar valley, is not suitable for utilisations that require pronounced relief energy. Storage options, such as geothermal energy and hydropower, are therefore heavily penalised. As described in chapter 3.1, the site is in the Isar valley, directly on the Isar in the flatlands (Interview 2). This makes the site less attractive for wind power utilisation at the site (Interviews 2, 7). Overall, wind speeds in Lower Bavaria lag far behind those in Northern Bavaria or Northern Germany (Interview 2). **Challenge: Topography**

5.2.3.4 Nature conservation areas

There are several Natura 2000 sites in the area around KKI 2 (Interview 2). To the south of the Isar, there are areas of high nature conservation value and probably alluvial forest on the slopes (Interview 2). Interview 2 assumes restrictions due to nature conservation in the area around KKI 2. Developments or infrastructure expansion in the regional environment must take these areas worthy of protection into account and must not impair them. If repurposing is limited to the site, it is unlikely to pose a problem for nature conservation areas, according to Interview 2. Interview 2 also mentions that planning obstacles or problems with nature conservation for various technological uses, such as storage facilities, are unlikely on this site, as other areas in Lower Bavaria are much more worthy of protection. Although the direct site is unlikely to pose any major nature conservation problems, the regional dimension and possible impact on surrounding protected areas must be kept in mind for larger infrastructure projects (Interview 2). There is a desire in the region to enhance the ecological value of the former industrial site, which could conflict with purely technical reutilisation (Interview 2). **Challenge: Nature conservation areas and ecological aspects**

5.2.3.5 Radiation as a threat to the environment

As mentioned, Castor casks containing radioactive material are temporarily stored at the KKI 2 site. The effects of this safety risk and potential radiation released into the environment are discussed by the experts mainly in relation to humans (Interviews 2, 3, 5, 6) but are also implied for the environment. Radiation as an environmental hazard is therefore a challenge for the region. **Challenge: Radiation as an environmental challenge**

5.3. Stakeholder landscape

Based on the interviews with experts from different areas of RET, several stakeholders can be identified. The actors mentioned as relevant by the interviewees are listed below. They all have an influence on and/or are affected by the decision on the repurposing of the KKI 2 site. For the sake of clarity and organisation, the relevant stakeholders are divided into four groups: Economic, social, environmental and political stakeholders. The following adds the information from chapter 3.. In addition, context-relevant information is added where necessary to ensure understanding.

5.3.1 Economic stakeholders

The operator and owner of the site is PreussenElektra. PreussenElektra and its parent company E.ON are therefore important players in the discussion about the repurposing of the KKI 2 site (Interview 6). Interview 2 names PreussenElektra as the most important partner that has ideas about the site and the structural possibilities after dismantling. Interview 1: "So first and foremost, of course, the site owner plays the biggest role." A change of ownership is not necessarily ruled out either. Interview 1 poses the question in the discussion about the role of the current owner of the KKI 2 site: "Is the current owner willing to sell his site or transfer it to the person who wants to continue using it?"

Actor: Operator and owner of the KKI 2 site

The grid operators are crucial, as the former nuclear power plant has very good grid connections at high and extra-high voltage level and are important stakeholders (Interviews 2, 3). Tennet, as the grid operator on the electricity side, and Bayernets on the gas side are the most important stakeholders (Interview 3, Interview 6). Although the energy market has been liberalised, grid operation is regulated by the state. The interface between these two areas is crucial and is strongly influenced by the regional companies involved (Interviews 4, 6).

Actor: Grid operator

Due to the liberalised energy market and subsequent energy use, (private) investors are an economic actor with important potential for influence (Interview 2, 4, 7). **Actor: Investors**

In the interviews, various energy-related subsequent uses were discussed, all of which have to do with a certain degree of grid expansion. In the discussion about expansion, landowners who own land in the immediate vicinity must be considered. Interview 7 mentions the example of transformer stations, where landowners must lease land.

Actor: Landowner

If the KKI 2 site is reutilised, the actors who realise or operate this repurposing come into play. In the case of large-scale battery storage facilities, this would be the operators of the corresponding facilities (Interview 7). Interview 7 points out the role of the project developer, who realises the cooperation between the various parties involved in a project. **Actor: Operator of the repurposing**

Local energy companies and municipal utilities are increasingly involved in the implementation of the energy transition and thus potential repurposing projects (Interview 2). Interview 2 brings Energie Allianz Bayern (EAB) into play, where the Free State of Bavaria itself also acts as a project developer. The EAB is an association of over 45 Bavarian municipal utilities and energy suppliers (EAB, 2025). **Actor: Municipal utilities and local energy companies**

Subsequent use has an impact on the regional economy. The construction and operation of a subsequent use can, for example, generate orders for companies and create jobs. The generation of regional added value is important (Interview 1, 7) and depends on the companies located in the region. Repurposing is therefore also influenced by the corporate and business landscape in the area surrounding the KKI 2 site. Companies as owners, regulatory addressees, investors, operators and as part of the regional economy are indispensable stakeholders whose interests, decisions and the regulatory framework under which they operate have a significant influence on the subsequent use of the site (Interview 4). **Actor: Regional companies**

5.3.2 Social stakeholders

This group of actors includes the population, local communities and groups in general that are affected by the impacts of repurposing, which have opinions or oppose/support certain after-use ideas.

Society in general, i.e. the population and the public, is affected by the impacts of a reutilisation and has an influence on the decision to do so (Interviews 1-7). Public protests, participation and regional value creation are decisive for the decision on repurposing (Interviews 1-7). **Actor: Society**

Within society, there are various groups with different wishes and interests that can influence the development of a repurposing. Farmers in the region, for example, have a special role to play (see chapter 3.1), especially when it comes to land utilisation (see chapter 5.2) (Interview 7). Overall, there are actors in society who are active across regional boundaries to realise certain interests (Interview 5). **Actor: Social interest groups**

5.3.3 Environmental actors

This category includes organisations and the natural environment itself, which can be influenced by or impose restrictions on reutilisation. Thus, the Bund-Naturschutz is mentioned as an important actor alongside other environmental organisations of Interview 2. They have ideas on how the subsequent use should be dealt with, must be consulted by the planning side and have an influence on decisions through protests (Interview 2). **Actor: Environmental associations**

The presence of nature conservation areas or high-quality ecological areas can pose a challenge for repurposing (Interview 2). Not only for ecological reasons and the preservation of nature, but also for visual reasons, nature is a decisive influencing factor regarding the repurposing of the KKI 2 site (Interviews 1, 2). **Actor: Nature**

5.3.4 Political actors

In addition to the economic, social and environmental actors, political actors also play a major role. The municipalities have planning sovereignty over the region and must amend development plans in the event of changes in utilisation. This can only be done by the municipality, and the municipalities are therefore very important players (Interviews 1, 2). The municipal planning associations are involved in planning (Interview 2) and the mayor can influence a development (Interview 7). The municipalities concerned are listed in the chapter 3.1. **Actor: Municipalities**

At state and federal level, politics determines various RET topics, such as grid expansion (Interviews 2, 5). Interview 3 emphasises the role of state policy as a relevant stakeholder, particularly in the context of funding, research and project development. Political regulations can also influence investments (Interview 4) and use tenders for the KKI 2 site to prioritise subsequent uses (Interview 4). **Stakeholder: Politics at regional, state and federal level**

Another stakeholder in this context is the government as legislator with its agendas, goals and programmes (Interviews 2, 4, 6). It is the stakeholder that must guarantee the fixed framework conditions, such as the Energy Industry Act (EnWG[6]) (Interview 4). Climate protection targets, such as CO_2 savings, are another example. The government therefore has an influence on the development of the repurposing of the former nuclear power plant. **Actor: Government as legislator**

The responsible licensing authorities are closely linked to this. They are relevant for the granting of building permits and other authorisations for new facilities on the site (Interviews 3, 7). It is up to them how quickly or successfully a subsequent use can be realised (Interview 4). **Actor: Licensing authorities responsible**

The location of KKI 2 is important for the Federal Network Agency if it is reutilised for energy purposes. For reasons of system stability, grid expansion, security of supply and the economic impact on the regulated grid infrastructure, the Federal Network Agency is both affected by the subsequent energy utilisation and has a decision-making role, as it plays the role of consumer protector (Interviews 1, 4). **Actor: Federal Network Agency**

The Ministry of Economic Affairs is responsible for all energy issues at state level but primarily sets the framework for subsidies and investments (Interview 1). It positions itself as an important stakeholder through legislation and regulation (Interview 4). **Actor: Bavarian State Ministry of Economic Affairs, Regional Planning and Energy**

5.4 Repurposing as solution for challenges and impact on region

In the sense of Rittel & Webber's (1973) "wicked problems", ideas for the reutilisation of the former KKI 2 site cannot be presented as final solutions, but rather as possible courses of action or strategic options that address certain challenges without completely solving them. "Solutions to wicked problems are not true-or-false, but good-or-bad." (Rittel & Webber, 1973, p. 14). The "assessments of proposed solutions are expressed as "good" or "bad" or, more likely, as "better or worse," [sic] or "satisfying," [sic] or "good enough." [sic]" (Rittel & Weber, 1973, p. 14). The assessment of good and bad based on the question of the extent to which reuse ideas are considered solutions and whether they are realisable is based on the expert knowledge of the interviewees in chapter 6..

This chapter summarises the various ideas for the subsequent use of the former nuclear power plant site after the dismantling work has been completed and the regional challenges. The focus here is on the impact of each repurposing on the region and the extent to which they address territorial challenges.

[6] Germ.: Energiewirtschaftsgesetz

5.4.1 Energy storage

The utilisation as energy storage is a topic which was discussed broadly. The following lists the different forms of storage, mentioned by the interviewees.

Battery storage is considered by the interviewees to be a promising repurposing idea for the site of the former KKI 2, as it addresses several economic, social and environmental challenges (Interviews 1-7). A major advantage of battery storage systems is their economic model, as they enable arbitrage. The electricity can be purchased cheaply when there is an energy surplus, as is the case in the region due to PV in summer and sold at a high price when demand is high in winter or during dark periods. Marketing can take place at short intervals (every 15 minutes) and intraday trading (Interviews 2-5). The necessary market for this already exists and the existing price differences between high and low-price phases in the electricity market favour this model (Interview 3). The system services that a battery storage system can provide are particularly interesting for grid operators, as they can react very quickly to fluctuations in the grid and thus support grid stability (Interview 4). The security of supply provided by regional energy storage systems can serve as protection against supra-regional power outages (Interview 5). Battery storage systems are designed as short-term storage systems and are technologically well suited for smoothing out the high PV peaks in the region and for grid stabilisation (Interviews 1, 4-6).

The experts argue that without storage, the fluctuations in renewable energies cannot be physically equalised. Battery storage systems are therefore a necessary part of a system with 100% renewable electricity generation (Interviews 1, 4, 6). The risk of overloading the grid and the associated need to switch off PV systems is also limited by the ability to temporarily store energy, which makes both ecological and economic sense (Interviews 1, 2, 4, 5, 7). From this point of view, battery storage systems are also relevant for the implementation of the energy transition and make a concrete contribution to achieving climate protection targets (Interviews 1, 4, 6). Particularly because battery storage systems are emission-free in operation and reduce the need for fossil-fuelled power plants (Interviews 5, 6), they are politically desired and part of the storage strategy of the energy plans (e.g. Energy Plan 2040), politically supported and promoted (Interviews 1, 2, 6, 7). This is also linked to the low approval hurdle for battery storage systems, which facilitates the realisation of such projects (Interview 2). For this reason, grid operators such as Tennet actively promote battery storage systems in their planning (Interview 6).

In addition to political and economic reasons, social acceptance also plays a role. Unlike gas-fired power plants, storage systems are not considered to be fossilised or backward-looking (Interviews 1, 3, 4, 7) and experience significantly less resistance than wind power, power lines or fossil-fuelled power plants (Interviews 1-4, 7). Battery storage is seen by the public as a "logical" and "green" repurposing (Interviews 1, 2, 5). The continued technical use of the site is seen as acceptable because the site has been characterised by the nuclear power plant for decades (Interviews 3, 7) and the population is used to the existence of large plants (Interview 3). At the KKI 2 site, storage projects can benefit from the energy infrastructure, such as high-voltage connections, transformer station, grid feed-in point and structural requirements (Interviews 2-5, 7). This makes the location particularly attractive for investors, as the existing infrastructure reduces construction cost subsidies (Interviews 3, 4, 7). Due to this available infrastructure, a large-scale storage facility on the scale of a power plant (1-2 GW) would be possible and sensible (Interview 7). The project planning of battery storage systems is currently experiencing a boom, which is since they are technologically mature, cost-efficient and have fallen massively in price over the last two years (Interviews 1, 7). The reasons for the technological and economic feasibility mean that the region benefits from seasonal surpluses from PV in deficit phases (Interviews 1, 4) and winter storage of wind energy from northern Germany (Interview 4). In addition, storage projects, such as battery storage, bring several benefits for the region, such as job creation, trade orders, regional added value or trade tax revenues (Interviews 1, 4, 7). Indirect regional effects, such as the use of heat (battery storage systems have a waste heat of 10-15%) in the local heating network or as a source of electricity for the charging infrastructure, can also favour development (Interview 4). Once a storage system has been realised, the resulting security of supply attracts energy-intensive companies (Interviews 4, 5) and makes the region attractive for investment and economic development (Interviews 2, 5). As sufficient capital is available, investors and construction companies are ready and all technical and regulatory requirements are in place, a battery storage system can be planned and realised immediately (Interview 7).

