



# Interim RIS4Danu regional report D3.2

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## Short description of the content of the deliverable

*This interim regional report (D3.2) presents and discusses six regional analyses conducted in the frame of the RIS4Danu project so far, offering information on each region's assets, challenges and several transformative opportunities that guide the revitalization of disused industrial sites in the Danube macro area.*

## Version history

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# 1 Executive summary

*RIS4Danu's fundamental goal is to prepare the ground for developing disused industrial sites in several regions in the Danube macro area into transformative directions and to advance green structural change in a place-sensitive way. In doing so, the project is guided by important conceptual underpinnings (summarized in this report) that rest on a combination of academic literature streams on green regional structural change and Smart Specialization and seek to contribute to a move towards a new challenge-led approach of Smart Specialization for Sustainability (S4).*

*Informed by these conceptual considerations, the project develops a deep understanding of the participating regions. Conducted by the team of the University of Vienna (WP3), in-depth regional analyses are provided, which guide the workshops at each industrial site, highlighting several transformative avenues for their revitalization. They do so by offering insights into the regions' asset bases as well as the manifold economic, social and environmental challenges they are facing. Both, assets and challenges alike are considered to provide opportunities for green regional structural change.*

*The regional analyses rely on a mixed methods approach, combining quantitative (statistical data analyses of 'conventional' and 'novel' indicators) and qualitative approaches (document analyses and expert interviews) to data generation and analyses. Thereby, a broad variety of different data points have been collected and combined, offering a solid evidence base in four key domains of inquiry: (i) general regional conditions, (ii) assets and potentials, (iii) challenges and problems and (iv) the transformative opportunities one can derive from them.*

*After the project has recently crossed the half-way mark, D3.2 (interim regional report) provides the opportunity to present and discuss six regional analyses conducted so far following these procedures. Accordingly, this report has synthesised key findings in each of the four domains for the following regions investigated at this point:*

1. Lower Austria (Austria)
2. Schwarzwald-Baar-Heuberg region (Germany)
3. Hajdú-Bihar County (Hungary)
4. Ústí nad Labem (Czech Republic)
5. Banská Bystrica (Slovakia) and
6. Podravje (Slovenia).

*In doing so, the report offers condensed information on the ambivalence of regional industrial structures, the varying potential of R&D impulses, the importance of regional social problems, the role of extra-regional connectedness, and a range of other issues in each of the region individually, but also a first cross-regional comparison.*

*The work done so far is an important basis for the second half of the project. At least three more regions will be investigated, which will provide further novel insights in new contexts, a more fine-grained understanding of assets, challenges and opportunities in relation to regional sustainability transitions and eventually more analyses to inform workshops at disused industrial sites in Romania, Croatia and Serbia. In addition, the insights gained through the project will feed into more academic work in the form of research papers and translation pieces.*

## 2 Introduction

We live in a time of grand societal challenges, marked by climate change, the fourth industrial revolution and rising inequalities, among others. Yet, not only slow burn changes, but also sudden shocks like the COVID-crisis contribute to an atmosphere of uncertainty and call for a recalibration of our development goals towards economic, social and environmental sustainability and challenge-orientation (Tripl et al., 2022).

The RIS4Danu project is embedded in these wider context conditions and seeks to contribute to finding solutions to these challenges (and others) by taking a distinct regional perspective. Indeed, regions – subject to a multitude of external influences – face very diverse challenges, often but not always manifestations of the global developments outlined above (Tödtling et al., 2022).

However, addressing these challenges in a sustainable way is far from trivial, especially (but not only) for disadvantaged places (e.g., characterized by ‘brown’ industrial structures). Against this background, the project’s goal is to initiate and advance green and sustainable forms of regional development through a challenge-led approach of Smart Specialization for Sustainability (S4). In doing so, it seeks to utilize the reopening of 21 industrial sites as platforms for transformative activities in regions in the Danube macro area. These sites should function as hubs and spark green and just regional restructuring.

From a Smart Specialization logic, this endeavour first requires a deep understanding of the host regions’ pre-conditions, innovation potentials and barriers, as well as the ecological, social and economic problems they are confronted with. This allows for the identification of transformative potentials derived from both, regional assets and challenges, based on which tailor-made and strategic business plans for the sites can be developed. The role of the team of the University of Vienna within the project is to provide investigations and insights into these key regional domains in preparation for the S4 workshops at the single sites.

Now, shortly after the halfway mark of the project in June 2023, this interim regional report provides the opportunity to present and discuss the first six regional analyses that have been conducted so far in the context of RIS4Danu (WP3) and to draw first conclusions with relevance for WP4 and WP5.

With this goal in mind, the remainder of the report is structured as follows. First, it outlines the methodology underlying the regional analyses conducted so far. This includes the conceptual underpinnings as well as information on the methods used. Second, the results of the regional investigations in six RIS4Danu countries will be summarized (Austria, Germany, Czechia, Hungary, Slovakia & Slovenia). The report will turn to each of the six regions individually, after which it will briefly outline preliminary key findings from a cross-regional comparison. The final section concludes.

## 3 Methodology

This section will now draw attention to the methodology underlying the RIS4Danu project, understood as the set of rules, principles and procedures that underpin the research process. In doing so, it will first briefly summarize the RIS4Danu S4 concept<sup>1</sup> (Deliverable 3.1), which is guiding the project and all analytical steps taken. Based on these conceptual underpinnings, it will then specify the methods used, i.e. the concrete tools applied for both data collection and analysis.

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<sup>1</sup> The full RIS4Danu S4 concept can be found online on the project website here: <https://ris4danu.eu/2022/10/19/outline-of-s4-methodology/>



### 3.1 RIS4Danu concept and its core principles

The RIS4Danu project is situated in a wider context marked by global challenges such as climate change and the loss of biodiversity, the fourth industrial revolution as well as growing social and territorial inequalities. All these changing conditions call for a reconsideration of regional economic development and regional innovation policies, demanding green and inclusive transition processes (Pontikakis et al., 2022). On top, sudden shocks like the COVID-19 pandemic and the Russian attack on Ukraine and the follow-up events triggered by them reinforce the need for a reorientation of established practices (Tripl et al., 2022).

Drawing on discourses in different academic literatures, such as sustainability transitions (Köhler et al., 2019) or mission-oriented (Mazzucato, 2018, 2021) and transformative innovation policies (Schot & Steinmueller 2018), the European policy landscape has reacted to challenges outlined above through new policy frameworks like the European Green Deal, through EU missions to combat climate change or the Recovery and Resilience Facility, which all seek to promote green structural change, sustainable and inclusive development and/or social and territorial cohesion (Tripl et al., 2022).

The RIS4Danu project acknowledges that regions face diverse challenges, which vary depending on their environmental, social, and economic circumstances. Disadvantaged regions, such as those relying on energy-intensive industries, must navigate the transition away from these activities and the development of new ones. This poses a significant struggle for less-developed regions with limited resources, as they strive to initiate and sustain green transition processes. It is crucial to address these challenges while minimizing social tension, requiring tailor-made actions specific to each regional context. Recognizing the importance of territorial perspectives on socio-technical-ecological transitions, policymakers and scholars alike have increasingly emphasized the need to consider regional characteristics (McCann & Soete, 2020; Tödtling et al., 2022; Flanagan et al., 2022).

Against this backdrop, the concept of **Smart Specialization** (Foray et al., 2009) is on the move. Researchers and practitioners increasingly recognize the need to reorient and adapt the EU's Smart Specialization policy approach to prioritize sustainability and well-being as important goals for research, development, and innovation (McCann & Soete, 2020; Miedzinski et al., 2021). By embracing these goals, smart specialization can become a valuable tool for transformative regional development that extends beyond the narrow focus on economic growth and contributes to the achievement of the UN Sustainable Development Goals (Tripl et al., 2022).

The RIS4Danu project draws inspiration from the rethinking of place-based innovation policies and strategies, like the Partnerships for Regional Innovation (Pontikakis et al. 2022), that prioritize sustainability and **green structural change** in regional development agendas. The project recognizes the potential of green restructuring not only as a response to the pressing challenges of our time but also as a source of new opportunities for industrial sites and the entire region. However, it is important to acknowledge that regions have different opportunities for green restructuring (Jakobsen et al., 2022). Academic research at the intersection of evolutionary economic geography and innovation system studies has unravelled the specific place-based structures, such as the industry mix, organisational support structures, policy and public administration traditions, institutional and cultural conditions as well as non-regional structures and dynamics that shape the conditions for green regional restructuring (Tripl et al., 2020). Thereby, this literature draws specific attention to regional assets, including natural resources, infrastructure, technology and firm competencies, labour skills and knowledge, and institutional frameworks. Importantly, these assets might be modified to overcome barriers and create favourable conditions for green structural change (Tripl et al., 2020).

Combining the concepts of Smart Specialization and green regional restructuring presents a promising opportunity for future regional innovation policies towards a **challenge-led approach of Smart Specialization for Sustainability (S4)**. While Smart Specialization incorporates stakeholder engagement through the Entrepreneurial Discovery Process (EDP),



green regional restructuring focuses on socio-ecological outcomes and the needed directionality to get there (Tripl et al., 2022).

To implement S4 effectively, the RIS4Danu project seeks to utilize **reopened industrial sites as platforms** for initiating and facilitating green and challenge-led transformative activities. These sites offer a unique opportunity to build regional-wide transformative capacity and resilience. By designing them as inclusive forums, they can serve as hubs that can spark and scale green restructuring (Tripl et al., 2022, see Figure 1).