In contrast to battery storage systems, hydrogen storage systems serve as long-term storage systems. They are necessary to bridge generation gaps (Interviews 1, 4, 6). In addition, hydrogen power generation in gas-fired power plants is intended as the main storage function for a climate-neutral electricity system (Interview 6). Research in the field of hydrogen storage, especially underground storage, e.g. in former gas storage facilities, complements technical solutions for long-term storage (Interview 1). The technical conditions are very suitable for hydrogen-based storage, as they are for battery storage (Interviews 1-3). In addition, the petrochemical pipelines (see chapter 3.1) can be used for hydrogen (Interview 1). Interview 3 emphasises that the structural conditions of a former power plant site, such as KKI 2, are ideal for the realisation of hydrogen-related technologies (Interview 3).

The use of hydrogen is politically supported (Interview 6) and, like battery storage, is seen as a politically desirable solution for implementing the energy transition (Interviews 1, 2). The realisation of a hydrogen core network by 2032 is already politically planned and forms the infrastructural basis for hydrogen storage projects (Interviews 3, 5, 6). The ramp-up of the hydrogen economy is to be facilitated by the Bavarian state government through regulations and funding programmes and forms a central pillar of the Energy Plan 2040 and is therefore part of Bavaria's storage strategy (Interview 1).

The economic prospects cannot be clearly assessed (Interviews 1, 5). As a pilot project, a successful hydrogen project at the KKI 2 site could generate media attention and attract companies (Interview 1). However, as with battery storage systems, the social perspective can be seen as positive (Interviews 3, 5). The population is "surprisingly open" to hydrogen as a technology of the future (Interview 3). This is also linked to the safety aspect of hydrogen storage, as hydrogen is no more dangerous than natural gas when handled correctly and is far removed from the danger posed by nuclear power (Interview 3).

In order to decarbonise the energy system, hydrogen-based solutions are needed to replace fossil fuels in the future (Interviews 1, 5). Hydrogen is therefore a key building block for climate neutrality (Interviews 1, 4, 6).

Compressed air storage systems are an alternative to storing surplus energy in the region and are very useful (Interview 5). Technologically suitable for utilising surplus peaks in PV energy, they can "buffer" the surplus in a similar way to battery storage systems and act relatively quickly, which is important for the use of volatile renewable energies (Interview 5). Like the other forms of storage already mentioned, a compressed air storage system contributes to achieving climate targets and enables the realisation of the energy transition (Interview 5). At the same time, it is certain that the energy transition process will take longer, which would favour compressed air, as there is no finite raw material potential for this technology (Interview 6). Compressed air storage is therefore a sensible technology that is ecologically sustainable in terms of the availability of the required raw materials (Interview 6).

Like battery storage, the pumped storage power plant model is based on the "price spread from night to day" (Interview 5). They are relatively easy to implement if the required topography is available and are the largest storage facilities currently available (Interview 2).

5.4.2 Energy generation

As already mentioned, several times, the KKI 2 site is connected to the high and extra-high voltage grid, which also makes it ideally suited for a gas-fired power plant (Interviews 1, 3-6). Planning and realisation are simplified by the sufficiently dimensioned grid and the cost savings of the existing connection (Interviews 1, 3, 6). In addition, gas-fired power plants are technologically uncomplicated, which enables construction within six months once authorisation has been granted (Interview 1). In addition to the energy components, cooling towers and cooling circuits can also be utilised (Interview 3). In terms of infrastructure, the location for a gas-fired power plant is also attractive due to the structural conditions, such as space, insulation and the basic technical structure (Interview 3).

Gas-fired power plants can initially be operated with natural gas but are also compatible with conversion to hydrogen (Interviews 1, 5). The basic idea behind a gas-fired power plant at the KKI 2 site is its function as a reserve power plant to ensure security of supply in phases of low renewable electricity production (Interviews 1, 4, 6). As a supplier of base load electricity, they are an important component of the future energy system (Interviews 1, 4). Even if they are only operated for 200-1000 hours per year in the future, they are indispensable for the stability and flexibility of the electricity system (Interview 6). In addition, heat could be extracted through combined heat and power (CHP[7]) and fed into the local heating network (Interview 4). The climate neutrality of gas-fired power plants is to be achieved by switching to hydrogen operation from around 2038, thus avoiding fossil emissions as part of the political and technical planning for a completely decarbonised energy system by 2045 (Interviews 1, 4, 6). The option of CCS as a possible transitional solution during the period in which green hydrogen is not available also stores CO_2 (Interviews 4, 6).

Due to the infrequent operating hours, gas-fired power plants cannot be financed via the electricity market, but a capacity market that remunerates the provision of capacity is necessary and is enshrined in the government's coalition agreement (Interview 6). The comparatively inexpensive construction and the service life of approx. 30 years complement the argument of utilising the existing grid connections without residual demand regarding the economic viability of a gas-fired power plant (Interviews 3, 5, 6). Finally, PreussenElektra is interested in a repurposing that can use the valuable grid location as quickly as possible due to the high economic potential (Interview 6).

[7] Germ.: Kraft-Wärme-Kopplung

The generation of regional added value from local labour, technology and services also strengthens regional acceptance (Interviews 1, 5, 6). Socially, the location makes sense for the one reason that the population here is used to such an infrastructure (Interviews 3, 6) and that the location is outside urban areas (Interview 6).

The German government has set the construction of 20 GW of open-technology residual power plants as a political goal, two thirds of which are to be realised in southern Germany, which brings KKI 2 into focus (Interviews 1, 3, 6). Gas-fired power plants are already included in the plans of the Federal Network Agency and political quantity structures in order to ensure security of supply, stabilise electricity costs and achieve climate neutrality (Interviews 4, 6).

The production of hydrogen would also benefit from the energy qualities of the KKI 2 site (Interview 3). New sites without a grid connection are often difficult to connect, which makes the site "predestined" for subsequent energy utilisation with hydrogen technology (Interview 1). The planned HVDC line[8] from northern Germany ends directly at the site and enables wind power to be fed into an electrolyser so that operation can be guaranteed even at times of low PV production (Interview 1). At the same time, the region's renewable surplus electricity can be converted into hydrogen ("sector coupling") (Interviews 1, 4), which would avoid wasting renewable energy when the grid is overloaded and contribute to the effective utilisation of locally generated electricity (Interviews 3, 4). As part of national infrastructure planning, the hydrogen core network could be fed by the electrolyser (Interviews 4, 5). Interview 5 also emphasises that electrolysis is an active field of research, particularly in connection with specific infrastructure development (Interview 5) and sector coupling (Interview 6).

As the ideas for the repurposing of the hydrogen storage facility and the hydrogen-based gas-fired power plant make clear, the availability of hydrogen is fundamental if it is to be a central component of a future climate-neutral energy system (Interviews 1, 4). In the future, hydrogen will play a decisive role in industry, mobility and power generation, where it will contribute to grid stability and balance out volatile electricity (Interviews 1, 3). In addition, large energy suppliers such as RWE and specialised project developers are initiating electrolyser projects (Interview 3).

Due to the industrial character of the location (Interview 3), the positive image of hydrogen, the low risk assessment, regional value creation and the contribution to security of supply, hydrogen production is socially favoured (Interviews 3, 4).

[8] Germ.: Hochspannungs-Gleichstrom-Übertragung (HGÜ-Leitung)

Hydrogen is "right at the top of the agenda" of the Bavarian state government and the ramp-up is politically supported with funding programmes and research initiatives (Interview 1). The hydrogen core network, which should be in place by 2032 at the latest, underlines this agenda (Interview 5). A designation as a "special energy sector" in regional planning could ensure long-term use (Interview 1) and contribute to achieving political climate targets, such as no more CO_2 emissions in the electricity sector from 2040, which makes electrolysis strategically important (Interview 5). As already mentioned, hydrogen plays an important role in environmental aspects (Interviews 1, 3, 4).

No clear challenges were addressed when discussing the repurposing of the waste-to-energy plant (Interview 5). In many respects, it can be assumed that a waste-fired power plant behaves like a small-scale gas-fired power plant. Other economic, social and environmental perspectives can be assumed.

According to Interview 7, two central options are necessary at the site: PV systems and battery storage (Interview 7). Battery storage was discussed in chapter 5.4.1. and does not need to be repeated. The combination with PV creates new local added value beyond the battery storage system, for example through construction, operation and maintenance (Interview 7). The municipality can receive a financial sideline in that a municipal levy of 0.2 cent/kWh can be achieved through the combined use with PV. The possibility of a municipal levy is politically anchored in the EEG (§6) and offers financial incentives for municipalities (Interview 7). The local added value and the financial benefit for the municipalities minimises potential resistance and contributes to the achievement of climate protection targets (Interview 7). The combination of gas-fired power plant (hydrogen-powered) and large-scale battery storage (Interviews 4, 5), gas turbine (initially with natural gas/CCS, later hydrogen) and electrolyser (Interview 4), power plant and electrolyser (Interview 3) and battery storage and server farm (Interviews 4, 5) "solve" several regional challenges in one fell swoop through multiple utilisations. The advantages of each idea are explained in the chapters on the respective repurposing ideas.

5.4.3 Energy consumption

The utilisation of the site through the establishment of energy-intensive industry is derived from the available energy infrastructure and the availability of surplus PV peaks (Interview 3). For large consumers, the connection to the electricity grid at high and extra-high voltage level could be an "important criterion" (Interview 3).

Server farms and data centres are also considered energy-intensive infrastructure (Interview 5, Interview 4). Future electricity requirements are described as "unbelievable" (Interview 4) and require a continuous power supply (Interviews 4, 5). A combination with battery storage is technically possible and could also enable smaller scaling of the server farm (Interview 5). The location of KKI 2 with its grid connection is suitable for this, especially because the realisation would be technologically feasible (Interview 5).

The infrastructure around the nuclear power plant, such as security infrastructure, fire brigade and crisis protection, could be used for the operation of a data centre and could be part of a strategy to reposition the site as an industrial location or business park (Interview 4).
Even if no specific figure is given, a certain employment effect is assumed, which would generate regional jobs and social acceptance (Interview 5).

CCS/CCU is a technology for capturing CO_2 at source and is therefore essential for the goal of making fossil fuels such as natural gas climate-neutral (Interviews 5, 6). In the context of gas-fired power plants, this technology will be necessary from 2040 to meet climate targets (Interviews 5, 6). With this technology, gas-fired power plants could potentially continue to be used for 50 to 100 years without violating CO_2 regulations, which is why economic and political action is being taken in this direction (Interview 6). Industry associations assume that CCS would tend to be more favourable than the use of hydrogen, although CCS could also be established as a complementary technology in a mixed system in which hydrogen and CCS coexist (Interview 6).

As the hydrogen strategy is currently not sufficient in terms of supply to achieve the targets set on its own, CCS is being discussed as a political and strategic alternative solution (Interview 6). Initial political concepts and plans for the development of CO_2 pipeline infrastructure in several federal states are helping to fulfil climate targets, guarantee security of supply and bring the development of CCS/CCU into the next phase (Interviews 5, 6).

5.4.4 Research and non-technical after-uses

As a forward-looking and important field of research, nuclear fusion research is currently still an area of basic research (Interview 1). With great potential for long-term energy supply, fusion technology is seen as a new key technology that could contribute to solving future energy problems (Interview 1). The Bavarian state government supports fusion research and is extremely open to such technologies, signalling its willingness to support new and risky research projects (Interview 1). Due to the high-quality energy infrastructure and the peripheral location of the site, a research use such as fusion at KKI 2 is suitable because it is not dependent on physical proximity to consumers (Interview 4).

The repurposing of the KKI 2 site as an industrial monument is seen as justified (Interview 2). Interview 2 himself had the personal experience of visiting KKI 2 a few years ago during a school visit and implies a social and educational value of a (now former) nuclear power plant (Interview 2).

The region around KKI 2 is already used for local recreation. In the surrounding Isar region there are options for fishing, cycling on the Isar cycle paths, jogging and walking, swimming in nearby lakes (Interview 2). The ecological value of the region can contribute to its use as a local recreation area (Interview 2).

5.5 Implementation prospects and challenges for the realisation of reuse ideas

Chapter 5.4 brought together the repurposing ideas and regional challenges and considered the extent to which the repurposing ideas address territorial challenges. This chapter brings together the repurposing ideas and regional challenges but looks at the prospects for implementation. The economic, technical, political, financial and scheduling perspectives are considered in order to find out what restrictions and hurdles exist for certain repurposing.

A repurposing of the KKI 2 site is of course affected by the regional challenges, just like the rest of the region. Even if the ideas for repurposing can address and "solve" these, the challenges can still represent obstacles to the implementation of the ideas. Tabel 3 in the appendix visualises the results of this chapter.

5.5.1 Energy storage

The idea of re-utilising the KKI 2 site in the form of a battery storage facility can be hampered by political aspects. At the moment, grid connections are being dismantled rather than being retained. The operators lack the justification and financial basis to maintain the infrastructure (Interview 4). The lack of a clear political decision on repurposing is also linked to the strict legal situation regarding the repurposing of nuclear power plant sites in the Atomic Energy Act, which makes it difficult to develop new projects at the KKI 2 site (Interview 4). Added to this are the risks for investors, which make Germany less attractive due to the constantly changing political and regulatory requirements. They prefer to go to the United Kingdom (UK), where attempts are being made to give investors free access to the market. The lack of legal clarification regarding the repurposing of nuclear power plant sites could be regulated by amendments to the Atomic Energy Act in order to create clarity for investors (Interview 4).

In addition, the neighbouring properties are partially blocked by dismantling work, which makes it difficult to set up a battery storage facility until the dismantling work has been completed (Interview 4). This also includes the argument of competition for space between storage infrastructure, power lines and other uses (Interview 2).

As already mentioned, the approval hurdles for battery storage systems are relatively low. Nevertheless, cooperation with the approval authorities and grid operators is essential, which means formally complex processes and can pose a challenge for this subsequent use (Interview 7). Particularly because there is uncertainty as to how the dismantling of KKI 2 can be dovetailed with the construction of new infrastructure, the realisation of a battery storage facility could be significantly delayed if the dismantling takes too long (Interview 6).

Regulatory uncertainty is another obstacle to the realisation of a battery storage system. Storage operators demand reliable regulations on grid charges, operating times and marketing (Interview 4). Regulatory uncertainty not only restricts the willingness to invest but also plays a role in the conflict between grid and market interests (Interview 4). Grid operators want storage systems where there are bottlenecks, while investors want to install them where arbitrage is possible (Interview 4).

Battery storage systems are generally regarded as short-term storage systems. Due to their limited effect, they are technically only suitable for short-term energy storage and therefore not suitable as a stand-alone storage solution to fully guarantee security of supply (Interview 1). This is a frequent criticism of battery storage systems, particularly in comparison to other storage technologies (Interview 2). Large battery storage systems with a higher degree of efficiency are currently still very expensive (Interview 6). Decontamination would also be very expensive, which would be necessary in the presence of significant radiation, because utilisation as battery storage is not possible in this case (Interview 5).

The realisation of a hydrogen storage facility at the KKI 2 site faces technical hurdles. There are geological requirements for underground hydrogen storage, for example in former gas storage facilities, which are not met at the site (Interview 1). In addition, this utilisation is still at the research stage (Interview 1) and the specific infrastructure connections are lacking (Interview 3). The lack of a hydrogen core network in particular makes a large hydrogen storage facility at the site unrealistic at present (Interview 3). An isolated island solution without a supra-regional hydrogen network (Interviews 3, 5) and without the availability of hydrogen (Interviews 1, 5) is not viable.

Furthermore, there is currently no hydrogen market (Interview 1). The economic risk for companies is therefore high and industry is not yet able to switch to hydrogen to a sufficient extent (Interview 1). The unclear cost-benefit ratio and the unclear economic viability are economic obstacles to the realisation of the idea of a hydrogen storage system (Interview 1).

There are also political and regulatory obstacles. It is unclear whether political priorities will remain so strongly focussed on climate targets (Interview 5). However, a stable regulatory framework is necessary for the market for hydrogen technologies to develop (Interview 5). Concrete legal and planning structures are lacking, particularly for the expansion of the hydrogen core network (Interview 6). An operational hydrogen core network is not planned until 2032 (Interview 6).

The geological prerequisites for a compressed air storage facility are also lacking, as underground caverns with suitable geological conditions are required. In the Isar valley and therefore also at the KKI 2 site, realisation is not so easy (Interview 5). The construction of caverns above ground is impractical and not technically feasible due to their size (Interview 5). Compressed air storage systems have not yet achieved economic success (Interview 5) and are not viable in the long term as an isolated solution that only works at certain locations (Interview 6).

In addition to the geological conditions, the Isar valley also lacks suitable topography for various ideas. Pumped storage power plants require significant differences in altitude, which are not present at the KKI 2 site. In Lower Bavaria, a possible site was identified in Passau with the Danube, while the area around Landshut, the focus region of this study, is not suitable for a pumped storage power plant due to the relatively wide and shallow Isar (Interview 2).

The original business model of pumped storage came under pressure due to the expansion of PV (Interview 5). PV's competitor in the model, which is based on the price spread between day and night, works better and is more economically viable (Interview 5). The trend towards battery storage and the "dormant" plans for pumped storage also do not speak in favour of an unproblematic subsequent use of the site (Interview 2).

5.5.2 Energy generation

The repurposing of the KKI 2 site as a gas-fired power plant is hindered in its implementation by various challenges. Firstly, there is no state-regulated capacity market, which is necessary to remunerate the "keeping available" of energy (Interview 6). Although this is politically planned, it has not yet been implemented (Interview 6). Secondly, the gas-fired power plants are only operated as reserve power plants for 200-1000 hours per year, which is why electricity prices would have to rise eightfold in the short term in order to be economically viable, which would be unrealistic in today's market (Interview 6). The option of operating a gas-fired power plant with hydrogen from 2040 is linked to all the implementation conditions for hydrogen technologies already discussed (Interview 5). Furthermore, it is not clear at what price a hydrogen-capable power plant would be available, which represents a considerable economic risk (Interview 5). Furthermore, the discussion about the cost-effective alternative CCS can delay investment decisions (Interview 6).

Just as the lack of H_2 infrastructure can be an obstacle to the realisation of a gas-fired power plant as a reserve power plant, the lack of a CO_2 transport network is also an obstacle (Interview 5). Power plants are designed to operate for 30 years. In a dynamic environment, this represents a risk (Interview 5), especially if operation with hydrogen is dependent on the availability of a hydrogen core network, which is not due to be realised until 2032 (Interview 3).

Although gas-fired power plants are politically desirable, there is a lack of concrete tendering conditions and legal framework conditions (Interview 3). The dependence on political prioritisation calls for a change in the Atomic Energy Act or the Decommissioning Act to prioritise subsequent uses such as gas-fired power plants (Interview 4).

Another factor affecting the realisation of this subsequent use is social acceptance and the image as a "fossil technology". Despite their future suitability for hydrogen, gas-fired power plants are sometimes seen as backward-looking, which can lead to social resistance in a region with a green image (Interview 5). The well-known issue of competition for space could be problematic (Interview 2), as well as the fact that expertise and capacities in plant construction could be limited at times because hardly any gas-fired power plants have been built in Germany in recent years (Interview 6).

Bavaria has hardly been a location for large hydrogen projects to date (Interview 3). It is questionable whether the techno-economic framework conditions at the location are good enough to make hydrogen production there economically viable (Interview 3). Overall, companies are currently taking too high a risk economically to invest in hydrogen, as the market is not yet attractive enough (Interview 1).

However, it is not only the better renewable energy potential in the north of Germany and the techno-economic framework conditions that can influence the realisation of an electrolyser at the location. Even if a hydrogen core network is planned, it is only planned to pass close to KKI 2 and a direct connection has yet to be established (Interview 3). Similarly, the existing components of KKI 2 could not be reused for reasons of age or potential radiation (Interview 3). The risk of having to rebuild everything and the hindrance to the dismantling process could represent obstacles to the realisation of this idea (Interview 3). There is also the political will to produce hydrogen, but not the corresponding market (Interview 1). The political framework conditions are also still inadequate (Interview 1).

The idea of waste-to-energy plants is not directly discussed in terms of implementation in the respective interviews. However, several experts emphasised that certain technologies are socially sensitive, especially if no direct regional benefit is perceived (Interview 5). There is also the possibility that, for example, the Bund Naturschutz or other environmental organisations can become relevant players in controversial projects and may well file lawsuits if there are ecological concerns (Interview 2).

The challenges regarding the realisation of (large-scale) battery storage systems have already been examined. The addition of a PV system poses further hurdles to the realisation of such subsequent use. Large ground-mounted PV systems compete with other utilisation interests and often encounter resistance from the population (Interview 2). As a result, citizens are increasingly less willing to compromise, space is becoming increasingly scarce, and projects are becoming increasingly difficult to realise (Interview 2). Especially in Lower Bavaria, with a growing PV area and a regular energy surplus from solar energy, competition for usable land is intensifying (Interview 2). There are also regulatory hurdles for PV projects in terms of land use and approval procedures, which can delay realisation (Interview 7).

5.5.3 Energy consumption

The major advantage of the site is the security of supply thanks to the grid connections. However, the site is peripherally located due to its former use as a nuclear power plant (see chapter 3.1). The rural location could be problematic for some industries that need to be close to customers (Interview 4).

Unlike energy-intensive industries, a server farm must be constantly supplied with electricity (Interview 5). This means that they cannot simply be operated during PV peaks (Interview 5) and are therefore not a solution to the region's energy problems, but are themselves an additional consumer (Interviews 4, 5).

CO_2 is usually stored in old mines or suitable geological structures. There are no such structures in the KKI 2 region (Interview 5). In addition to this condition, there is also a lack of hydrogen, which is often required as a feedstock for CCU, making this option technologically complex and very expensive (Interview 5). Furthermore, the CO_2 infrastructure in Germany does not currently exist and there are only conceptual designs and no real projects that have been successfully realised to date (Interview 5). The existing gas pipelines cannot be used as CO_2 pipelines either, which puts existing infrastructure into perspective (Interview 6).

Although the concepts for CCS and CCU exist, their implementation is still unclear and in its "infancy"[9] (Interview 5). In addition, the current focus on hydrogen can be seen as an obstacle to the implementation of CCS/CCU projects because prioritisation is lacking and CCS/CCU is seen more as an emergency or supplementary solution and not as part of the main strategy (Interview 6). In view of the political uncertainty, it is unclear whether investments in this area are economically viable and worth the risk (Interviews 5, 6).

5.5.4 Research and non-technical repurposing

Nuclear fusion research is currently still in basic research and is a long way from market-ready application (Interview 1). It is therefore a long-term and visionary project that is more suitable for large-scale international projects such as ITER (see ITER, 2025). Independent development at the KKI 2 site is considered pointless (Interview 5).

The technology is also extremely cost-intensive (Interview 1). Public and private sources would be necessary to even think about site development (Interview 1). A region like Lower Bavaria cannot provide the billions required for such a research project (Interview 5).

For the KKI 2 site to be used as a nuclear fusion research centre, a political majority would have to be achieved at state or federal level to enable the construction of a centre in the first place, which current political initiatives do not promise (Interview 1). Furthermore, there are conflicting attitudes at various levels of politics (e.g. mayors vs. state government), which makes planning even more difficult (see also Kuntschner, 2025).

The Bavarian state government's proposal is seen as an attempt to tap into national funds with a prestige project without any realistic chance of success (Interview 5), which speaks more in favour of prestige politics than factual politics. Furthermore, Germany has more pressing problems to solve, particularly in energy infrastructure, which is why focussing on nuclear fusion in this context would be "a waste of money" (Interview 5).

The authority to decide on future utilisation lies essentially with PreussenElektra and the municipality (Interview 2). PreussenElektra comments on the subsequent use to the extent that the subsequent use contributes to the success of the energy transition and an energetic utilisation of the KKI 2 site is an obvious option (Kuntschner, 2025). Nuclear fusion or industrial monuments are seen more as "secondary ideas" (Interview 3).

[9] Germ.: Kinderschuhen

Strong doubts are expressed about the idea of using the site as a recreational area for leisure activities. The site is technically very used, the area is characterised by infrastructure and commercial areas and is not visually appealing (Interview 2). The site itself is visually characterised by its previous use and is therefore not very suitable for traditional leisure activities. In general, there are no factors at the site that would make it attractive for such use. The cycle path, for example, runs on the other side of the Isar, i.e. not in the immediate vicinity of the site, and access to the Isar is limited, which makes local recreation even more difficult (Interview 2).

In addition, other places in the neighbourhood, such as a quarry pond in Wörth with a wakeboarding facility and beach bar, are much more attractive and already established for tourism (Interview 2). Interview 2 lacks the "imagination" of how the location could be used for leisure activities. There are currently no concrete plans or ideas for a conversion into a local recreation area and a sophisticated and innovative concept would be needed, which is currently not in sight (Interview 2).

6. Discussion and conclusion

In chapter 5., the ideas for the repurposing of the site of the former Isar 2 nuclear power plant were first presented, based on the interviews with the experts. The challenges that are relevant for the region according to the experts were also listed. Chapter 5.4 examines the extent to which the reutilisation ideas "solve" the challenges, and chapter 5.5 looks at the implementation perspective of the ideas. All in all, it becomes clearer that by talking about the repurposing of the former nuclear power plant, “wicked problems” are to be dealt with.