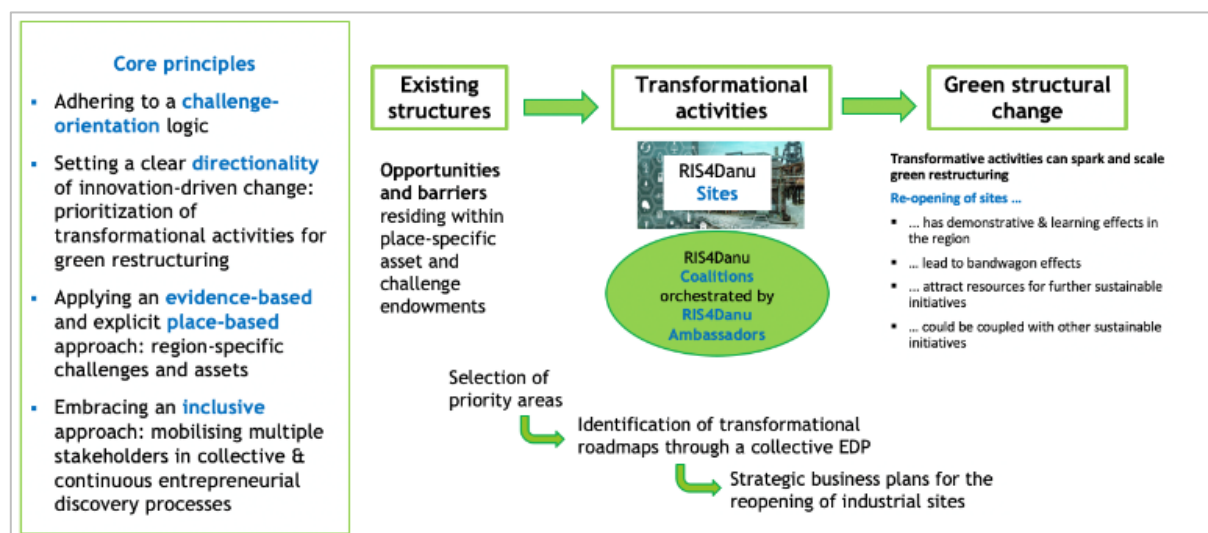


Figure 1: Schematic depiction of the RIS4Danu S4 concept, source: Tripl et al., 2022

Drawing on the conceptual underpinnings outlined above, it is hence necessary to first understand and analyze the regional structural conditions in which these sustainability transition processes take place, on which they fundamentally depend and to which they are to be related. Therefore, the team of the University of Vienna has mapped and identified place-specific innovation potentials and barriers, pinpointed region-specific pressing socio-ecological and socio-economic development challenges and opportunities for transformative activities. This report provides a first summary of key findings from 6 such regional analyses based on the following core principles derived from the conceptual considerations (Tripl et al., 2022; see also Figure 1).

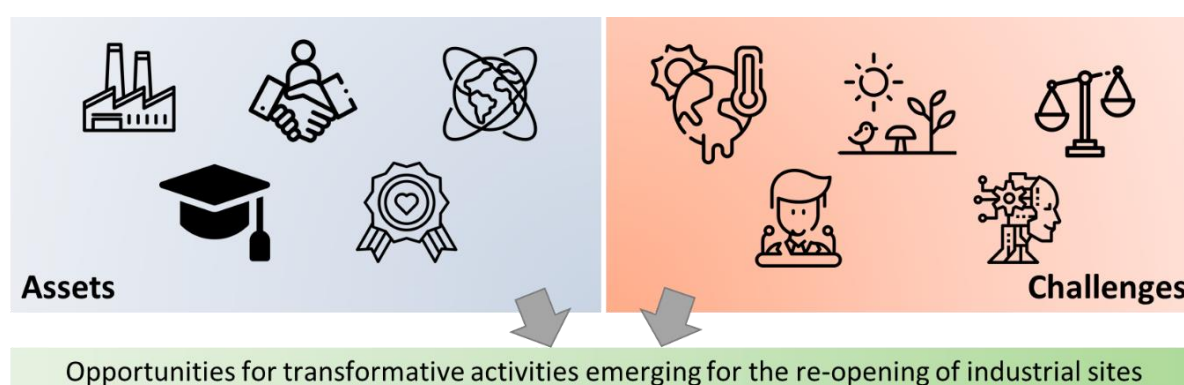
The aim of the in-depth analyses of the RIS4Danu regions is to provide the empirical evidence base necessary to achieve the project's ambitious goals, namely, to identify transformational roadmaps (through a broad stakeholder process) and design business plans for these brownfields **in a place-sensitive and evidence-based way**. To this end, the analyses provide evidence on three fundamental building blocks of the RIS4Danu concept (Tripl et al., 2022) and is structured as follows.

First, it offers insights into the **general regional context** and the regional development trajectory of the recent past. Hence, this part sets the scene and provides information on the conditions (e.g., development in key socio-economic indicators, recent innovation performance or key development fields identified in relevant documents) in which the sites, workshops and, ultimately, the transformative activities are embedded.

Second, adhering to a challenge-oriented innovation approach, this analysis identifies **the key challenges the region is currently facing**. These can either come in the form of regional manifestations of challenges that are global in nature (e.g., climate change, environmental degradation or the fourth industrial revolution) or challenges that are confined or specific to the region under investigation (e.g., due to its specific industry structure, policies or informal institutions). Either way, addressing these challenges and, in particular, contributing to solving them is a key motive of the project.

Third, the analysis investigates **the regional asset base and identifies key regional strengths** linked to the regional innovation system. Accordingly, existing place-based structures (such as the industry mix, organizational support structures, policy and public administration traditions), institutional and cultural conditions, as well as non-regional structures and dynamics (e.g., the region's embeddedness in national and global innovation and production networks or the proximity to innovation hubs) might offer 'entry points' and a platform for the project (Trippi et al., 2022).

Importantly, both the challenges the region is facing and the assets it is providing might be translated into **opportunities for transformative activities**. As such, the analysis will briefly discuss potential transformative avenues in each region connected to the assets and challenges identified. With that being said and with RIS4Danu's underlying EDP logic in mind, however, this step shall indicate directions, not take away the key part played by the workshops taking place at the sites based on the analyses. Figure 2 offers a simplistic schematic representation of the underlying logic of the analyses.



**Figure 2: Building blocks of the regional analyses, source: own elaboration<sup>2</sup>**

Before going *in medias res*, a few paragraphs on methods seem warranted. This regional interim report, as well as the regional analyses it rests upon, are based on a mixed-methods approach, making use of various data sources. In doing so, it combines both quantitative and qualitative methods. Both will be explained in more detail down below. Drawing together these different methods and data sources, the team of the University of Vienna has sought to develop a balanced evidence base for the RIS4Danu project.

### 3.2 Quantitative methods

The quantitative data analysis has two main goals: first, to give a comprehensive overview of the socio-economic position of the region (within the frame of its country) and second, to support the identification of assets and challenges by applying different analytical steps based on various data sources. Importantly, the fundamental underlying idea of the quantitative data collection and analysis was to identify and select alternative indicators and measures which offer novel perspectives and support the determination of local assets and challenges (e.g., on regional climate change manifestations) in addition to the more traditional indicators (like GDP, patents, ...).

The first goal has been completed in two ways: on the one hand, we prepared a NUTS-2 level overview analysis of the region where the industrial sites are located and, on the other hand, we provided a quantitative document analysis by using the so-called 'SDG Mapper', a tool that

<sup>2</sup> All icons used in this and various other similar figures throughout the document were downloaded from Flaticon under the premium subscription: [simon.baumgartinger-seiringer@univie.ac.at](mailto:simon.baumgartinger-seiringer@univie.ac.at)

has recently been launched by the Joint Research Center of the European Commission (JRC, 2022).

To conduct the regional overview analysis, we have collected economy-, society - and innovation-related indicators (Figure 3). This step was important to get a general idea about and identify the basic position a region finds itself in in the context of its national framework based on the more 'conventional' indicators. The values of a given NUTS-2 region have been compared to the other NUTS-2 level regions from the given country. For each indicator, the region has received a rank number from 1 to the total number of NUTS-2 regions within each country, where rank 1 refers to the highest value and the biggest rank number to the lowest performance in terms of each indicator. To illustrate the region's position by the collected indicators, we created a stellar graph showing the region's ranking. In this way, the longest bar demonstrated the best place (rank 1), while the shortest bar indicated the lowest. The only exception has been the unemployment rate, where long bars should always display a strong performance of the region under investigation for the sake of consistency. Therefore, in the case of unemployment, rank 1 (and the longest bar) represent the lowest unemployment value, while the biggest rank number for the highest unemployment value and the shortest bar. We also drew up the median position within each country, represented by a dark green circle on the graphs. In addition, we extended our data collection with the available NUTS-3 level indicators. Similarly, in the NUTS-2 level analysis, we used the ranking of the territories to show the position of those NUTS-3 regions where the designated industrial sites are located compared to other NUTS-3 level areas from the country. The results and the stellar graphs for each region analysed so far can be found in the summary sections (4.1 - 4.6).

<b>Economic-related indicators</b> Net disposable income per capita (2019) New firms per 1,000 people in all sectors (2019) Gross domestic product per capita (PPS) (2019) Gross value added per employed person (2019) Unemployment rate (2021)	<b>Society-related indicators</b> The growth rate of the population between 2000 and 2021 European Quality of Government Index (2021) The composite index of the Quality of Life (QoL) ESPON project (2019)
<b>R &amp; D &amp; Innovation-related indicators</b> Employment in high-tech manufacturing and knowledge-intensive services (2021) Patents per 1 million inhabitants (patent applications submitted in 2014) Total and business R&D expenditures in percentage of GDP (2020 or the latest data) Innovation expenditures (excluding intra- and extramural R&D expenditures) per total turnover for SMEs (2021) SMEs introducing product innovations per total number of SMEs (2021) Number of SMEs with innovation co-operation activities per total number of SMEs (2021) Percentage of tertiary educated people within the 25-64 years old population (2021)	

**Figure 3: The indicators used for the socio-economic & innovation analysis of the regions, source: own elaboration**

Besides ranking the region based on the collected indicators, we applied the 2021 edition of the Regional Innovation Scoreboard to analyse the region's innovation performance level. According to the methodology of the RIS, regions are grouped into four main categories:

- Innovation Leaders (regions with a relative performance of more than 125% of the EU average in 2021),
- Strong Innovators (regions with a relative performance between 100% and 125% of the EU average in 2021),
- Moderate Innovators (regions with a relative performance between 70% and 100% of the EU average in 2021) and

- Emerging Innovators (regions with a relative performance of less than 70% of the EU average in 2021)

The RIS methodology also uses three additional sub-categories within each main category: the top- (+), the middle- and the bottom-third of the regions (-).

As outlined above, we also sought to approach the complex question of development paths in novel ways. One way to do so was to apply the recently published and much discussed “regional development trap” to each analysed region. The phenomenon of the development trap refers to regions facing significant structural challenges in retrieving past dynamism or improving prosperity for their residents (Diemer et al., 2022). The risk level of approaching or being in a development trap has been measured by a composite indicator that includes the growth trends of productivity, economic development (in terms of GDP) and employment. The categorisation of the regions is also distinguished based on their income levels (high-, medium- and low-income regions). This analytical step has given us a general understanding of the regions’ past development trajectories.

Finally, we also identified the top three and the three most dynamic industrial activities, respectively, using the share and the growth of the total workforce in certain activities to learn about key regional sectors. Again, the results and a short discussion regarding the Regional Innovation Scoreboard, the development trap, and the most important industrial activities of all RIS4Danu regions investigated so far can be found below in the respective sections.

The “SDG Mapper” mentioned before is a tool based on a text-mining method. It can be considered another novel approach to understanding regional circumstances based on a quantitative document analysis of key regional development and innovation strategies. The tool identifies relevant Sustainable Development Goals (SDGs) addressed in documents and creates easily comparable figures in form of bar charts. These charts provide a comprehensive overview of the identified SDGs and their relative distribution and importance in the text. If a goal is not represented by a bar, it has not been identified at all in the documents. As such, the SDG Mapper can help profoundly to get a first general understanding of where regional development strategies place emphasis on in terms of sustainable development.