Based on the expert interviews, the reutilisation ideas will now be evaluated according to this approach. What counts here is the extent to which the ideas "solve" regional challenges and the extent to which their implementation is hindered and restricted. The former is visualised in table 4 in the appendix. It is important to understand here that a challenge is only understood to be "solved" by an idea if this can be clearly understood as such in the interviews with experts. An example for understanding: An electrolyser needs the hydrogen core network and an electrolyser at the KKI 2 site thus favours expansion in the region. However, the electrolyser is not a solution to the regional challenge of "specific grid expansion/non-existence of the specific grid" and, as I, the researcher, understand it, does not address the challenge. An expansion of the hydrogen core network as a repurposing idea would address the challenge of "non-existence of the specific network". However, the expansion of the hydrogen core network is not one of the reutilisation ideas of the KKI 2 site listed by the experts.

The regional challenges are numbered consecutively for reasons of space. An overview of the corresponding challenges with a brief supplementary description is provided in the appendix (table 7).

Table 9 in the appendix shows that, based on the expert opinions, some ideas "solve" more regional challenges than others. Thus, a high sum value can be taken as "better" and a low one as "worse" according to the “wicked problems” approach. It should be made clear here that an attempt has been made to methodically summarise the uncertainty of long-term economic, technical, political, financial and scheduling developments. The assessment is based on the current state of the economy, technology, political regulations and objectives, finances and scheduling aspects. Political plans, such as the hydrogen core network planned by 2032, are only considered as a realisation factor if the experts emphasise a high probability or certainty of implementation in the interview. Goals such as climate neutrality by 2045 or the construction of reserve power plants (Interview 6) are also considered to be firmly established and are included as an assumption in the feasibility, regardless of whether they would already be technically or financially feasible today. Overall, it can be said that the assessment is based on the perspective of a project developer. This means scrutinising which risks currently exist in order to implement a subsequent use idea and which risks currently justify a decision not to plan.

Looking at table 3 in the appendix, it becomes clear that some subsequent use ideas are inhibited by fewer implementation perspectives and others are more difficult to realise. The sum of the crosses results from the number of realisation perspectives that do not inhibit a subsequent use idea. The two tables (Table 9+3) can then be combined in the next step to form a total for each repurposing idea. The result is summed up in table 4 in the appendix. The amount of the value is therefore the evaluation of the ideas on an expert basis. The higher the value, the "better" the reutilisation idea and the lower the value, the "worse".

In order to be able to discuss the results from the expert interviews, the reutilisation ideas are evaluated in the discussion based on their ability to address regional challenges and their practical feasibility. In table 4 in the appendix, the results were aggregated into a combined assessment measure that allows the ideas to be categorised into three groups. The ideas with a large sum are in the group of highly rated reutilisation ideas, those with a moderate impact and feasibility are in the group of medium rated reutilisation ideas and those with a small sum are in the group of low rated reutilisation ideas. The discussion of the results starts with the low-rated reutilisation ideas and ends with the high-rated ones.

6.1 Discussion of the results for the subsequent use of the KKI 2 site

In order to further analyse and discuss the ideas and ultimately answer the research question, the "key challenges" must be identified. The selection is made according to six self-selected criteria, which are based on the context of the expert interviews and literature research.

Criteria for the selection of key challenges:

1. Systemic relevance as a prerequisite for the functioning of several technologies
2. Political-strategic anchoring as a link to climate targets, energy plans or regulatory requirements
3. Economic relevance for willingness to invest and market conditions
4. Social acceptance as a prerequisite for the implementation of repurposing
5. Multiple mentions in the interviews and explicit highlighting as an indication of relevance
6. Multiple addressing through various subsequent use ideas as an indication of broad relevance

Based on these criteria, eight key challenges can be identified (see table 5 in the appendix), whereby the regional challenge of the attractiveness of the region for labour was combined with that of regional value creation.

In the following, the "worse" reutilisation ideas are discussed first and concluded with the "better" ones. This guarantees a cumulative argumentation, a coherent reader guidance and the avoidance of repetitions.

6.1.1 Low-rated repurposing ideas

The following list the low-rated repurposing ideas.

6.1.1.1 Local recreation

The area in and around KKI 2 could be transformed into a local recreation area and used for leisure activities such as cycle paths, fishing, walking or swimming. The reutilisation idea only solves two regional challenges, neither of which is one of the key challenges (see table 5). Similarly, the experts do not indicate any prospects for implementing leisure activities at this location, even though the idea of utilising nuclear power plants in this way exists in North Rhine-Westphalia (Wunderland-Kalkar, 2025; Yamamoto et al., 2020).

This repurposing idea is not an energy use, as it is preferred by the landowner and operator of KKI 2 PreussenElektra (Kuntschner, 2025). In particular, the repurposing should "contribute to the success of the energy transition and integrate harmoniously into the landscape." (Kuntschner, 2025). In addition, the Deputy Bavarian Minister President and Minister of Economic Affairs, Regional Development and Energy Hubert Aiwanger has spoken out in favour of the construction of new power lines and power lines (Reiner, 2024), further paving the way for energy use.

Compared to other reuse ideas, the option of local recreation is also discussed rather marginally and with scepticism. According to Interview 2, he lacks "a bit of imagination" about what to do there in terms of local recreation and describes the area as unattractive and "rather grey" (Interview 2). In this respect, this reutilisation idea neither addresses regional challenges nor would it be simple and straightforward to implement.

6.1.1.2 Industrial monument

The idea of utilising the site of the former nuclear power plant as an industrial monument presupposes the preservation of the buildings. This subsequent use would merely address a regional challenge and would not be particularly easy to realise. Particularly because the demolition work on the buildings of KKI 2 is planned and has already been completed, this subsequent use is no longer an option (see chapter 3.3).

Interview 5 emphasises that in this case, KKI 2 is in competition with other nuclear reactors that are more attractive for subsequent use as industrial monuments. He assumes that complete decontamination (if necessary) and preservation of the buildings would be more expensive than complete demolition and disposal of the rubble (Interview 5). Interview 2, on the other hand, does not find an industrial monument unworthy to discuss, although other options for subsequent use are far more popular and Interview 1 also emphasises the energy efficiency of the site (Interviews 1, 2).

The idea of an industrial monument was propagated by the Bavarian state government (Kutscher 2025). The proposal from Munich was rejected by the mayor of the affected municipality of Essenbach, Dieter Neubauer (see chapter 3.1), with the words: "If you want, instead of demolishing the cooling tower, you can dismantle it and rebuild it in Munich, then you have your memorial." The municipality with its decision-making authority makes the idea unlikely.

6.1.1.3 Nuclear fusion research

Bavaria has its own expert commission for nuclear fusion (founded in April 2024), which has recommended using the KKI 2 site for research and training. This reutilisation idea only addresses three regional challenges, of which the key challenge 15 is part (see table 5). The idea of the nuclear fusion research centre is discussed rather critically and marginally by the interview partners. Interview 5 argues quite vigorously against such utilisation, as "endless amounts of money" are already being wasted on nuclear fusion. He considers it "completely pointless" to go into nuclear fusion research at the KKI 2 site and emphasises that nuclear fusion will be "available in 50 years" and "really has no value" for the current problems (Interview 5). According to Interview 5, the idea is viewed negatively as a "work programme for unemployed physicists" and because Germany has "other construction sites"[10]. Interview 1 concedes that it is an "important field of research“ but emphasises that fusion research "devours a lot of money" and is "very cost-intensive" (Interview 1).

The municipality of Essenbach and its mayor are equally unenthusiastic about the state government's proposal to build a nuclear fusion research centre: "Pure research locations that bring us prestige but nothing financially, we can do without them, to put it in good Bavarian terms" (Kuntschner, 2025). The power plant site is a commercial area that must also generate business tax (Kuntschner, 2025). The financial aspect of a nuclear fusion research site is once again difficult to realise from an economic perspective with the limited resources of a municipality.

6.1.1.4 Pumped storage power plant

The repurposing of the site as a pumped-storage power plant stems from the idea of using the reservoir, which was used to cool the nuclear reactor, as storage energy. In comparison to other ideas discussed, this option is only marginally considered in the expert interviews, and most experts do not consider it practicable or a priority for the KKI 2 site. The idea only addresses three regional challenges and a total of two key challenges (see table 5), which makes the idea more attractive than those already discussed, but is not feasible at the KKI 2 site due to the topographical conditions.

As pumped storage power plants are "geologically bound" and "certainly do not fit in such a location" (KKI2), this idea is not a real repurposing option (Interview 5). Interview 2 also notes that there are virtually no pumped storage power plants in Bavaria and that realisation is

[10] German expression for „bigger problems“ (germ.: andere Baustellen)

"not at all easy" due to the topography (Interview 2). Interview 2 rules out the possibility of raising the reservoir to a suitable height.

No relevant stakeholders, such as the operator PreussenElektra, the Bavarian state government or regional energy companies, have publicly commented on the repurposing as a pumped storage power plant. Although this option is an energetic utilisation and would solve regional challenges as a storage facility, it is not a significant repurposing idea compared to alternative storage options.

6.1.1.5. CCS/CCU

In view of the climate targets and the urgency of avoiding CO_2 emissions, the idea of repurposing with CCS/CCU is obvious. In total, this idea addresses four challenges, one of which is a key challenge (see table 5). This repurposing idea was discussed by specific experts (Interviews 5, 6) and received more attention than the ideas already discussed in chapter 6.1. In particular, the role of CCS and CCU for industry and the fulfilment of climate targets makes the option of CCS/CCU at the KKI 2 site relevant. The Federal Ministry for Economic Affairs and Climate Protection also sees CCS/CCU as a building block for a climate-neutral and competitive industry (BMWK, 2025a). In the interviews, however, the experts point out various challenges for the realisation of CCS/CCU at the site, from investment risks to the lack of CO_2 infrastructure. Overall, the idea of reutilisation can be considered promising and important if various conditions are met.

6.1.1.6 Waste-to-energy plant

A waste-to-energy plant is an idea that addresses three challenges and a total of two key challenges (see table 5). As a power plant, it fulfils several criteria that make it more attractive as a subsequent use option than the previously mentioned ones. However, this idea was only mentioned by one expert and only very briefly (see Interview 5). In the discussion about power plants, it was only said that a waste-fired power plant could be an alternative form of power plant (Interview 5).

There are waste-to-energy plants in Lower Bavaria that are used for the thermal utilisation of waste. The nearest one is in Upper Bavaria but is also important for the districts of Rottal-Inn and Dingolfing-Landau (Energie-Atlas, 2022). The "Zweckverband Abfallverwertung Südostbayern" says that the "golden age" is over, partly because waste fees are rising significantly (ZAS, 2024). The idea of repurposing of the waste-to-energy plant is therefore not a viable option for the KKI 2 site, especially in comparison to the ideas that are still being discussed.

6.1.1.7 Compressed air storage

A compressed air storage facility is a cavern with air at different pressures, whereby higher pressure is generated when there is a lot of energy, which can then be called up by releasing the air (Interview 5). As a storage option, this idea solves four regional challenges and a total of three key challenges (see table 5). This repurposing idea was brought into play by Interview 5 and received less attention compared to other storage options. This is because pumped storage power plants can act quickly, but must fulfil geological requirements, which is "not so easy in Bavaria" (Interview 5). Such storage facilities must be built underground (Interview 5). Even if this option were feasible above ground, it is questionable whether it is the "right way" (Interview 5). Interview 6 emphasises that storage technologies are not about "one-off solutions" that only work at a few locations, but about a technology being "scalable and more cost-effective". This means that a compressed air storage system is generally not an attractive storage option. No statements or comments from important stakeholders on this storage option can be found in the relevant literature, which makes the repurposing idea even less likely.

6.1.2 Medium-rated repurposing ideas

The following list the medium-rated repurposing ideas.

6.1.2.1 Energy-intensive industry

Due to the existing grid infrastructure and the associated security of supply, the repurposing idea of locating energy-intensive industry at the KKI 2 site tends to be assessed positively. Four out of five challenges addressed are key challenges (see table 5). Nevertheless, it should be noted that the option addresses few regional challenges and does not stand out in terms of implementation. The idea is discussed by several interviewees, but neither at length nor in depth. Interview 5 tends to argue that the site would be suitable for an energy-intensive industry, but that this subsequent use would not necessarily be well suited to the location and the impact region, even if the region would experience regional added value, such as through the creation of jobs (Interview 6).

The municipality of Essenbach is also clearly in favour of commercial use of the site. Interview 4 also expresses concerns about the establishment of energy-intensive industries. He considers this to be "rather unlikely", as existing industries do not relocate quickly and the availability of space in the vicinity of the power plant is unclear (Interview 4). It cannot be ruled out that stakeholders such as Stadtwerke München, as a 25% shareholder in KKI 2, are interested in such utilisation. The proximity to Munich and the short distance for commuters could be an advantage (see chapter 3.).

6.1.2.2 Server farm

In the context of the relocation of energy-intensive industries, a moderate amount has been said about the subsequent use idea of a server farm or data centre. As a specific industry, this idea addresses four regional challenges, three of which are key challenges (see table 5). Some experts consider the use as a server farm to be feasible and easy to implement, however, it is emphasised that, like the general energy-intensive industry, a server farm "does not solve a problem, but is another consumer in the electricity grid" (Interview 5). Furthermore, a server farm cannot be switched off in the event of an energy deficit, which requires absolute security of supply. Interview 4 describes reutilisation as a "very, very good idea" (Interview 4). However, he goes into the advantages of the existing infrastructure, the safety aspect regarding the radiation problem and the availability of, for example, the fire brigade and crisis protection. In the event of residual radiation, a data centre would be "ingenious" (Interview 4). The server farm after-use idea can therefore be described as a good idea, but not as the best solution for the site.

6.1.3 High-rated repurposing ideas

The following list the high-rated repurposing ideas.

6.1.3.1 Hydrogen production

Hydrogen production using electrolysers is a very relevant option for the repurposing of the former Isar-2 nuclear power plant. The production of green hydrogen in conjunction with the utilisation of surplus renewable energy addresses 11 regional challenges and seven key challenges (see table 5). However, realisation is proving difficult due to the main argument of the lack of expansion of an H_2 infrastructure. The planned completion of the hydrogen core network by 2032 plays a role in all repurposing ideas that have to do with hydrogen (Interviews 3, 5, 6). Interview 6 also confirms that the hype surrounding hydrogen is diminishing, resulting in a more sober view of corresponding ideas (Interview 6). Nevertheless, hydrogen remains a promising solution for the industry in terms of industry, storage and supply (Interviews 3, 6). Interview 3 describes the possibility of an electrolyser (Power to X plant) to produce hydrogen as one of the primary options for the subsequent energy utilisation of the site (Interview 3). He adds considerations that an isolated solution in which hydrogen is produced, stored and consumed on site is "unrealistic" (Interview 3). It can be concluded that an electrolyser cannot exist without the hydrogen core grid and that a supplementary utilisation, such as a hydrogen-ready gas-fired power plant, is necessary. In addition, hydrogen production would not utilise any other components of the nuclear power plant apart from the electricity grid connection (Interview 3) and would still require additional expansion.

A hydrogen core network is essential. However, petrochemical pipelines can also be used to transport hydrogen (Interview 1). There is such a pipeline near the KKI 2 site that could be used (see chapter 3.1; MIT, 2023). The refurbishment of existing natural gas infrastructure for up to 100% hydrogen is also seen as one of the most energy- and resource-efficient energy transport methods (Klopcic et al., 2022). In 2022, Huber Aiwanger described the order for the construction of a 5 MW electrolyser to produce green hydrogen in the hydrogen region of the Landshut, Ebersberg and Munich districts as a "historic step into a new era, from the fossil world to the world of renewable energies" (StMWi, 2022). The operator Hy2B Wasserstoff GmbH has built an electrolyser in Pfeffenhausen, which is less than 30 km from the KKI 2 site (Hynergy, 2025). The Hydrogen Technology User Centre (WTAZ) is also being built here, which is being funded by the federal government and the Free State of Bavaria with a three-digit million sum (StMWi, 2022). It is therefore clear that the region is already investing in hydrogen and that the expansion of a hydrogen core network is not unlikely. Hydrogen plays a central role in the Bavarian Security of Supply Strategy - Energy Plan Bavaria 2040 and forms a pillar for the future energy system (StMWi, 2024a+b). Accordingly, a subsequent use with hydrogen is to be assessed very positively, although no hydrogen core network has yet been realised and there are therefore economic risks.

6.1.3.2 Gas-fired power plant/back-up power plant

The idea of utilising the KKI 2 site as a gas-fired power plant shows clear tendencies as a sensible and necessary option. Four of the seven challenges addressed by this idea are key challenges (see table 5) and a gas-fired power plant can be realised in all implementation perspectives. In the interviews, this idea is discussed particularly intensively and designed in different variants, which speaks in favour of the malleability of gas-fired power plants. Gas-fired power plants are also regarded as long-term storage facilities and as reserve power plants they guarantee security of supply (Interview 6). Interview 6 emphasises that 70 to 100 TWh of the expected electricity demand of 1000-1100 TWh in 2045 will have to be covered by gas-fired power plants. They are therefore of crucial importance in the future energy system (Interviews 1, 6). From an economic and scheduling perspective, gas-fired power plants are also a favoured subsequent use, particularly because they can be operated on both a CCS/CCU and hydrogen basis, which is in line with climate targets and political regulations (Interviews 1, 3, 5, 6). A hydrogen core network is to exist from 2032 and the transition to hydrogen operation is planned for gas-fired power plants from around 2038 (Interview 6). This also fits in with the current coalition agreement, which provides for the construction of 20 GW of technology-neutral gas-fired power plants as reserve capacity (Interview 3). It is stipulated that two thirds of the reserve power plants are to be built in the so-called grid south (Interview 6). Interview 6 says: "The location is regionally sensible and correct, so to speak." On 2 June 2025, Katherina Reiche, Germany's Minister of Economic Affairs and former head of E.ON subsidiary Westenergie, announced the "southern bonus"[11], which is intended to support the construction of two thirds of the new capacity in southern Germany (Reuters, 2025). Hubert Aiwanger also says: "Bavaria needs additional secured capacity from new gas-fired power plants." (StMWi, 2025) The Bavarian Energy Plan 2040 also favours controllable gas/hydrogen power plants (StMWi, 2024a+b). This idea is therefore politically fixed and can be implemented quickly. Plans are also underway for a market-based capacity market, which is to be regulated by the state and established by 2030-2032 (Interview 6). There are no technical problems with this repurposing and there is also social acceptance of this idea (see chapter 5.5). In terms of technical compatibility, a gas-fired power plant is " the simplest thing that can be erected [...] [at the KKI 2 site]" (Interview 5). In Lower Bavaria, the districts of Rottal-Inn, Dingolfing-Landau and Landshut have the highest land consumption and are well above the Bavarian average. In 2016, approx. 0.6 ha per day were consumed (RPL, 2018), which calls for intensive and effective utilisation of the already developed areas. A gas-fired power plant can typically be operated for 30 years (Interview 5) and run on hydrogen in the long term if it is hydrogen-ready. This ensures the most effective utilisation possible, which sets this idea apart from other short-lived repurposing ideas. Interview 3 sees the KKI 2 site as a potential power plant site rather than an electrolyser (Interview 3). However, it must be said that other ideas are addressed more after the regional challenges mentioned by the experts. The fact that the necessary infrastructure for a hydrogen-based gas-fired power plant does not yet exist also means that this repurposing idea is associated with a certain risk in terms of investment. The option of CCS/CCU, which may be necessary to meet climate targets, is described as expensive

[11] Germ.: Südbonus

and economically uncompetitive (BMWK, 2025a). Nevertheless, the (climate) political, technical, social and, in many respects, economic security makes the idea a very promising one for experts.

Such a gas-fired power plant has already been realised at the Schwarze Pumpe industrial park in Brandenburg (RefLau, 2025). The task of the storage power plant is to offer grid-supporting balancing power and to enable sector coupling using hydrogen. This means that surplus electricity from renewable sources is stored in the form of hydrogen and positive and negative balancing power is offered for the electricity grid (RefLau, 2025).

6.1.3.3 Hydrogen storage

The realisation of a hydrogen storage facility at the KKI 2 site was discussed extensively by the experts and is considered one of the most promising options. Often associated with a hydrogen-ready gas-fired power plant, this idea addresses eleven regional challenges and seven key challenges (see table 5). Due to the technical prerequisite of hydrogen availability, the idea cannot be realised soon and is not (yet) economically viable (Interview 5). Underground storage is not feasible for geological reasons (Interview 3). However, Interview 3 also says that above-ground storage would be a "relatively safe issue" if implemented correctly, where there will be "no catastrophic explosions". However, local tank storage facilities are "too small and too expensive" for power plant scales (Interview 3). Nevertheless, Interview 6 sees a hydrogen-capable gas-fired power plant as the main long-term storage option (Interview 6). Hydrogen has the great potential to minimise industrial greenhouse gas emissions, secure jobs and make German industry more resilient (DVGW, 2025) and is considered a key element in the future energy system (Umweltbundesamt, 2024). Hydrogen storage enables the integration of renewable energies, increases security of supply and contributes to the decarbonisation of various sectors (BMWK, 2025b). Storage systems are particularly important in the region due to the well-known problem of energy surpluses caused by midday PV peaks. The regional electricity grid is at its capacity limit because the expansion of PV systems is too high (Hildebrandt, 2023). Long-term storage systems are particularly needed for this reason and are also highly recognised by experts, despite the difficulties of implementation.

6.1.3.4 Battery storage

The idea of a battery storage system for subsequent use was discussed at length and in depth by all interviewees. These are either small-scale battery storage systems or large-scale battery storage systems that can cover up to 20 hectares and consist of containers with batteries

(Interview 2). A battery storage system addresses seven regional challenges, six of which are key challenges (see table 5). Storing energy is the key to solving many of the region's challenges, making this idea a very popular and likely one in the conversation of repurposing the former nuclear power plant. Economically, politically, technically and socially, the idea faces no hurdles to realisation. Interview 7 does not see any major challenges in realising a battery storage system, apart from "don't hesitate. Do it!"[12] (Interview 7).

This also fits in with the planned interim utilisation of the KKI 2 site as a battery storage facility (see chapter 3.3). The construction project on the site of the Isar 2 nuclear power plant is currently Bayernwerk's largest planned battery project. The company is investing a double-digit million euro amount in this project (Sedlmeier, 2025). The first expansion stage of the plant with an output of 50 MW and a storage capacity of 100 MW is scheduled for completion by 2026. Further expansion stages are planned for 150 MW and even 500 MW (Pichlmaier, 2024). Interview 7 describes this planned storage facility in the first expansion stage as "ridiculously small" and a "Lego toy", as a storage facility in the order of 1000 - 2000 MW (the capacity of the former nuclear power plant) could be built at the site (Interview 7). However, it should also be noted that Bavaria's largest battery storage facility with 100 MW was commissioned in Arzberg in Upper Franconia at the end of 2024 and the largest approved electricity storage facility in Europe currently has "only" 137.5 MW (located in Lower Saxony) (Pichlmaier, 2024). In general, research by the Fraunhofer Institute for Solar Energy Systems found that battery storage of 5 to 6 GWh would be possible at the Isar 2 nuclear power plant site, based on the area assumptions described in the paper (Wille-Haussmann et al., 2022).

The disadvantages and negative points of repurposing of the KKI 2 site as a battery storage facility are the storage capacity and regional added value. Battery storage is limited to 4 to 12 hours of storage capacity (Interview 4) and would create fewer jobs in the region than other reutilisation ideas (Interview 5). Nevertheless, battery expansion is important (Interview 4) and can certainly be practically combined with other uses, such as an electrolyser or a server farm (Interview 5). In Lower Bavaria, several plans for large-scale battery storage systems have emerged in the last quarter of the year, even if not many of them are yet in the process (Interview 2). According to Interview 2, there is "some music" in the region as far as battery storage is concerned. According to data from the Federal Network Agency, around 200 large-scale battery storage facilities are specifically planned in Bavaria, almost half of which are to be built by 2025 (Storch et al., 2025). The approval hurdles have also been set relatively low

[12] Germ.: „Nicht lang fackeln! Machen!“

and the requirements for these storage facilities have been lowered (Interview 2). In addition, a municipality would probably be more likely to support a battery storage system than a gas-fired power plant, as battery storage systems are perceived as "more renewable" (Interview 4). Compared to other ideas, Interview 3 also sees a large battery storage system at the KKI 2 site as "more interesting than hydrogen".

Nevertheless, a battery storage system is not the best idea for repurposing. With battery storage systems, you can be glad if they are operated for 10 years and must be partially renewed over time (Interview 5). They are also not long-term storage systems (Interview 5), but they are agile and flexible in terms of electricity sales (storage revenues through arbitrage in electricity trading) (Wrightsman, 2025). Interview 6 adds that large-scale battery storage systems are not an alternative to gas-fired power plants but only serve as a supplement (Interview 6). In view of the focus on cost efficiency in the context of the energy transition, large-scale battery storage systems tend to be used with restraint ("as much as necessary, but as little as possible"). This is one of the reasons why home storage systems should feed into the system in future. Tennet is currently experiencing a certain "battery storage hype" and is a great advocate of large-scale battery storage. But the existence of reserve power plants is yet another category than the main system, because battery storage systems are only "supplementary components" (Interview 6).

Overall, it can therefore be said that the idea of battery storage as reutilisation is very attractive in many respects. In particular, the interim utilisation until completion of the dismantling measures for KKI 2 speaks in favour of large-scale battery storage. However, battery storage alone is unattractive in some respects, such as the long-term perspective.

6.1.3.5 Combined solution

Based on the interviews, the idea of a combined solution can be rated as particularly "good". The idea is to bring together various energy-related uses at the KKI 2 site in order to utilise the existing infrastructure, consider regional advantages and address challenges. In doing so, 16 regional challenges and all key challenges are addressed (see table 5). It should be noted that the respective combinations address different challenges to varying degrees. One example of this is the combination of a battery storage system and a PV system (Interview 7). Energy production by PV would further increase the challenge of surplus energy, even if a battery storage system could utilise it directly. An on-site consumer in combination with a storage system would have virtually the opposite effect (Interviews 4, 5). The implementation can therefore also be categorised differently. Overall, all combinations proposed by the experts can be realised relatively easily in four implementation perspectives.