There are two important caveats to be aware of. First, the results reflect the documents used. This means that the results might differ substantially depending on the selection of documents (and their publisher, topic, content, etc.). The documents used in the course of the analyses are important innovation/economic strategies of the participating regions in the RIS4Danu project and are usually those documents that have been sent to the team of the University of Vienna by our regional partners. Second, the results are a representation of strategies, plans and reports and not (necessarily) of actions, which – as we all know – speak louder than words.

The SDG Mapper has been prepared for each analysed region. Subsequently, we have analysed the results in a cross-regional way, e.g., by calculating the number of hits per page (indicating how many mentions of SDGs have been found in these documents per page in comparison to other RIS4Danu regions). Thereby, it was possible to define more or less ‘SDG-heavy’ regions based on the documents analysed. In this interim regional report, we demonstrate this work done using the Schwarzwald-Baar-Heuberg SDG mapping as an example (see Figure 17), which has been particularly interesting.

The second main goal of the quantitative analysis has been to identify relevant assets and challenges of the investigated regions. To do so, we collected and analysed relevant data from the European regions like the databases of Eurostat, OECD, and World Bank, the recent waves of the European Social Survey and data from specific ESPON (European Spatial Planning Observation Network) projects, but also country-specific ones (e.g. the data derived from the national statistical offices), particularly data for the lower spatial level.

The quantitative analysis sought to incorporate both ‘more conventional’ and alternative indicators to get a comprehensive perspective on regional conditions. As the RIS4Danu project is focusing on transformative changes related to sustainability, we have also been looking for



data which has helped to identify region-specific assets and challenges like the indicators of the European Climate Risk Typology, data of meteorological stations, ranking of regions by their renewable energy potentials or the recently launched Energy and Industry Geography Lab by the JRC, which particularly helped identify the energy-intensive companies and activities in the specific regions.

In addition to the indicators mentioned above, each regional analysis contains a comprehensive examination of the research and development activities. To identify the sustainability-related research directions, we revised the relevant ongoing research projects and Horizon2020 project participation by the local university and research organisations. In addition, patent analyses of patent applications from the specific region have been conducted. The data for the patent analysis were derived from the OECD Regpat database. Besides doing a general overview of the number and the geographical concentration of patents, we specifically focused on the relative technology advantages of the regions on the one hand and their existing as well as potential connections to climate change-related technologies or applications on the other hand, providing interesting results into transformative regional avenues based on R&D capabilities.

In sum, all this quantitative work has, on the one hand, helped to get a good general understanding of the RIS4Danu regions and their current development position in various domains. These insights have proven to be highly complementary with information gathered through preparatory qualitative document analyses. On the other hand, quantitative analyses have been instrumental to pinpoint promising regional assets, pressing challenges and transformative opportunities derived from them. These analytical steps have matched very well with qualitative expert interviews and in-depth document analyses. These qualitative methods will now be explained in the following section.

### 3.3 Qualitative methods

In relation to qualitative work, the analyses draw fundamentally on two different methods: qualitative document analyses and in-depth semi-structured expert interviews. This section will now briefly outline how information based on documents and interviews have been captured, analysed, and fed into the regional analyses.

First, qualitative document analyses have crucially contributed to get a good understanding of regional preconditions, assets, innovation potentials, development goals and transformative fields, but also of regional challenge manifestations, threats, and barriers to sustainable development. As such, regional development/innovation strategies, reports on economic development, and smart specialization strategies – among others – have been analysed and coded along the key building blocks of the conceptual framework (see above). These documents have been identified in two ways. On the one hand, and most importantly, our regional partners with profound knowledge of the RIS4Danu regions have been asked to provide a broad collection of the documents most relevant. On the other hand, and in order to prevent selection bias, a complementary online search by the team of the University of Vienna has been conducted to identify further strategies and reports, focusing on the regional or national level. The data generated through these document analyses have been incorporated into the regional analyses directly (especially in relation to key transformative fields identified, see “Results” section) but also indirectly as preparatory material for the interviews and further analytical steps.

Second, the work done for the RIS4Danu project so far has profited greatly from insights gained through semi-structured in-depth interviews. Regional experts from industry, the public sector and civil society with profound knowledge of the region have shared their perspectives on assets, challenges, opportunities, and barriers. However, given a large number of RIS4Danu regional cases, only four to five interviews per region could be conducted due to time constraints. For obvious reasons, this has been a challenge in terms of data saturation. Hence, the team of the University of Vienna developed a procedure for carefully and

transparently selecting experts. Accordingly, four key regional domains have been defined with the goal of enabling different perspectives on regional conditions: (i) Regional Innovation Strategies, (ii) Regional Research Landscape, (iii) Regional Business Environment & Economic Structure and (iv) a Critical Perspective on Regional Development (see Figure 4). For each of these domains, at least two to three knowledgeable persons have been identified with the help of our support partners in the RIS4Danu regions, usually persons who represented important regional organizations (such as development agencies, business representatives, universities, chambers, etc.). The team of the University of Vienna has then selected and contacted one person per domain based on the principle of diverse participation, particularly with respect to gender and age. In the vast majority of cases, the selected persons were willing to talk to us<sup>3</sup>. In several instances, the experts expressed the wish to bring additional persons (representing the same organization), either because of language barriers or to provide wider perspectives. As such, sometimes more than one expert took part during a single interview, which has always positively influenced the conversation. All in all, the team of the University of Vienna has so far discussed with 29 interview partners in 25 interviews from 6 regions.



**Figure 4: Four key regional domains for selecting experts for interviews, source: own elaboration**

The interviews have been conducted using a guideline that corresponds to the conceptual underpinnings of the RIS4Danu project. At the same time, the conversation with the experts have been open-ended, giving the interviewees enough room to contribute in novel ways and provide new interpretations. Therefore, the interviews have been conducted in a semi-structured way (Gläser & Laudel, 2009).

The guidelines have been adapted according to the region under investigation based on information gathered during the preparatory phase (e.g., for the Vienna Conference in M04) and to the background of the experts (i.e. the domain and organization they represent, see above).

The interviews lasted for around one hour each and were held in English usually. They only exceptions were the interviews for our Austrian and German case study regions, which have been held in German. Conversation with experts from outside Austria have been conducted online for reasons of flexibility and to mitigate costs as well as potential environmental damage through travelling. Four interviews in Austria were face-to-face due to Lower Austria's proximity to Vienna, one online due to time constraints. We guaranteed all interview partners full anonymity, allowing them to talk freely and express their perspectives, knowledge and interpretations without hesitation. The interviews were transcribed, coded according to the conceptual considerations and interpreted (using the software MAXQDA). Interview quotes used in the analyses have been translated to English by the team of the University of Vienna when necessary.

All in all, the qualitative investigation of the regions can be seen as highly complementary to the quantitative analyses outlined above, offering new perspectives hard to capture with

<sup>3</sup> We would like to take this opportunity to express our gratitude to all regional experts who have spoken with us thus far. Their help has been key for the success of the project so far.



quantitative data alone (e.g., in relation to regional networks & relations, socioecological challenges, recent discourses or activities in certain niches), proving the high value of mixed-methods research. Drawing on these different methods and data sources, the team of the University of Vienna has sought to provide regional analyses that offer a fruitful basis for the EDP workshops at the single industrial sites, casting light on a selection of the most crucial regional assets, challenges and transformative avenues. The results of the first set of regions can be found in a condensed form in the next section.

## 4 Results

So far, the team of the University of Vienna has analysed the following six RIS4Danu regions: Lower Austria in Austria, Schwarzwald-Baar-Heuberg region in Germany, Hajdú-Bihar County in Hungary, Ústí nad Labem region in the Czech Republic, Banská Bystrica region in Slovakia and the Podravje region in Slovenia. This section, first, summarizes key findings from the in-depth investigation of each of the regions analysed so far (in chronological order based on the workshop dates) and, subsequently, offers some first insights into key findings (e.g., commonalities, differences, etc.) between those regions<sup>4</sup>.

It should be noted that the single in-depth analyses of the regions that have been sent to the workshop team in advance of the workshops, have been substantially longer and contain more detailed investigations than what is presented here. On average, they were around 50 to 60 pages long, resting on considerably more data points (statistical analyses, interview quotes, etc.). The goal of this report is to present the results in a condensed and concise form, casting light on the different regional contexts, all the identified assets and challenges and the derived opportunities for green structural change based on a selection of several representative data points. This should offer readers a well-balanced overview of the work done so far in terms of the regional analyses within the RIS4Danu project.

### 4.1 Lower Austria, Austria

Lower Austria is one of the structurally stronger regions among the participating regions in the RIS4Danu project. It has a relatively strong economic base in several sectors, clear areas of specialization that exhibit a comparably strong innovation performance and is characterized by a high level of education and the presence of several R&D organizations. However, Lower Austria faces several challenges despite these assets and strengths, as this section will show.

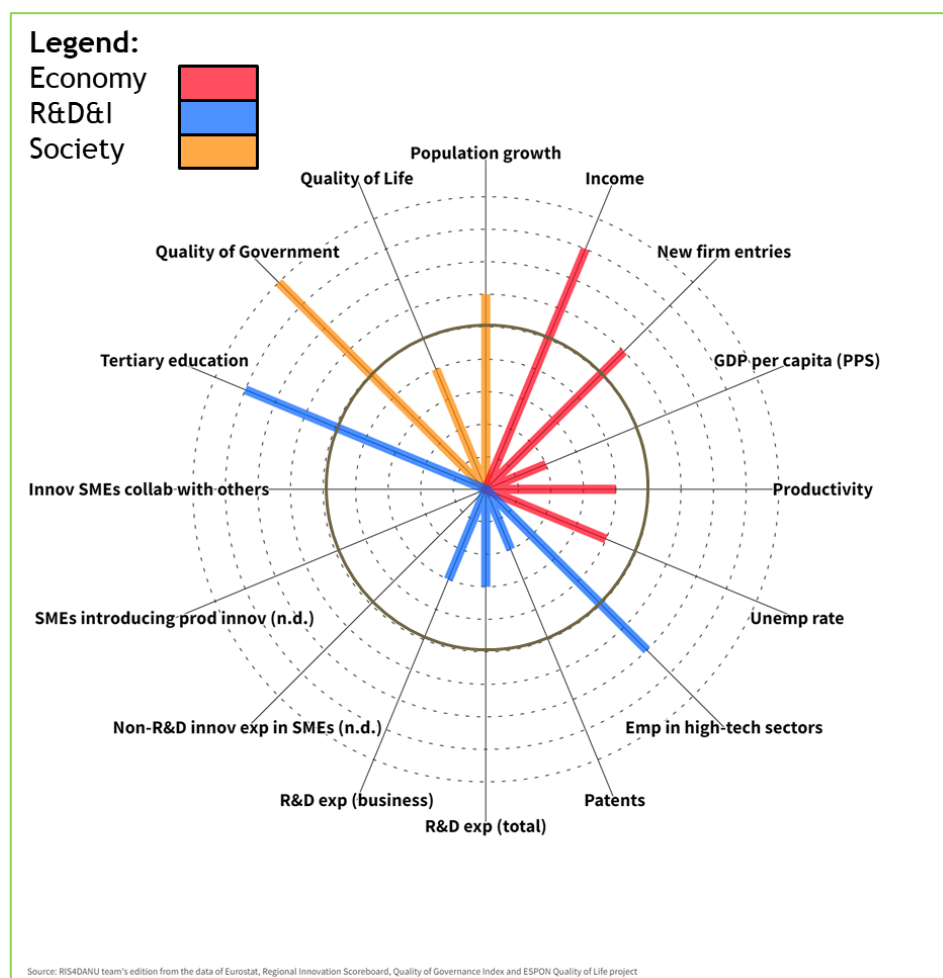
First, this summary of the regional analysis will cast light on the **general regional context**. Hence, in what follows, the scene is set and information on the wider regional conditions provided (e.g., development in key socio-economic indicators (Figure 5), recent innovation performance (Table 1) or key development fields identified in relevant documents (Figure 6)).