Overall, multiple utilisations of the site are welcomed in order to combine different services and create multiple benefits (Interview 4). These include the utilisation of waste heat (e.g. for heating networks in surrounding municipalities), the provision of charging stations for electromobility or peer-to-peer electricity sales for the municipalities (Interview 4). Such combinations could increase the attractiveness for the establishment of energy-intensive industries and regional development in general, as well as social acceptance (Interview 4).

One combination that is less favoured by experts is that of CCS/CCU and a power plant or industries (Interviews 5, 6). Interview 5 and Interview 6 point to the CO_2 transport network, which would have to be completely rebuilt with new pipelines. However, CCS/CCU is potentially a more favourable option if the hydrogen import strategy does not work (Interview 6).

Combinations that function as isolated solutions are also less popular. Although the production, storage and consumption of hydrogen at one location does not require a fully developed hydrogen core network, it is categorised as economically unlikely, as the quantities are too large and the above-ground storage options are too expensive (Interview 3). Overall, a connection to the planned hydrogen core network is seen as a prerequisite for large hydrogen projects (Interview 3).

The combination of battery storage and server farm complements itself. The battery could serve as a buffer for the energy-intensive consumer and thus supply electricity 24 hours a day (Interview 5). The assessment of the combination of battery storage and server farm can be found in chapters 6.1.3.4 and 6.1.2.2.

Interview 7 considers the combination of a battery storage system and energy production with a PV system to be the most sensible repurposing (Interview 7). The cost efficiency of battery storage systems, which has increased significantly in the last two years, makes project planning attractive. Chapter 6.1.3.4 discusses the battery storage option. For the combination with a PV system, it should be added that although energy production using PV at the site with a large battery storage system makes sense, there are already PV peaks in the region that are seven times as high as required in the region. Additional production could further exacerbate the regional challenge of the surplus.

ABO Wind's first PV-battery hybrid project in the district of Rhön-Grabfeld in Bavaria (ABOENERGY, 2023) shows that the combined solution of PV and storage works. The plant is a combination of a solar park (8.7 MW output) and a battery storage system (2.9 MW output and 5.8 MW capacity) (ABOENERGY, 2023). Bayernwerk has since taken over the project (Bayernwerk, 2023), which means that important stakeholders in the region of this research also believe in this combined solution. The idea is also gaining popularity on a smaller scale, such as the installation of PV systems on private rooftops and battery storage in basements (see also 1KOMMA5°, 2025; Enpal, 2025).

Hydrogen-ready gas-fired power plants are mentioned by several experts and linked to other technologies. Interview 6 proposes a "combined cycle power plant", which could include a gas turbine (initially with natural gas and CCS, later with hydrogen) and an electrolyser to feed surplus electricity into the hydrogen core network. Electricity generation using gas-fired power plants is seen as more attractive for investment than pure battery storage (Interview 6), which should make a combination of energy production and energy storage the most attractive option. Interview 1 sees a hydrogen-based gas-fired power plant as a long-term storage solution and as a way of supplying the base load electricity needed to stabilise the grid (Interview 1). Interview 4 also agrees that production and storage are needed and sees a combined cycle power plant as sensible (Interview 4). Nevertheless, as discussed in chapter 6.1.3.2, the lack of a hydrogen core network and the political and economic uncertainties regarding hydrogen should be mentioned at this point.

As mentioned earlier, there is a gas-fired power plant at the Spremberg site that combines various technologies. The battery system in this reference power plant can store surplus energy from renewable sources. There is also an electrolyser here (RefLau, 2025). Stakeholder RWE commissioned a 14 MW electrolyser on the site of the Emsland gas-fired power plant in summer 2024. With the help of green electricity, the H_2 pilot plant is an example of how gas-fired power plants can be used in the future (RWE, 2025). Until it is connected to the hydrogen grid, the hydrogen is transported to the customer by road via tankers. With this pilot project, RWE is testing on a small scale what the company wants to implement in the three-digit MW range just a few metres away in the GET H_2 Nucleus by 2027 (RWE, 2025).

The combinations of different technologies are discussed particularly intensively and in detail in the interviews. In addition to the content-related statements, the duration of these topics can be taken as an indication of the positive assessment of this idea. In addition, the experts explicitly stated that the combination of different technologies is promising. Overall, the idea of a combined solution can be assessed as "good" regarding the "wicked problems" and can be seen as the favoured solution across all interviews.

Such a combined cycle power plant means openness to technology, which is important in times of the energy transition. However, this point can also be interpreted as a hurdle, as questions arise regarding planning security: Will hydrogen be the energy source of the future? Will hydrogen dominate the industry? What role will batteries play in the various sectors? Will battery storage be used as the main storage system in the future energy system? We can only estimate how the respective technologies will develop. The political plans and objectives as well as the climate targets to which Germany has committed itself support a corresponding development. The flexibility and malleability of gas-fired power plants is also a plus point regarding the uncertain future of RET.

6.2 Answering the research question

Based on the results and their discussion, the central research question of this thesis can be answered: "How can the former Isar 2 nuclear power plant be repurposed in regional energy transitions to address territorial challenges?"

Tables 3 and 4 clearly show which ideas can be realised according to which implementation perspectives and which reutilisation ideas address which challenges. This makes it possible to assess how the KKI 2 site can be reused in order to address as many challenges as possible and can be realised in as many perspectives as possible. The ideas were discussed further in chapter 6.1 and placed in a context outside of the interviews.

According to the theory of "wicked problems" by Rittel & Webber (1973), ideas can be expressed as "better or worse" or rather “good or bad” solutions (Rittel & Webber, 1973, p. 14). All the reutilisation ideas presented address the identified regional challenges to varying degrees. After analysing the results of the expert interviews and their discussion, the reutilisation idea of the combined solution is particularly "good". A combination of solutions can address more regional challenges than a stand-alone solution/technology. As described earlier, "to address" is understood to mean both "to solve" and "easy to implement". The example projects and sources listed in chapter 6.1.3.5 with political, social and economic statements emphasise the potential of the idea of a combined solution. The length and depth of the interview sections on combined transport solutions are a further indication.

Interviews 1, 3-7 welcome multiple utilisations and it is also implied in the interview with Interview 2. The combinations of PV and battery storage (Interview 7), gas-fired power plant (hydrogen-ready) and storage (battery or hydrogen) (Interviews 1, 2 (implied), 3, 4, 6), gas-fired power plant (hydrogen-ready) and electrolyser (Interviews 1, 2 (implied), 3, 4-6), gas-fired power plant and CCS/CCU (Interviews 4-6), gas-fired power plant and battery storage

(Interviews 1, 6), battery storage and server farm (Interviews 3 (implied), 4, 5) and the combination of battery storage and electrolyser (Interviews 3 (implied), 5).

If the combined solution is the answer to the question of the most promising idea, further considerations can be made regarding the specific combination, i.e.: "Which combination addresses the regional challenges "best" in regional energy transitions?" Considerations in this direction are no longer part of the research question and should therefore not be part of this research. In order to answer this further question, further interviews would have to be conducted that focus precisely on this question. Based on the knowledge and state of research in this thesis, one assumption can be made. Based on the interview results and political plans and projects already established in Germany, a combined cycle power plant in the grid related south is very likely (see chapter 6.1.3.5). A reserve power plant based on hydrogen with an electrolyser or storage facility could therefore be built at the site of the former Isar 2 nuclear power plant once the dismantling measures have been completed. It must also be considered what the interim use as battery storage and the associated plans means for the final subsequent use of the site.

6.3. Researcher's assessment

In the previous chapters, the expert interviews were systematically evaluated, the results analysed and then discussed based on empirical findings and scientific literature. This chapter is dedicated to a personal reflection on the results and adds my own ideas and considerations. In addition, we briefly describe what the results teach us about RET. It does not claim to be empirically objective but is intended as a reasoned and reflective contribution to the discussion.

6.3.1. Further considerations/suggestions

In the interviews with the experts, it became apparent that nature is not necessarily perceived as a stakeholder. The environmental aspects were only discussed in depth in the interviews because the guiding questions addressed them. The ecological perspective took second place to the economic, social and political perspectives always during the discussions. This probably cannot and will not change in the coming years, but perhaps it should. Long-term environmental consequences and sustainability issues, for example biodiversity or noise emissions, need to be discussed more intensively, particularly in conflict between nature conservation and energy utilisation and considering the land use conflict in the region.

In the interviews, various topics that deserve more attention were discussed only marginally or not at all, just like the stakeholder nature. The role of responsibilities and administrative boundaries is important for the repurposing of the site. Such repurposing requires coordination between the district, municipality, operator, etc. As a key factor for the realisation of a subsequent use, the interaction of these actors is decisive and deserves closer consideration, which was not given in the interviews.

The international perspective and European embedding are particularly important in the discourse on energy issues. The electricity grid extends across Europe (Interview 6) and cannot be considered separately within national borders. A good example of the importance of an international perspective is the widespread power outage on the Iberian Peninsula at the beginning of May 2025 (Dilger, 2025). For reasons of grid stability, security of supply and resilience, the international perspective and European embedding are important to consider. There was little discussion in the interviews about how the repurposing is embedded in European energy strategies (e.g. EU Green Deal) or whether European financing instruments would be relevant.

In general, neighbouring countries could be more closely involved in the considerations regarding the subsequent use of the former Isar 2 nuclear power plant. In particular, the extent to which they re-utilise former industrial sites. A current example is the subsequent use of the former Aldel aluminium shelter, where a large battery storage facility with a capacity of 300 MW and an output of 1,200 MWh is currently being built. The GIGA Leopard project shows that a former industrial site in RET, which is connected to a high-voltage grid like KKI 2, can be reused in a few years. The grid operator here is also Tennet (Giga-Storage, 2025). Interview 6 describes the question regarding neighbouring countries and their approach to the energy transition as a "super good question" and says that it could be a topic for a master's thesis (Interview 6). Interview 6 says that neighbouring countries do it "differently" and cites France and the 60% of electricity consumption that it covers with nuclear power. Norway has a different situation, as it has a lot of hydropower. Denmark developed offshore wind very early on. Austria also has a lot of hydropower, which accounts for around 60% of its electricity grid (Interview 6). The latest developments in Belgium are particularly interesting. The four remaining reactors were due to be shut down this year. However, on 15 May 2025, the Belgian parliament cancelled the nuclear phase-out and decided to continue operating the reactors and build additional nuclear power plants (Spiegel, 2025). Minister Bihet argues that Belgium must increase the share of nuclear power in the Belgian energy mix to generate CO_2-free electricity (Spiegel, 2025).

The discussion about the recommissioning of KKI 2 or Germany's nuclear phase-out in general could fill a master's thesis of its own and will be briefly touched on here. In 2022, RWE CEO Krebber made it clear that the hurdles for the continued operation of a nuclear power plant were high, but not insurmountable (Bundestag, 2024). PreussenElektra Chairman Knott is more optimistic. His company was prepared to continue operating the Isar 2 plant for reasons of security of supply for Germany. The power plant was in top condition at the time of the shutdown, and the nuclear power plant was described as one of the best plants in the world (Bundestag, 2024). In February 2025, Bavarian Minister President Markus Söder expressed confidence in a return to nuclear power. He has since abandoned this plan because a restart is no longer economically viable and no political majority can be found in favour of it (Jerabek, 2025). This makes the expansion of gas power, which the current government has decided on, even more important (Jerabek, 2025).

Another major and complex issue can be raised in relation to this topic. The question of the gas required for the initial operation of the planned reserve power plants, where it comes from and what consequences and effects the use of gas has can be discussed intensively in the context of the RET of a repurposing of the KKI 2 site as a gas-fired power plant. Until the beginning of 2022, around 55% of German natural gas imports came from Russia (BpB, 2022). After the start of the war in Ukraine and the Nord Stream 1 and parts of Nord Stream 2 pipeline being blown up, Russian pipeline gas is no longer an option. Since August 2022, no more Russian natural gas has been flowing through the pipelines to Germany (Rudolph, 2025). Since 2022, the focus has increasingly been on liquefied natural gas (LNG), which comes from the USA, the United Arab Emirates, Australia or Norway, for example (NDR, 2025). The energy landscape has thus been reorganised, and Germany is facing new dependencies on LNG countries, which creates new geopolitical risks.

Demographic and social transformation processes as well as long-term cost consequences for the region are further topics that can be discussed superficially and potentially in greater depth in the interviews. Overall, it should be noted that due to the scope of this research, the weighting of the topics was largely left to the experts. Thus, the length and depth to which the content was discussed in the interviews is indicative of the importance of the topic of this research.

In connection with topics that were only discussed in passing or not at all, other regional challenges that were not mentioned by the experts may be of significance. For example, the shortage of skilled labour and general demographic change, competition for resources, logistical connections to the location or planning capacities on the part of the municipality or state government. Planning uncertainty could be cited as a particularly relevant strategic challenge. The topic of nuclear waste was also only touched on and can be analysed in more detail. This major discussion should be briefly addressed at this point. No final solution has yet been found to the problem of radioactive nuclear waste. Where there are no geological conditions for a sensible final repository in Germany, international strategies must be adopted. However, innovation is also progressing in this area. A new study by the Federal Network Agency for Leap Innovations shows that nuclear waste can be dismantled more quickly through recycling and transmutation. Instead of remaining dangerous for over a million years, waste could be reduced to less than 1,000 years of radiation and become a valuable source of raw materials (Focus, 2025). Overall, it should be noted that more attention could have been paid to other regional challenges in research with a larger scope and interviews with a broader guideline.

6.3.2 What do the results teach us about regional energy transitions?

The results of this research teach us that transition is highly location dependent. Geography and regional infrastructure are crucial, as topography, geological conditions and the existing energy infrastructure create the framework conditions. There is also the balancing act between system logic and feasibility. The realisation of projects depends on political framework conditions, such as the hydrogen strategy or climate targets, regulatory clarity, economic viability and social acceptance. The role of stakeholders also influences the discourse and planning processes. Another finding is that nature as a stakeholder is still subordinate to other aspects. Overall, the results clearly show how important energy storage is as a central regional field of action and that issues such as grid stability and security of supply are fundamental for decisions in RET. It is clear that RET require time, planning security and flexibility. RET are long-term, adaptive processes that need to take uncertainties and developments into account, especially at regional level. In conclusion, it can be learnt from the results that RET are complex, context-bound processes in which technical, economic, political, social and environmental factors are closely interwoven. The case study of the repurposing of the KKI 2 site shows by way of example that the reutilisation ideas that "best" address regional challenges are not only the most suitable in terms of energy but are also the result of a balancing act between infrastructure, stakeholder interests, politics and society.

6.4 Critical reflection

The aim of critical reflection is to critically analyse the selected research question, the selected research design and the limitations of the research. Alternative research questions are rejected for good reason, the data basis and methodology are critically reflected upon, the lack of generalisability is listed, my role as researcher is explained, and further research needs are discussed.

6.4.1 Research question

The formulation of the central research question was chosen deliberately. "How can the former Isar 2 nuclear power plant be repurposed in RET to address territorial challenges?" The research question has already been explained and its meaning defined in chapter 4.1. In the critical reflection on the research question, we will discuss why alternative formulations were rejected.

The research question is not: "What is the best reutilisation idea?" The "best idea" would presuppose that there is an objectively correct path and that this can be identified by the research. This would mean that the research would neither do justice to the complexity of regional energy transitions nor to the context-related and interdisciplinary nature of after-use. Nevertheless, a comparative evaluation is carried out in this paper. This also makes sense without missing the research question. The comparative evaluation is not an objective, but the result of the systematic analysis. By working out that certain reutilisation ideas address a particularly large number of (key) challenges and can be implemented at the same time, it follows that they appear particularly sensible under the given conditions. This means that some ideas are identified as particularly promising in the regional context, but not as the one best idea. Even if one reutilisation idea performs "better" than the others, this does not mean that it is the one reutilisation that is objectively the best in all cases. Due to the contextualised and interdisciplinary nature of RET, it is only possible to assess the extent to which reuse ideas address the regional challenges and how "well" they do this.

6.4.2 Data basis and methodology

At the outset, it must be considered whether a combination of qualitative and quantitative data would have complemented or validated the results of this research. A mixed-methods approach was rejected in the process before the start of the research, as there is a risk of losing focus and going beyond the scope of the work. No hypotheses are to be tested in this research, which makes quantitative data collection irrelevant. Where quantitative data collection was dispensed with, the analysis of the qualitatively collected results from the interviews is presented quantitatively. This creates a generalisability and comparability that enables further analysis and subsequent discussion.

When conducting research with qualitative interviews, there are several limitations. The interpretation of the data is never completely objective and therefore the evaluation depends on my own knowledge, expectations and decisions along the research process. Transcription is also an interpretative act where pauses can be misunderstood. In order to ensure transparency and comprehensibility, this is pointed out at several points in this work.

Likewise, the findings are always contextualised and only apply to the topic discussed in the specific interview. In some cases, the results of the interviews are characterised by the framework conditions of the year 2025. Repeating the research later could lead to different results. It is not possible to generalise unless this was clearly stated in the interview. The aim of this work is not to find generalisable statements, but merely to answer the research question. The design of the research is suitable for this purpose and the results of the interviews fulfil the requirements.

Without disregarding the anonymity of the interviewees, the diversity of the interviewees can be cited as a limitation. Gender, age, origin, etc. can play a role and have an influence. At this point, my own gender, age, origin, etc. must also be considered. The selection of interview partners may also have been influenced by various factors. I always selected the interview partners to the best of my knowledge and belief and did not self-select according to other factors, such as opinions or social affiliation.

The interview partners were selected according to various criteria. Some of these include the timeliness of the interviews, the thematic expertise of the interviewees and their regional focus. At this point, the diversity of stakeholders should be mentioned, which cannot be fully guaranteed by the seven interview partners.

The number of interview partners resulted from the preliminary discussions with the supervisor of this master's thesis and the intensive preparation. This included extensive research into potential interview partners, coding relevant topics and categories and evaluating the suitability of various experts. Thematically, there was repetition in the interviews and a certain theoretical saturation, which indicates that the number of interviewees was not too many or too few.

Theoretical saturation in the classical sense cannot be guaranteed. However, after conducting and analysing the seven expert interviews, it became apparent that central topics and assessments were repeated, which indicates that the central research question was largely covered. In line with the studies by Guest et al. (2006), data saturation can be said to have been achieved due to one specific argument. In their study, which comprised 60 interviews with women in two West African countries, it was found that general saturation occurred after the first twelve interviews. However, fundamental elements for thematic topics were already present after six interviews. In particular, 80% of all themes were identified within the first six transcripts. It can therefore be concluded that in the study by Guest et al. (2006), a sample of six interviews would probably have been sufficient to develop meaningful themes and useful interpretations. This argument should also be applied to the present research on the reutilisation of the former Isar 2 nuclear power plant.

An information sheet was sent to the interview partners in advance. The presentation of my questions may have influenced the response behaviour. The knowledge that they were being recorded may also have had an influence. The research design is such that it does not force answers, but on the contrary leaves room for spontaneous and unforeseen answers.

During the interview, the order of the open-ended guiding questions may have led to different results. This is unavoidable because a semi-structured interview is designed to encourage and structure a conversation more than a prefabricated sequence of questions and answers. I always clarified misunderstandings and clarified ambiguities during the interview.

Non-verbal cues are particularly lacking in interviews conducted purely by telephone. The lack of these can also influence the results during transcription. In addition to this aspect, however, technical conditions such as a poor connection or the time limit can be ruled out. At no point during the interviews did the technology or the time limit influence the quality of the results.

Some of the content limitations have already been listed. It was not possible to conduct an interview with the important stakeholder PreussenElektra. A justification has already been provided in this chapter, and it has already been argued why there is no major gap in the research. Other stakeholders whose perspectives are underrepresented in the interviews conducted can also be listed. However, the argument that all important categories are covered thematically by the seven interviews and that important perspectives are sufficiently covered by expert opinions also applies here. Nevertheless, it should be mentioned at this point that some of the perspectives that could have revealed new aspects or contradictions may be missing. In the interviews, the experts' ideas were very much considered and new ideas were only thrown into the room by me when necessary and appropriate. This meant that some topics received special focus and other topics less so. This varies from interview to interview. Nevertheless, it is possible to compare and analyse the results because the interviewees were responsible for the answers. There was an open discussion space in which the experts could decide how deeply they wanted to go into a topic.

At this point it should also be mentioned that the AI-based translation tool DeepL was used to translate and improve the text. It should be noted that the text was written by myself and myself only. The language and translation tool was only used for the purposes of language improvement, writing style, and grammatical and linguistic polishing. Following Frivold & Rypestøl (2025), the use of Notebook-LM should also be mentioned. Like the case of Frivold & Rypestøl (2025), only textual suggestions were received from this explicit tool, which were critically evaluated and revised. This ensured that the writing style and analytical approach were consistent. I assume full responsibility for the final content, as Notebook-LM was used as a background tool and not to generate independent passages. Thus, no direct references to any tools may appear in the research paper.

Overall, it should be noted that the chosen research design and the implementation of empirical work always ensured transparency and traceability. I always acted to the best of my knowledge and belief and in accordance with all the rules of scientific work.

6.4.3 Generalisability

A central lesson of the results of this research is that repurposing is site-specific. RET are dependent on regional factors, which vary from region to region. It is therefore important to emphasise that the statements of the interviewees, the evaluation of reuse ideas and the identified regional challenges are context-specific and cannot be easily generalised. At the same time, however, the results show structural similarities that may be relevant in the context of reutilisation in RET. The deeper understanding of this topic can be related to other cases but cannot be adapted in detail. A direct generalisation to other nuclear power plant sites in Germany or Europe is therefore not possible.

It was not possible to go into the exact starting position of repurposing in the interviews. On the one hand, the dismantling work is only in the early stages, and it is not possible to say exactly what the site will look like when a reutilisation is realised. On the other hand, it is not clear how certain reutilisations are to be combined with the demolition work, which is why this point is listed as a challenge in this work. Chapter 3.3 lists all relevant information available on the dismantling and interim utilisation of KKI 2. Just as the case study of KKI 2 cannot be projected onto other nuclear power plants, the ideas for repurposing cannot be projected onto all scenarios of the initial position. It remains to be seen how this starting position will develop and what developments will take place in the coming years.

6.4.4 Implications and limitations

Follow-up research that brings together and discusses the identified stakeholders could answer open questions and go beyond the limitations of this research work. The research in this thesis is based exclusively on expert interviews, remains explorative-analytical and does not include an implementation phase. Furthermore, the results cannot be generalised and transferability to other exnovation locations is only possible under certain conditions. The most important limitation of this research is the uncertain political framework conditions, which may relativise the results of this research at a future date. Open questions remain regarding the involvement of different stakeholders in a real post-utilisation process, the positioning of the owner PreussenElektra regarding the national hydrogen and storage policy and the further development of the CORIS approach and its applicability.

6.4.5 Further research needs

The temporal component is elementary in the planning of repurposing. Further research is needed to investigate the exact time planning factors that are relevant to different repurposing ideas. The problem of the uncertain future was addressed in particular regarding the expansion of an operational hydrogen core network. However, in order to be able to plan concretely, there must be no uncertainties regarding the future and research into this problem must be carried out. In this paper, the discrepancy between political objectives and actual implementation and the methodological problem between forecasts and an analysis of the actual situation were only superficially addressed, if at all. A separate master's thesis could address what changes could occur in RET until the dismantling measures are completed and a subsequent use is realised.

Further research needs could also be an in-depth investigation of governance structures. This could clarify responsibilities, competences etc. more precisely. Following on from this, further research into civil society is necessary. The influence of social and cultural factors and social acceptance form a broad field of research that can be investigated using other and complementary methods.

In this paper, a repurposing idea was labelled "good or bad" according to Rittel & Webber (1973). Complementary research could be conducted on how to evaluate the success or failure of repurposing. Research could focus on the development of indicator-based monitoring and evaluation approaches. Of course, the need to conduct research on the next core processes within the CORIS approach (see Trippl et al., 2024a) should also be emphasised at this point.

6.5 Outlook and concluding thoughts

Regions are the key locations of the energy transition, as they are not only the venues of these transitions, but also central actors in the design and realisation of new energy systems. RET emphasise that the energy transition will not be shaped at national or global level alone but must be implemented specifically in regions. The "wicked problems" become visible through the regional perspective (e.g. grid expansion, battle for space, conflicts between actors), which are often covered up at national level. RET thus opens new perspectives on economic, social and environmental reorientation.

The nuclear power plant in the region of Lower Bavaria is to be decommissioned by 2037. It has not yet been decided what reutilisation will be made of the KKI 2 site. This work merely provides a theoretical basis. Project planning is the responsibility of the regional players. A possible next step as an outlook for this work would be the establishment of a regional reutilisation forum for KKI 2. This step would correspond to the orchestration sub-process and function as a cooperative space for action in which the relevant stakeholders develop reutilisation perspectives.

Exnovation does not mean standstill but change. The decommissioning of the nuclear power plant should not create an industrial void, but an opportunity with energy potential and symbolic power to make the energy transition possible. Especially with the German climate targets, a regional energy transition that addresses key challenges is fundamental. Theory can provide structure, but actors are needed to implement the RET. This work provides the knowledge, now it needs the decisions and the will to shape the change.

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Appendix

Realisation prospects /Post-utilisation ideas	economic	technical	political	financial	time planning	**sum**
Battery storage	x	x	x	x	x	**5**
Hydrogen storage			x			**1**
Compressed air storage			x			**1**
Pumped storage power plant						**0**
Gas-fired power plant/standby power plant	x	x	x	x	x	**5**
Hydrogen production			x			**1**
Waste-to-energy plant		x				**1**
Combined solution	x	x		x	x	**4**
Energy-intensive industry		x	x	x		**3**
Server farm	x		x	x	x	**4**
CCS/CCU						**0**
Nuclear fusion research						**0**
Industrial monument		x			x	**2**
Local recreation						**0**

Table 3: Which reutilisation idea is realisable according to which implementation perspective? (Source: author's elaboration (2025)).