#### **The most important findings of the socio-economic and innovation analysis of the region**

- The level of regional economic development in terms of GDP is relatively low.
- The productivity of Lower Austria is relatively weak compared to other Austrian regions.
- Lower Austria shows a relatively good quality of human capital (tertiary education, employment in high-tech sectors)
- The innovation-related performance (primarily patents and R&D expenditures) seems to be rather weak compared to other Austrian regions

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<sup>4</sup> A more thorough cross-regional comparison will be provided in the final report on S4+ applicability (M22).



**Figure 5: The socio-economic analysis of Lower Austria, source: own elaboration based on different data sources**

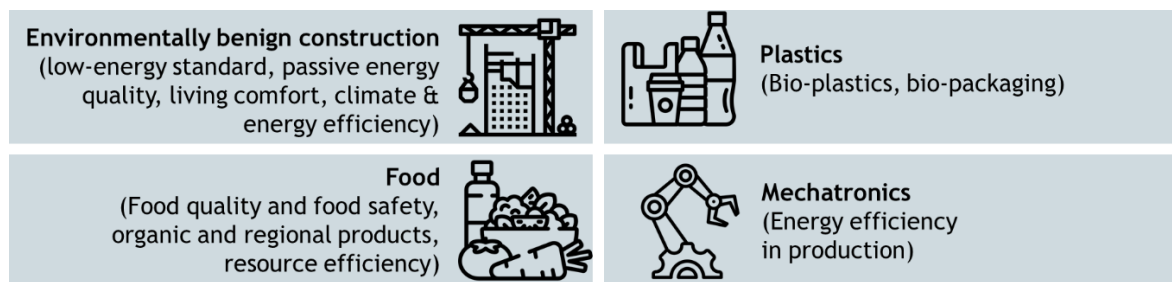
As can be seen in Table 1, Lower Austria is categorized as a “Strong Innovator +” in the Regional Innovation Scoreboard (2021). It is important, however, that this rating is based on a NUTS-1 level analysis, meaning that Lower Austria is grouped together with Burgenland and the capital Vienna. In terms of the development trap indicator, Lower Austria is categorized as a region that finds itself in a development trap at high-income, meaning that the region – despite being relatively prosperous in the European context – struggles to retain its dynamism in key indicators such as productivity in contrast to comparable areas on a similar development level.

**Table 1: Lower Austria’s innovation performance and development trap risk**

<b>Regional Innovation Scoreboard (2021)</b>	<b>Strong innovator+</b>
<b>Development Trap category</b>	<b>In development trap at high-income</b>

Source: Own edition based on data from Regional Innovation Scoreboard and Diemer et al. (2022)  
 Note: Only NUTS1 level data are available for Austria in the Regional Innovation Scoreboard. Therefore, this category refers to the “AT1” NUTS1 region, which includes Burgenland, Lower Austria and Vienna.

Key transformative fields defined: S3 in Lower Austria by ÖROK (2016)



**Figure 6: Key transformative fields defined in: Policy framework for smart specialisation in Austria (2016), source: own elaboration**

These central transformative fields (see Figure 6), defined in one of the region's most important development strategies, offer some first insights into potential key economic development avenues. The goals to transform (into) these fields are assumed to be widely shared by regional stakeholders, hence we consider them highly relevant for the analysis and the workshops alike. As such, some of them will be taken up again, some complemented and some might be critically commented upon from a sustainability perspective in our investigation of Lower Austria's challenges, assets and transformative opportunities over the following pages.

Adhering to a challenge-oriented innovation approach, the next paragraphs identify some of the **most pressing challenges the region is currently facing**. Addressing these challenges and, in particular, contributing to solving them is a key motive of the project.

Climate change, Russia's recent invasion of Ukraine, the following hike in energy prices and dependencies on Russian fossil fuels have raised the energy supply of the region as one of the central issues currently. Hence, the first regional challenge identified is Lower Austria's **dependence on oil & gas, high energy intensity and dynamism in the "wrong" industries**, posing questions of future viability not only in relation to sustainability concerns, but also economic competitiveness.

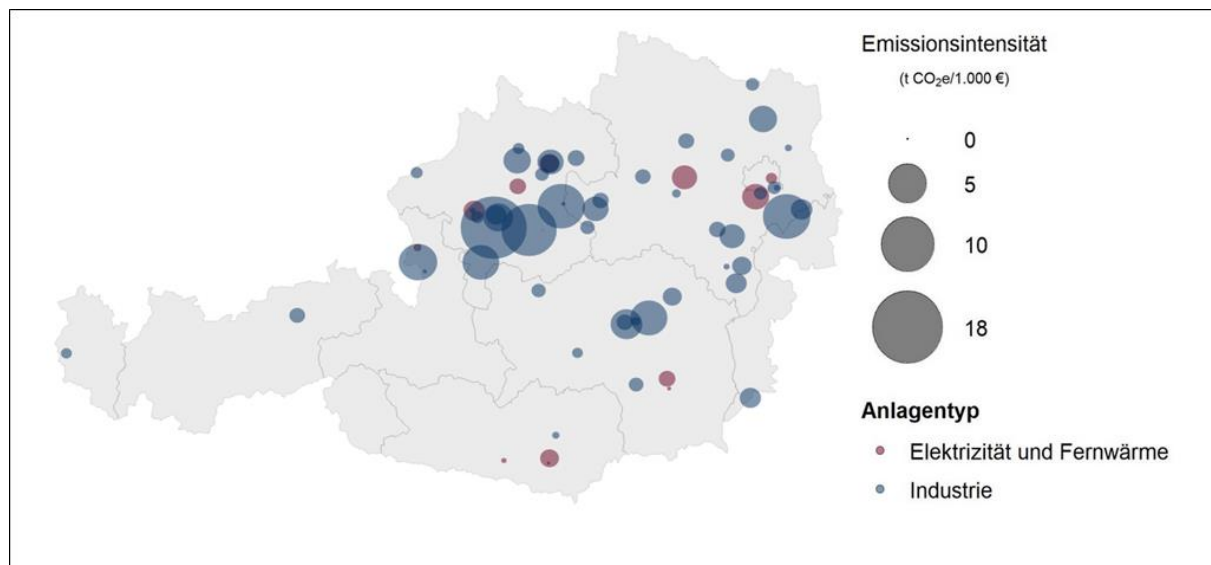
Generally, Lower Austria's industry has a 25% share of the total energy consumption in Lower Austria in 2021. While this is only slightly higher than the national average (24.8%), the industrial composition of the region is rather unfavourable. Table 2 indicates the branches in which the share of employment in the total workforce in relative terms has been higher than in Austria (location quotient). The notes in the right column underline those industries exhibiting the highest shares (like chemical, metallurgy or food industries). Branches classified as energy-intensive are highlighted in grey (using the classification of energy-intensive industries by Trinomics et al. (2020)). In one glance, this table shows the spatial concentration of energy intensity in Lower Austria. Spending a closer look, the chemical industry is by far the biggest consumer, as it is responsible for 28.4% of the total energy consumption of industrial activities. Due to their relatively significant share (more than 10% in the total industrial energy consumption), it is also worth mentioning the manufacturing of non-metallic minerals, the food industry and the manufacturing of pulp, paper and print as relatively energy-intensive industrial activities in Lower Austria.

Apart from energy-intensity generally, emission of Greenhouse Gases (GHG) more specifically is another crucial topic. Its reduction should be considered one of the key fields to slow down climate change. Lower Austria was responsible for about 22% of the total Austrian emissions in GHG in 2020 (Umweltbundesamt, 2022). This is the second-highest emission share among the Austrian federal states after Upper Austria. Figure 7 exhibits the spatial distribution of the most energy-intensive firms in Austria. The chemical, cement, and paper industries have the most significant impact in the area of Lower Austria. A key issue is that the GHG emissions of the industry have risen by 20% over the last 30 years (1990–2019), primarily due to the growth of the chemical industry and marginally because of an increase in the food industry. A reversal of this trend is of utmost importance for the region to meet sustainability goals.

**Table 2: Sector specialization and energy-intensive industries in Lower Austria**

Branch	Note
Manufacture of food products (C10)	2nd highest relative employment share within Austria
Manufacture of beverages (C11)	
Manufacture of wood and of products of wood and cork, except furniture (C16)	
Manufacture of paper and paper products (C17)	
Printing and reproduction of recorded media (C18)	
Manufacture of coke and refined petroleum products (C19)	Highest relative employment share within Austria
Manufacture of chemicals and chemical products (C20)	Highest relative employment share within Austria
Manufacture of other non-metallic mineral products (C23)	
Manufacture of basic metals (C24)	2nd highest relative employment share within Austria
Manufacture of fabricated metal products, except machinery and equipment (C25)	
Manufacture of furniture (C31)	
Other manufacturing (C32)	

Source: Authors' edition using Eurostat data and the classification of energy-intensive industries by Trinomics et al. (2020)

**Figure 7: Spatial distribution of emission-intensive facilities in Austria, source: WIFO, 2020**

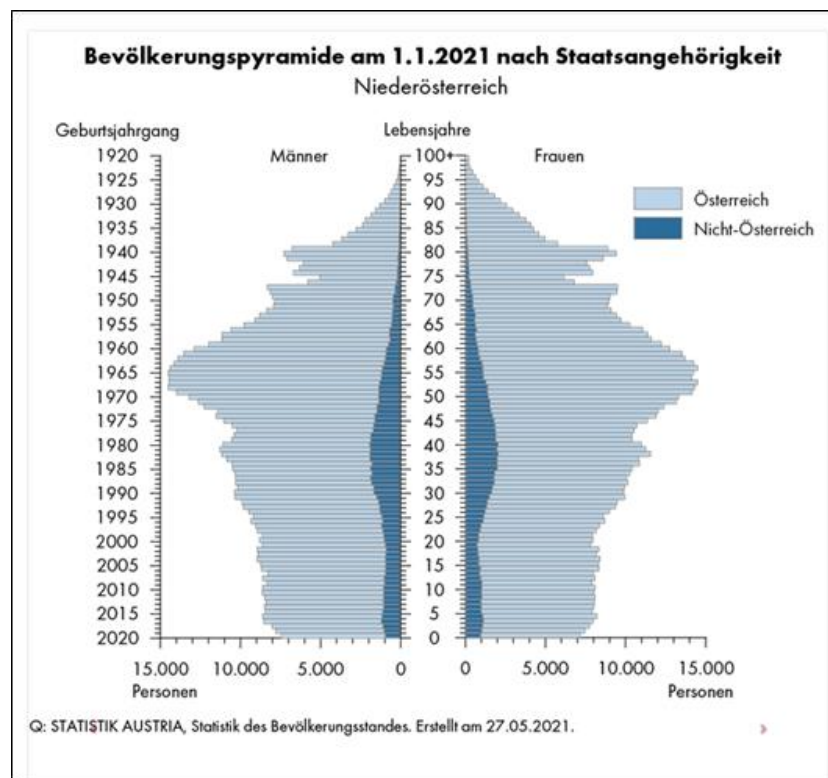
Given the issues in relation to energy-intensity and emissions, it is imperative for Lower Austria to initiate new development paths. However, here another core issue identified comes into play the: **lack of specialists**. Almost all the screened documents in unison highlight the lack of specialists as a key challenge in Lower Austria. The interviewees have repeatedly mentioned this issue as well. A study on Austrian small and medium-sized firms (SMEs) has found that the lack of specialists as a barrier affects around 7 out of 10 companies. Every tenth position in Lower Austria is currently vacant (WKO, 2022). According to the statistical data of the Economic Chambers of Austria, about 45 to 50% of the SMEs are affected by the shortage of

specialists. The president of the Lower Austrian branch of the Economic Chambers recently stated (WKO-NÖ, 2022):

*"The shortage of skilled workers is becoming more and more acute; according to the latest data, this shortage costs Lower Austria's companies around 400 million euros per year - and the trend is rising. This corresponds to a GDP growth of 0.7 %, which cannot be realised." (translated)*

Given that Lower Austria registers the second-highest population growth among the Austrian federal states over the last 20 years, this might sound surprising. However, this process primarily affects the agglomeration area of Vienna. One key issue might be related to a shift in the educational structure. Accordingly, we found that the number of students has increased in a few types of secondary schools ('AHS-Unterstufe', 'AHS-Oberstufe' and 'Oberstuferealgymnasium'). In parallel, a considerable decrease can be observed in the student numbers of 'higher-vocational technical schools' ('Berufsschulen' in German abbreviation BMS/BHS) over the last 10 years.

The lack of specialists must be considered a significant challenge, impeding the implementation of transformative activities and maintaining the current level of economic development. However, our interview partners have also shed light on the fact that this is not a challenge that recently emerged. Accordingly, the aging of society and problems with care work are well-known issues in the region. Thus, **social challenges, i.e. childcare and demographic change**, have been identified as the third core problem the region is currently facing.



**Figure 8: Austria's population pyramid by nationality, source: Statistik Austria, 2021**

Indeed, the increasing share of elderly people is perceived as a central issue at the upper end of the population pyramid (Figure 8). Of course, Lower Austria is not alone in this respect, as this problem is widespread in many Western countries. Nevertheless, our interview partners and many documents attribute high importance to demographic change in the region. The so-called 'Hauptregionenstrategie 2024 NÖ-Mitte' (the sub-region in which the RIS4Danu sites are located), for instance, considers it as the framework condition "most notable in regional



development as it is reflected in all fields of action, (sub)themes and strategic directions” (p. 10, translated). Furthermore, Figure 8 shows that the baby boomer generation will fully retire from working life in the years to come, creating huge challenges in relation to elderly care and workforce participation.

When confronting our regional experts with potential solutions to these problems in our interviews, they highlighted the need to look at the lower end of the pyramid, as the following quote shows exemplarily:

*“Childcare is the central issue. Well-developed childcare enables the mobilisation of women’s know-how and labour potential. I would see that as central, as many women are not full-time employed, and we have a shortage of skilled workers. So, I would rather see the solution in the social sector and in this compatibility of childcare with full employment.”*

As such, the lack of sufficient structures for adequate childcare (especially full-time care) in the region has been identified as an important challenge, which – if addressed – could become an opportunity and one response (among others, such as the influx of skilled migrants) to the problems of unfavourable demographic development and the lack of specialists.

In more unrelated but equally important terms, Lower Austria suffers from unsustainable space consumption and usage, bringing unwanted consequences. As such, **land use, ground sealing and loss of biodiversity** has been identified as Lower Austria’s fourth pressing challenge.

Indeed, ground sealing is considered a major problem in almost all relevant documents that have been analysed. And for a good reason: Lower Austria is only behind Burgenland when it comes to land consumption per capita in a comparison of the Austrian federal states (Profil, 2022). One reason for these extremely high levels of ground sealing is the ongoing housing sprawl, which not only on its own consumes land but also implies the building of roads to remote areas (ibid.). As such, ground sealing and unsustainable traffic patterns based on individual transport (see down below) are tightly connected.

In terms of biodiversity, the screened documents exhibit a growing interest in new ways of doing things in agriculture and forestry. This is driven by both necessity and opportunity. On the one hand, the impact of climate change, monocultures, land consumption and associated ecological impoverishment and the loss of biodiversity call for a reconsideration of conventional agricultural practices. On the other hand, know-how, several interesting H2020 projects, the Technopole and the Department for Agrobiotechnology of BOKU Vienna in Tulln – among other things – might offer important assets for transformative activities in these domains.

Hence, it should be noted that one can observe a change in awareness in recent years. New regulations, the climate and energy programme 2030, and new approaches in building, agriculture and forestry are important connecting points for more sustainable activities. At the same time, the experts underlined that current strategies are still insufficient, highlighting the important role of further projects like RIS4Danu.

Ground sealing, loss of biodiversity but also emission intensity, all of which key challenges are characterizing Lower Austria, are closely related to **unsustainable mobility and transport patterns**, which we consider the finale key challenge for the region of Lower Austria. Indeed, with a motorisation rate of 654.4 cars per 1.000 inhabitants, the region exhibits a value second only to Burgenland in a comparison of Austrian federal states. Moreover, 42,6% of private cars are second or third cars, again leaving the region in a (rather undesired) top 3 position. The share of e-cars is close to the Austrian average (Global 2000, 2020).

When confronting our regional experts with this topic, they pointed towards two key underlying problems. First, the transport system is deeply entrenched among the population. One expert said that many inhabitants simply *“cannot imagine a life without a car, especially with kids. Even in cities, couples have two cars.”* Second (and closely related), there was simply no sufficient political will to change things, as demonstrated by this quote from an interviewee: *“there is a lot of work to be done in Lower Austria in the transport sector, where we have actually developed in the wrong direction in regards to sustainability over the last ten or 20*



years because we have actually promoted individual transport much, much more than it was already anchored in the region. Entire railway lines have been closed and have not even been adequately replaced". This critical assessment is confirmed by a recent publication of the Umweltbundesamt (Figure 9), showing that emissions in the traffic sector (dark red line) – in contrast to many other sectors such as energy or buildings – have risen significantly over the past 30 years in Lower Austria. A fact partly explainable by an almost complete lack of sustainable transition processes in terms of the region's model split between 2008 and 2018 (Figure 10).

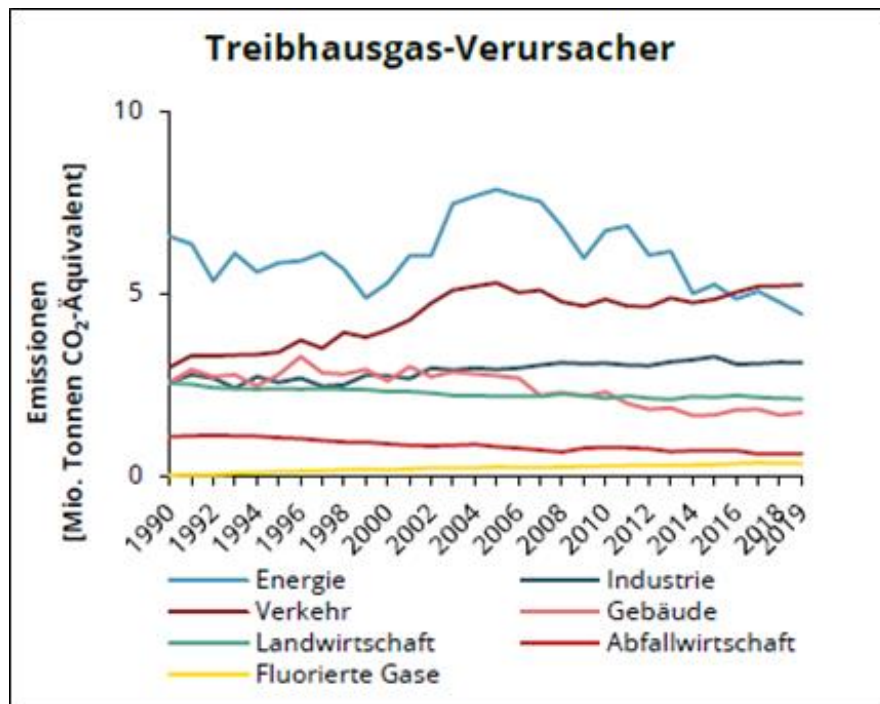


Figure 9: GHG emissions in Lower Austria by different sectors: energy, traffic, agriculture, fluorinated gases, industry, buildings, waste management, source: Umweltbundesamt, 2021