Post-utilisation ideas	Total ideas as solutions	Sum of reutilisation perspectives	**Final total**
Battery storage	7	5	**12**

Hydrogen storage	11	1	**12**
Compressed air storage	4	1	**5**
Pumped storage power plant	3	0	**3**
Gas-fired power station/back-up power station	7	5	**12**
Hydrogen production	11	1	**12**
Waste-to-energy plant	3	1	**4**
Combined solution	16	4	**20**
Energy-intensive industry	5	3	**8**
Server farm	4	4	**8**
CCS/CCU	4	0	**4**
Nuclear fusion research	3	0	**3**
Industrial monument	1	2	**3**
Local recreation	2	0	**2**

Table 4: To what extent do the reutilisation ideas address regional challenges based on the definition of "to address" (see chapter 4.1) (Source: author's elaboration (2025)).

Challenge	**Challenge number**	**Challenge category**	**Brief justification**
Dominance of PV and seasonal/daily imbalance	1	Summer/midday energy surplus and winter/night deficit	Systemic dependency, explicit naming, political relevance, many addressing ideas
Utilisation of surplus energy	2	Summer/midday energy surplus and winter/night deficit	Systemic dependency, political target commitment, high discourse presence, many addressing ideas
Limited renewable energy potential	3	Potential for renewable energies	Explicit naming, political target commitment, many addressing ideas

Alignment of the grid with the past	4	Grid connection and grid expansion	Systemic dependency, political/regulatory relevance, explicit mention, central prerequisite for almost all ideas
Utilisation of the existing infrastructure	5	Grid connection and grid expansion	Systemic dependency, economic, technical implementation prospects, high discourse presence
Supply gap due to loss of fossil fuels	11	Energy transition	Political target commitment, systemic dependency, central argumentation basis for many ideas
Regional attractiveness for investment in energy transitions	15	Market conditions and economic risk	Economic relevance for realisation, addressed several times, high influence on financing prospects
Regional value creation	25	Regional value creation	Social dimension, political relevance, high relevance for acceptance

Table 5: Identified key challenges based on the expert interviews (Source: author's elaboration (2025)).

Category of the idea of subsequent use	**Idea of subsequent use**	**Description of the idea**	**Discussed by experts**
Energy storage	Battery storage	Storing electricity in large battery storage systems	1-7

	Hydrogen storage	Storage in the form of hydrogen as long-term storage	Interview 5, Interview 2, Interview 6, Interview 3, Interview 1, Interview 4
	Compressed air storage	Storage by means of air pressure	Interview 5, Interview 6
	Pumped storage power plant	Storage in the form of positional energy	Interview 5, Interview 2
Power generation	Gas-fired power plant/reserve power plant	Energy production and storage in combination with hydrogen	Interview 5, Interview 6, Interview 3, Interview 1, Interview 4
	Hydrogen production	Production of hydrogen using an electrolyser	Interview 5, Interview 3, Interview 1, Interview 4
	Waste-to-energy plant	Waste incineration for energy generation	Interview 5
	Combined solution	Storage, consumption and production of (solar) energy	Interview 5, Interview 7, Interview 3, Interview 4
	Energy-intensive industry	Utilisation of the energy potential	Interview 3
Energy consumption	Server farm	Utilisation of the energy potential	Interview 5, Interview 4
	CCS/CCU	Storage and utilisation of CO_2	Interview 5, Interview 6
Research into	Nuclear fusion research	Research centre for nuclear fusion	Interview 1, Interview 4, Interview 5
culture	Industrial monument	Industrial monument as a memorial and educational centre	Interview 5, Interview 2

Local recreation	Local recreation	Local recreation and leisure activities	Interview 2

Table 6: Overview of the ideas discussed in the interviews for the reutilisation of the KKI 2 site (Source: author's elaboration (2025)).

Challenge category	Number of the challenge	Regional challenge	Description of the challenge	Discussed by experts
Summer/midday energy surplus and winter/night deficit	1	Dominance of PV and seasonal/daily imbalance	Loss of solar peaks and imbalance in solar energy production	Interview 2, Interview 5
	2	Utilisation of surplus energy	Lack of storage options for PV energy surplus for utilisation	Interview 3, Interview 6, Interview 2, Interview 4, Interview 1
Potential for renewable energies	3	Limited renewable energy potential	Bavaria is lagging behind nationally in the expansion of renewable energies	Interview 2, Interview 7, Interview 1, Interview 3, Interview 6
Grid connection and grid expansion	4	Alignment of the grid with the past	Orientation of the grid towards energy production from non-renewable energies	Interview 3, Interview 5
	5	Utilisation of the existing infrastructure	Adapting the grid to new technologies	Interview 5, Interview 3
	6	Availability of specific grid types	Expansion of electricity, gas, H_2 and CO_2 infrastructure	Interview 5, Interview 6

	7	Decision-making authority of the grid operators	Authority to decide on grid feed-in power, grid connection, choice of location to guarantee grid stability and energy supply	Interview 3, Interview 4
	8	Restrictions due to political perspectives and authorisation procedures	Obstacles to grid expansion due to lack of political prospects, inadequate legal framework and lengthy authorisation procedures	Interview 5, Interview 4, Interview 6
	9	Conflicts of interest between affected stakeholders	Complex environment due to sometimes conflicting interests, economic desires and political objectives	Interview 5, Interview 2, Interview 4, Interview 1
Energy transition	10	Effects of the EEG	Effects of existing political frameworks and laws	Interview 1, Interview 5
	11	Supply gap due to the loss of fossil fuels	Lack of potential for renewable energies to cover the supply gap due to the elimination of fossil fuels	Interview 1, Interview 6

Market conditions and economic risk	12	Unattractive market conditions	Dissatisfaction of energy market participants due to the not fully functional and mature market for new energy technologies and the economic market and framework conditions	Interview 5, Interview 1
	13	Risk of deindustrialisati on and the need for low-cost electricity production	Threat of deindustrialisation in Germany and increase in energy prices for renewable energies	Interview 6, Interview 5
	14	Economic risks of specific technologies	Investment risks in modern technologies dependent on regulatory framework conditions, costs of all kinds and uncertainties of development	Interview 5, Interview 6, Interview 3
	15	Regional attractiveness for investment in energy transitions	Investment risk due to profitability depending on location	Interview 6, Interview 2
Costs and financing	16	Financial possibilities of the region	Financial difficulties of project realisation for municipalities without external financing	Interview 5, Interview 7

	17	High costs for the expansion of existing and new construction of infrastructure	Cost issue for necessary adaptations and integration of new technologies and expansion of energy grids	Interview 5, Interview 6, Interview 3, Interview 4
	18	Project financing and construction cost surcharges	Dependence of project realisation and profitability of a project on investors and construction cost subsidies	Interview 4, Interview 1
Authorisation and planning processes	19	Lack of quick approvals and clear framework conditions	Lengthy and complex processes as a significant hurdle to project realisation	Interview 5, Interview 1, Interview 4, Interview 5
	20	Political hesitation and lack of prioritisation	Lack of prioritisation of the subsequent use of former nuclear power plants in the Atomic Energy Act or Nuclear Decommissioning Act	Witter, Interview 5
	21	Planning at different levels	Obstacles and loss of time due to planning at municipal, regional, state and federal level	Interview 2, Interview 4, Interview 1, Interview 5

	22	Connection with dismantling schedule	Potential hindrance to the construction of the subsequent use due to dismantling work and risk of unsuccessful dovetailing of the two projects	Interview 6, Interview 3, Interview 4
Social acceptance and protests	23	Acceptance by communities and residents	Approval or rejection of reutilisation ideas as an influencing factor	Interview 1, Interview 7, Interview 5, Interview 2, Interview 6
	24	Safety aspects of industrial after-use	Safety concerns of the population despite economic profit	Interview 3, Interview 6, Interview 2
Regional value creation	25	Regional value creation	Regional added value as a criterion for acceptance of repurposing	Interview 5, Interview 1, Interview 6
	26	Participation and involvement of the public, municipalities and citizens	Public participation as an influencing factor for repurposing and acceptance factor	Interview 1, Interview 4
	27	Regional technology development	Social status and regional technology development in connection with regional value creation	Contactor

Regional image	28	Regional image	Correspondence between reuse ideas and regional image as a realisation factor	Interview 1, Interview 5, Interview 7
Land conflicts/struggle for space	29	Land conflicts	Land use as an obstacle to energy expansion	Interview 2, Interview 6
Jobs and attractiveness for the population	30	Attractiveness of the region for (young) workers	Creating jobs for the (young) population as an important component of regional value creation	Interview 5, Interview 6
Peripheral location	31	Peripheral location	Influencing factor of the peripheral location of the site	Interview 6
Dealing with nuclear waste	32	Dealing with nuclear waste	The problem of the final repository and the unpopularity of interim storage as an obstacle to the development of repurposing	Interview 5, Interview 2, Interview 3
	33	Radiation as a social challenge	Potential radiation as an unattractive factor for a workplace at the site	Interview 5, Interview 6, Interview 3
Climate-neutral technologies and climate targets	34	Climate targets	Climate protection targets for 2045 as an obstacle to repurposing	Interview 6, Interview 1

Geological conditions	35	Geological conditions	Restrictions on geological conditions and raw material situations for certain subsequent uses	Interview 5, Interview 2, Interview 6
Topography	36	Topography	Restriction of topographical conditions for certain subsequent uses	Interview 2, Interview 7
Nature conservation areas	37	Nature conservation areas	Restrictions due to ecological conditions and guidelines for subsequent use	Interview 2
Radiation as a threat to the environment	38	Radiation as an environmental challenge	Radiation as a danger to humans and the environment	Interview 3, Interview 5, Interview 6, Interview 2

Table 7: Overview of the challenges for the region discussed in the interviews regarding the repurposing of the KKI 2 site (Source: author's elaboration (2025)).

Challenge	1st criterion	2nd criterion	3rd criterion	4th criterion	5th criterion	6th criterion	Total score
1	1	0	0	0	2	6	**9**
2	1	0	0	0	5	6	**12**
3	1	0	0	0	5	4	**10**
4	0	0	0	0	2	7	**9**
5	1	0	0	0	2	8	**11**
6	0	0	0	0	2	2	**4**
7	0	1	0	0	2	0	**3**
8	0	0	0	0	3	0	**3**
9	0	0	0	0	4	0	**4**
10	0	1	0	0	2	1	**4**
11	1	0	0	0	2	6	**9**

12	0	0	0	0	2	0	**2**
13	0	0	0	0	2	1	**3**
14	0	0	1	0	3	1	**5**
15	0	0	1	0	2	6	**9**
16	0	0	0	0	2	6	**8**
17	0	0	1	0	4	0	**5**
18	0	0	0	0	2	0	**2**
19	0	1	0	0	4	0	**5**
20	0	0	0	0	2	1	**3**
21	0	1	0	0	4	0	**5**
22	0	1	0	0	3	0	**4**
23	0	0	0	1	5	2	**8**
24	0	0	0	0	3	0	**3**
25	0	0	0	1	3	7	**11**
26	0	0	0	0	2	0	**2**
27	0	0	0	0	2	1	**3**
28	0	0	0	1	3	4	**8**
29	0	0	0	0	2	0	**2**
30	0	0	0	1	2	6	**9**
31	0	0	0	0	2	1	**3**
32	0	0	0	0	3	0	**3**
33	0	0	0	0	3	0	**3**
34	0	0	0	0	2	6	**8**
35	0	0	0	0	3	0	**3**
36	0	0	0	0	2	0	**2**
37	0	0	0	0	2	1	**3**
38	0	0	0	0	4	0	**4**

Table 8: Identification of key challenges based on the criteria (Source: author’s elaboration (2025)).

Regional challenges /Re utilisation ideas	**1**	2	3	4	5	6	7-9	10	11	12	13	14	15	16	17-19	20	21-22	23	24	25	26	27	28	29	30	31	32-33	34	35-36	37	38	**Total**
Battery storage	x	x		x	x				x											x					x							**7**
Hydrogen storage	x	x	x	x	x	x			x									x		x					x			x				**11**
Compressed air reservoir	x	x	x																									x				**4**
Pumped storage power	x	x																										x				**3**

plant																																
Gas-fired power plant/back-up power plant				x	x				x		x		x							x			x									**7**
Hydrogen production	x	x	x	x	x	x							x							x			x		x			x				**11**
Waste-to-energy plant				x	x				x																							**3**
Combined solution	x	x	x	x	x	x		x	x		x		x	x				x		x			x		x			x				**16**

Energy-intensive industry				x	x								x							x					x							**5**
Server farm					x								x							x					x							**4**
CCS/CCU									x			x				x												x				**4**
Nuclear fusion research													x									x				x						**3**
Industrial monument																							x									**1**
Local recreation																							x							x		**2**

Table 9: Which reutilisation idea "solves" which challenges based on the experts' opinions (Source: author’s elaboration (2025)).