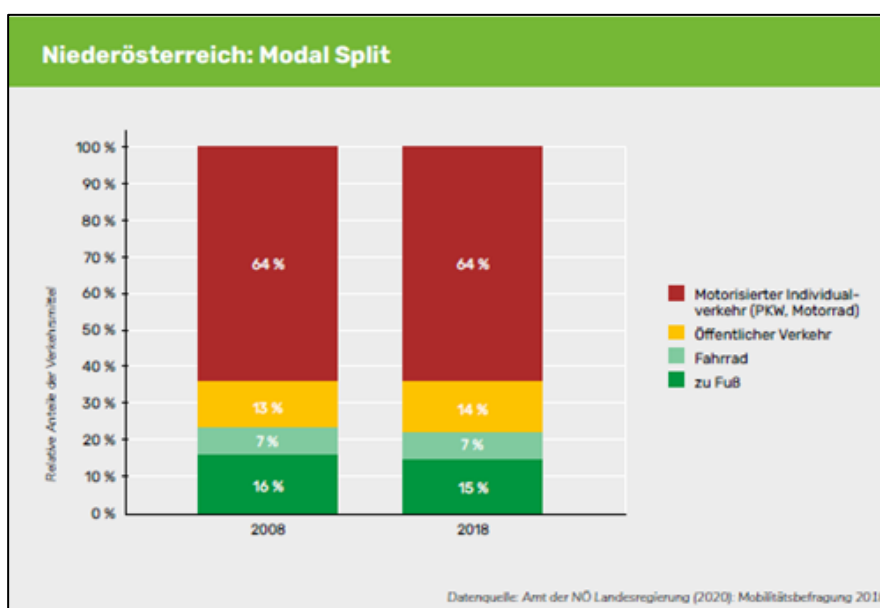


Figure 10: Lower Austria's Modal Split in 2008 and 2018, source: Global 2000, 2022

All of these five regional core challenges call for sustainability action and challenge-led innovation. Following the core principles and conceptual underpinnings of the RIS4Danu project, these challenges should hence be seen as opening up future transformative avenues in the region.

Yet, not only challenges are connected to opportunities, but also **various assets**. These can be used, exploited and/or mobilized for transformative activities in the region. Accordingly, in what follows, the analysis turns to the regional asset base and identifies key regional strengths that offer entry points and a platform for the RIS4Danu project.

The first one is rather horizontal in nature, thus important for all sustainability transition processes. We found a **growing awareness and a window of opportunity** opening up in Lower Austria. There are a number of indications leading to this verdict. First, the 9th wave of the European Social Survey (data from 2017–2018) shows that a high share of residents is aware of environmental challenges and willing to address them. Lower Austria has a value (around 84%) among the highest in a comparison of Austrian federal states of respondents agreeing that it is important to care for the environment and nature (national average 80,5%). Our interview partners confirmed a growing awareness in the population, but also pointed out that much work is yet to be done in terms of legitimacy problems, meaning that – depending on the concrete topic – this general trend is not easily translated into a platform for transformative activities.

Still, one can come to the conclusion that a window of opportunity is opening up right now, which not only has to do with growing acceptance for change regionally, but also with global macro-trends, as one interview partner with expertise in industry policy summarized strikingly:

*“I still see opportunities, especially now that it is becoming clearer and clearer that the value chains with China don't work so well [...] and that we must bring back the production of PV and wind, the energy supply. [...] Lower Austria would be predestined to re-establish such an industry. Then there is the whole story of Industry 4.0, which actually has increasingly automated processes. In other words, I actually need less workforce, I can produce comparatively efficiently, i.e. more cost-efficiently than in the Far East. In addition, transport routes are very expensive right now and will have to become more and more expensive with the taxation of fossil fuels. It will simply be like that, whether it is today or tomorrow or the day after tomorrow. But what will happen is that it will become more expensive. And in this mix, I just have a lot, a lot of potential.”*

In this respect, the pharmaceutical ‘giant’ Boehringer-Ingelheim serves as an interesting example. The company has recently announced the opening of a new site in Bruck an der Leitha in Lower Austria, which will create 800 jobs. The decision was largely based on the presence of enough **renewable energy** close by in the form of wind parks and a biogas plant (Kurier, 2022). The fact that energy security and sufficient supply of renewable energy are, to an ever-increasing extent, key factors in the competition between regions might be a huge opportunity for Lower Austria, given the potential in wind, water and biomass. Indeed, renewable energy potential and availability must be considered an important regional asset.

In this regard, one can observe some dynamism in the field of renewables, which however must be further boosted. The share of renewable energy in total energy consumption between 2010 and 2018 increased by 13.2%, while fossil energy consumption decreased by 2.7% over the same period. The share of renewable energy has increased during the last years and amounts to about 34%, which is equivalent to the federal average. Regarding electricity production from renewable energy, hydropower has the most significant share (almost 50% of the total production), while the most dynamic subfield has been wind power, as its share increased by 19% within the whole energy mix between 2010 and 2020. In terms of producing wind power, Lower Austria holds the second-best position among the Austrian federal states. Bio-, photovoltaic and geothermal energy (altogether about 10.5%) have a marginal role in energy production. (Global 2000, 2022)

In the field of hydropower, the Sankt Pölten district, where the sites are located, ranks in the top position (1st out of 35 Austrian NUTS 3 districts) when it comes to the potential of electricity generation per land area by small hydropower (<10MW) (GWh/km<sup>2</sup>, 2018). As our interviewed experts confirmed, this potential has already been recognised and used in many locations in the federal state. Therefore, a possible collaboration with Voith in Sankt Pölten (one of our sites) and the WasserCluster Lunz on sustainable use of hydropower could support transformative activities in this field. In this respect, one interviewee even argued for a return and reactivation of the assets that once made Lower Austria an attractive place for industrial activities:

*"I hope - with the Ukraine conflict, that much more will now be possible. Yes, also in terms of use and regulations. [...] Yes, we do have many streams and rivers in Lower Austria. And if you wonder, why did industries develop in Lower Austria in these valleys? The answer is: Hydropower in many cases. Also, iron ore and wood, of course. [...] Yes, a recollection to what was always the case and to the reasons why they developed there."*

Hence, hydropower in conjunction with wind power should be further strengthened to become the backbone of energy supply in Lower Austria. In addition, the Hauptregionsstrategie NÖ.Mitte (p. 18) places emphasis on biomass potential and decentralized supply to achieve energy autarchy:

*"The pursuit of renewable energy production is taking the region one step closer to energy self-sufficiency. Agriculture and forestry offer very good conditions for biomass and woodchip power plants, especially in the south. At the same time, the spatial structure of the region is attractive for a decentralised energy supply. The objective is to focus here, also because wood as a raw material can contribute even more to regional value creation than in the past." (translated)*

Thus, renewable energy supply already now can be considered an important and future-proof source of competitiveness for Lower Austria, but should be substantially boosted – also with new approaches in terms of small hydropower, biomass and decentralized energy supply – in the future. This is crucial, not least to retain what we consider the third big asset of the region: its **strong industrial culture**.

Lower Austria has a solid industrial base. The share of industrial workplaces within all workplaces is 24.4% which is slightly above the national average and ranks Lower Austria in fourth place among the Austrian federal states. The employment shares of certain industrial activities also suggest a diversified structure of industrial activities in the Lower Austria economy. The interviewees emphasised that the diversified industrial structure might be a clear asset of the region because its industrial performance does not depend only on the efficient operation of a few leading branches. But they have also referred to its other side, namely the fragmentation of industrial networks, which might hinder cooperation.

The SMEs are serving as the backbone of the Lower Austrian economy. Our interview partners confirmed that they have particular importance in implementing innovations. According to the data of the Austrian Economic Chamber, about 112,000 SMEs are active in the secondary sector in Lower Austria, and they employ about two third of the workforce of this sector. Furthermore, they also play an essential role in attracting partners from Central and Eastern European countries through international collaboration.

Several sectoral clusters created over the last two decades prove that the regional actors (large firms, small and medium-sized enterprises, research institutes and intermediaries) attribute importance to collaboration (Table 3). Besides the clusters mentioned in the table, new clusters in [healthcare technology](#), [e-mobility](#), [aerospace](#) and [green transformation and bioeconomy](#) have been initiated over the last years. Particularly, the initiation of green transformation and bioeconomy can provide a proper base for transformative activities in the region.

Table 3: Overview of clusters' activities in Lower Austria

Cluster	Number of members	Key areas for innovation
<b>Food cluster</b>	100	<ul style="list-style-type: none"> <li>• Food quality and food safety</li> <li>• Regional and organic products</li> <li>• Resource efficiency</li> </ul>
<b>Plastic cluster</b>	390	<ul style="list-style-type: none"> <li>• Bioplastics</li> <li>• Multifunctional component development</li> <li>• Material cycle/recycling</li> </ul>
<b>Mechatronic cluster</b>	320	<ul style="list-style-type: none"> <li>• Energy technology</li> <li>• Additive manufacturing</li> <li>• Smart production</li> <li>• Digitalization/Advanced manufacturing</li> </ul>
<b>Green building cluster</b>	216	<ul style="list-style-type: none"> <li>• Climate-adaptive technologies</li> <li>• Constructive efficiency</li> <li>• Digitization in construction (Building Information Modelling)</li> </ul>

Source: Ecoplus, 2022

Hence, several interesting avenues for future activity exist on the basis of established industrial paths. However, it should be noted that several clusters are confronted with fundamental transformative challenges and require deep-rooted reorientation towards sustainable practices (e.g., food, building or plastics).

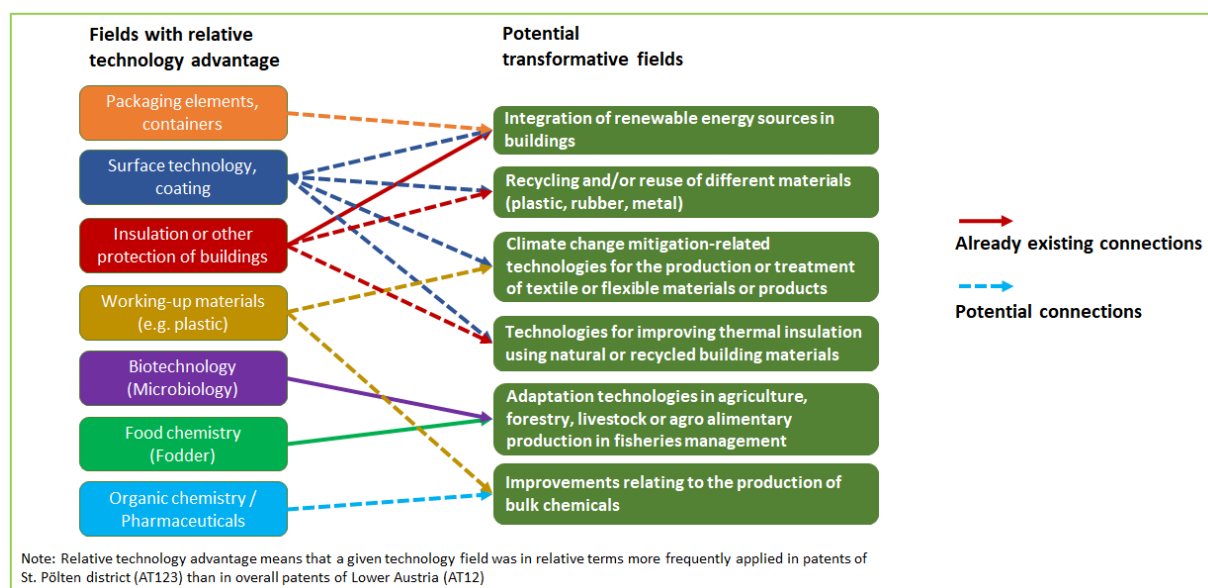
This draws the attention to **R&D: New impulses for the region** (fourth asset), which can potentially contribute to addressing these transformative challenges. However, according to the quantitative analysis, the research and development activities of Lower Austria are clearly below the national average. As for the R&D expenditures in the percentage of the GDP, Lower Austria has the third lowest value among the Austrian federal states both in terms of total R&D (1.8% while the national average is 3.1%) and the business sector R&D (1.35% while the national average is 2.2%). This relatively low performance in R&D is also reflected in the recent population-related number of patents, as the federal state has the second lowest value after Burgenland.

With that being said, our interviewees mentioned that Lower Austria has always been a region for applying instead of inventing new products. Moreover, using the patent data of the OECD, we identified some fields in which the St. Pölten region has relative technological advantages (with the location of the key actors in brackets), meaning that a given technology field was in relative terms more frequently applied in patents of St. Pölten district (AT123) than in overall patents of Lower Austria (AT12).

- Biotechnology, Chemistry (in Getzersdorf and collaboration with the Technopole in Tulln),
- Layered products (mainly in Weinburg and partly in Unterradlberg),
- Working up used materials (mainly in Sankt Pölten and partly in Weinburg),
- Insulation of buildings in construction (mainly in Sankt Pölten)
- Aluminium production (in the Southern part of Traisental)

Spending a closer look on those technological fields, also focused on those patents which include “technologies or applications for mitigation or adaptation against climate change” (based on the patent data of the OECD Regpat database). Therefore, we checked which climate change-related technologies or applications might be combined with those technologies in which the area has competitive advantages (Figure 11). We reviewed the combinations that already exist in the region (continuous line) and extended the search with those climate change-related technologies or applications that might be related to the technology fields which have relative advantage in the area (based on data from other regions

with the same technological advantage) but are not yet existent regionally (dashed line). In other words: the dashed lines indicate potential new developments towards transformative fields based on regional R&D strengths that have already been proved possible elsewhere.



**Figure 11: The existing and potential future combinations between fields with relative technology advantage and transformative fields in Lower Austria,**  
**source: Own edition based on the data of OECD Regpat Database**

Figure 11 showcases several interesting transformative avenues based on R&D capacities in Lower Austria, ranging from renewables in buildings, to thermal insulation or improvements in agriculture and forestry. All of these fields match well with the regional industrial profile (see 'Strong industrial culture'). For the final asset identified in this analysis, however, we want to draw attention to the field of 'Recycling and/or reuse of different materials', as this domain in particular matches well with the **right conditions to implement a circular economy** in Lower Austria, our final identified asset.

*"But I think we have a great opportunity in Lower Austria in the area of sustainability, which we have not really used so far. (...) We are one of the largest agricultural producers in Austria, we produce a lot (...), and to take a closer look here, to better manage raw materials that we have in the cycle, to make better use of them is certainly a topic that we must tackle."*

This has been the answer of one expert with a broad perspective of industrial structures in Lower Austria to the question where the key opportunities for the future lie. Hence, given the byproducts and waste that are generated, Lower Austria might provide ideal conditions to implement more circularity in its economic processes.

However, the interviewees also stressed that the collaboration of the actors is essential to recognize the potential connection points and assets among them, for instance, using the material or waste in the production process of one company, which has already been redundant for the other. To exchange their experiences, the already established bioeconomy platform (also within the federal state and nationwide) might serve as an appropriate option. Yet, the experts pointed out that the actors need to recognize the potential opportunities for collaboration on the circularity of materials. Therefore, scientific organizations (universities, research centres) might have a key role in revealing possible innovative solutions for reusing materials and the relevant branches and actors. As one university professor admitted in a self-critical manner, there is still much to do in regards of such industry-university partnerships:

*"In principle, this has to come from the research institutions and I think we have to try harder to somehow bring the companies and the research institutions together. So that's also a bit of*



*self-criticism, the universities would have to go out of their way a lot more, approach the companies, look what we have".*

Thus, we consider the implementation of more circularity, as well as more awareness raising and networking activities as important transformative initiatives in Lower Austria and as suitable connecting points for RIS4Danu.

**Table 4: Summary of assets & challenges identified for Lower Austria**

<b>Assets</b>	<b>Challenges</b>
Growing awareness and a window of opportunity	Dependence on oil & gas, high energy intensity and dynamism in the 'wrong' industries
Renewable energy	Lack of specialists
Strong industrial culture	Social challenges: childcare and demographic change
R&D: New impulses for the region	Land use, ground sealing and loss of biodiversity
Right conditions to implement a circular economy	Unsustainable mobility and transport patterns

*Source: own elaboration*

Now, after having discussed Lower Austria's most promising assets and most pressing challenges based on the in-depth analysis (Table 4), the final paragraphs of this section will briefly discuss these findings in relation to possible transformative development paths for the region that can be derived.

Generally, it could be observed in the quantitative analysis that Lower Austria has a relatively low performance in terms of productivity. The slowing growth trends in economic development and productivity over the recent years underline that the region has been stuck in a development trap situation. Therefore, the region needs new impulses for regional development.

Clearly, those development impulses should be directed in a sustainable and future-proof path that support the re-shaping of the energy-intensive industrial structure. This calls for an ever-increasing role of renewable energy sources and turning to activities with lower GHG emissions than recent ones. Not only can Lower Austria support such endeavours with potential in hydropower, biomass and wind power, but such developments might also be backed by a strong industrial culture and several important R&D activities.

Furthermore, transformative activities should be directed towards social challenges, especially in relation to demographic change, education and childcare. This is not only important for social security but might also be beneficial to bring talented people to transformative fields and combat the severe lack of specialists.

In addition, unsustainable traffic and transport patterns require novel solutions in Lower Austria. While this certainly beyond the scope of a single site, RIS4Danu could contribute to transition processes in this field with a new innovation-hub for mobility-related activities, which might also contribute to awareness raising. These efforts would simultaneously help to tackle the challenges of ground sealing and the worrying loss of biodiversity.

Moreover, innovation in the agri-food and forestry sectors could be another important transformative goal to combat ecological impoverishment. This also goes hand in hand with key transformative fields identified in the documents.

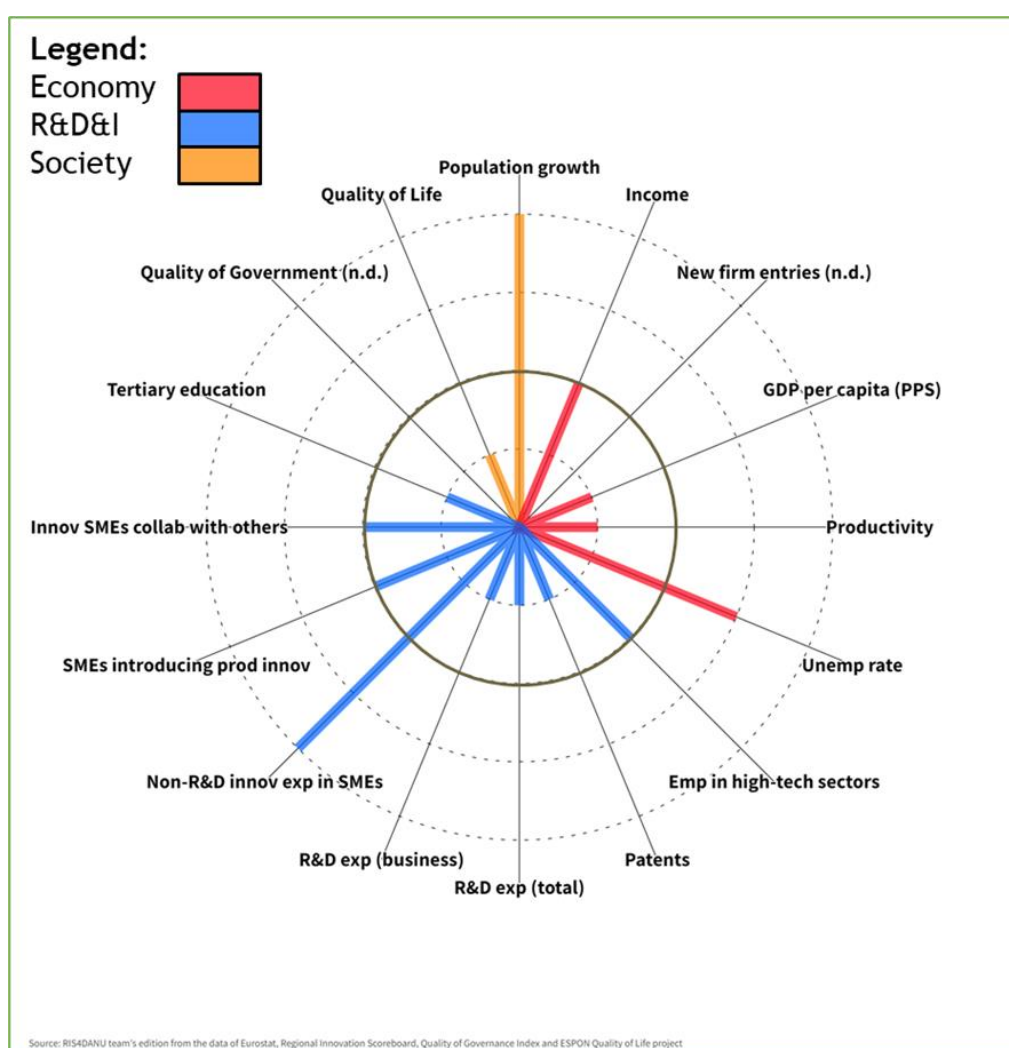
Finally, and closely connected, measures to propel the transition to the circular economy should rank high on agendas of all relevant stakeholders. This transformative avenue checks many boxes from the regional analysis; hence we assume great potential and a good chance of success based on the right conditions, interesting R&D opportunities and a suitable industrial structure.



## 4.2 Schwarzwald-Baar-Heuberg region, Germany

The Schwarzwald-Baar-Heuberg region is one of 12 planning regions in Baden-Württemberg. It is located in southwestern Germany and – as was the case with Lower Austria – belongs to the structurally stronger areas among the participating regions in the RIS4Danu project. Schwarzwald-Baar-Heuberg is part of the Freiburg NUTS-2 statistical region. Schwarzwald-Baar-Heuberg has a relatively strong base in manufacturing, especially in microtechnology, smart systems and medical technologies. The analysis has revealed a strong awareness of the key strengths of the region, in particular concerning key industrial paths. Despite these assets and strengths, the Schwarzwald-Baar-Heuberg region faces several challenges that are not entirely unrelated to those found in Lower Austria, as this section will show.

First, this summary of the regional analysis will cast light on the **general regional context**. Hence, in what follows, the scene is set and information on the wider regional conditions provided (e.g., development in key socio-economic indicators (Figure 12), recent innovation performance (Table 5) or key development fields identified in relevant documents (Figure 13)).



**Figure 12: The socio-economic analysis of the Freiburg region,**  
source: own edition based on different data sources

**The most important findings of the socio-economic and innovation analysis of the region (Freiburg, NUTS-2)**

- The level of regional economic development in terms of GDP is relatively low compared to other NUTS-2-level regions in Baden-Württemberg, but it is still higher than the German average. The same is valid for productivity (gross value added per worker).

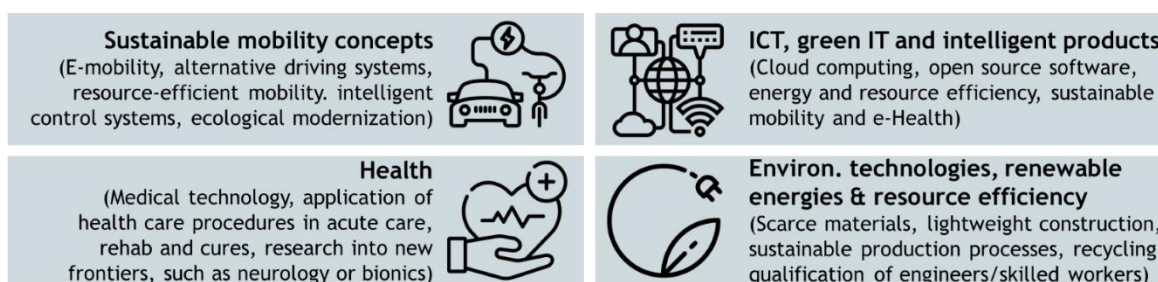
- The unemployment rate is relatively low as the region has the second-best performance in this indicator within the NUTS-2 regions of Baden-Württemberg.
- Freiburg region shows the highest values in population growth within the NUTS-2 regions in the federal state of Baden-Württemberg.
- The innovation-related performance of the Freiburg region (primarily in terms of patents and R&D expenditures) is close to or below the median ranking.
- The only exception is the “Non-R&D innovation expenditures in SMEs”, in which the region holds the highest relative position compared to its peer regions from Baden-Württemberg.

As can be seen in Table 5, the Freiburg region is categorised as an “Innovation leader - “. The Freiburg region has a 126% relative innovation performance of the EU average in 2021. It is the lowest among the Baden-Württemberg regions but is significantly higher than the average German relative performance (115.7% of the EU average). Regarding the development trap indicator, the Freiburg region has been categorised as a region at or close to the threshold of being considered in development trap risk (Diemer et al., 2022). Accordingly, there are a few warning signs, like the region’s relatively low level of productivity. Also, the industrial structure of the region might have an ambivalent effect. On the one hand, there is no doubt that some manufacturing branches perform very well (especially considering the rural character of the region). However, too high level of industrial specialisation might also have adverse effects in the future. Therefore, it might be necessary to consider the diversification of the industrial structure to enhance the resilience of the regional economy.

**Table 5: The Freiburg region’s innovation performance and development trap risk**

<b>Regional Innovation Scoreboard (2021)</b>	<b>Innovation leader -</b>
<b>Development Trap category</b>	<b>Close to development trap risk</b>

Source: Own edition based on data from Regional Innovation Scoreboard and Diemer et al. (2022)



**Figure 13: Key transformative fields defined in: Innovationsstrategie Baden-Württemberg (2020), source: own elaboration**

These central transformative fields (see Figure 13), defined in one of the region’s most important development strategies, offer some first insights into potential key economic development avenues. The goals to transform (into) these fields are assumed to be widely shared by regional stakeholders, hence we consider them highly relevant for the analysis and the workshops alike. As such, some of them will be taken up again, some complemented and some might be critically commented upon from a sustainability perspective in our investigation of Schwarzwald-Baar-Heuberg’s major challenges, assets and transformative opportunities over the following pages.

Adhering to a challenge-oriented innovation approach, the next paragraphs identify some of the **most pressing challenges the region is currently facing**. Addressing these challenges and, in particular, contributing to solving them is a key motive of the project.

To begin with, it should be highlighted that the Schwarzwald-Baar-Heuberg region, despite being a predominantly rural area, is characterised by strong manufacturing activities. Considering the employment structure of the region by the Eurostat data, it can be observed that about 40% of the total employment is in the manufacturing sector. Looking at the Tuttlingen district (sub-region) separately, we find that the share of manufacturing workers within the total employment is even higher (about 50%). This is the highest value of this indicator among the districts of Baden-Württemberg.

This specific characteristic of the Schwarzwald-Baar-Heuberg region is crucial to understand conditions for sustainability transitions, bringing both promising strengths, but also challenges. Concerning the latter, the **topic “Energy”: intensity, production, decarbonisation** should be placed prominently in such an analysis. We consider it the region’s first main challenge. The energy supply is a crucial point in maintaining the competitiveness of the manufacturing activities, while also leading to significant transformative tasks for the regional economy. This has also been confirmed by our interviewees:

*“(…) The big break is now, of course, the energy transition, which is now being triggered by climate change and the Ukraine crisis. The increased expansion of renewable energies, which is now becoming more and more logical from my point of view and was always actually necessary. But that is certainly a large chunk that still must be achieved.”*

Spending a closer look at the regional economic structure, Table 6 indicates the branches in which the share of employment in the total workforce in relative terms has been higher than in the federal state of Baden-Württemberg (location quotient). The notes in the right column underline those industries exhibiting the highest shares. Branches classified as energy-intensive are highlighted in grey (using the classification of energy-intensive industries by Trinomics et al. (2020)). It can be seen that a large portion of the most important activities must indeed be considered in high demand of energy, especially in the Schwarzwald-Baar district. This underscores the importance of the issue for the region.

**Table 6: Sector specializations and energy-intensive industries in the Schwarzwald-Baar and Tuttlingen districts**

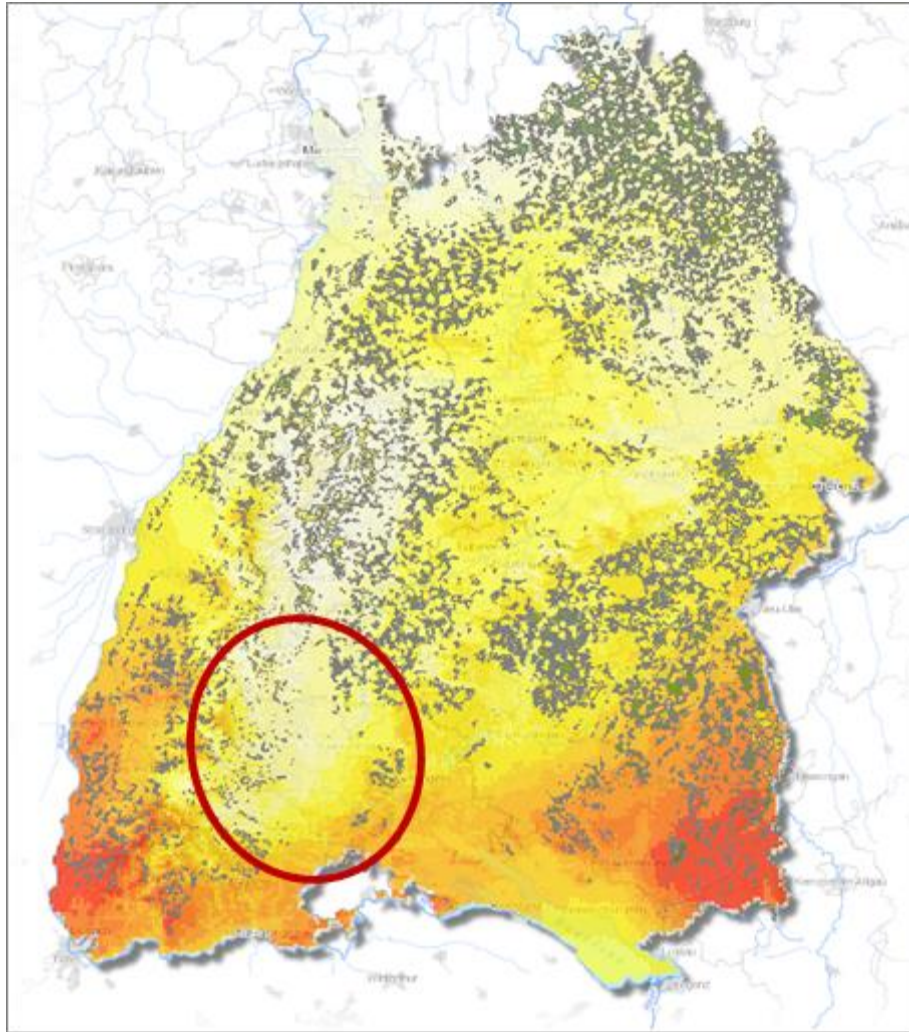
Schwarzwald-Baar district	
Branches with a relative concentration in the area	Note
Manufacture of wood and of products of wood and cork, except furniture (C16)	
Manufacture of paper and paper products (C17)	
Printing and reproduction of recorded media (C18)	
Manufacture of rubber and plastic products (C22)	
Manufacture of basic metals (C24)	
Manufacture of fabricated metal products, except machinery and equipment (C25)	Among the <b>TOP 5</b> districts within the federal state
Manufacture of computer, electronic and optical products (C26)	<b>Third</b> highest relative concentration rate within the federal state
Manufacture of electrical equipment (C27)	Among the <b>TOP 5</b> districts within the federal state
Tuttlingen district	
Branches with a relative concentration in the area	Note
Manufacture of fabricated metal products, except machinery and equipment (C25)	<b>Second</b> highest relative concentration rate within the federal state
Manufacture of electrical equipment (C27)	Among the <b>TOP 5</b> districts within the federal state
Other manufacturing (C32) - also including the manufacture of medical and dental instruments and supplies	The <b>highest</b> relative concentration rate within the federal state

Source: own edition using Eurostat data and the classification of energy-intensive industries by Trinomics et al. (2020)

At the same time, Schwarzwald-Baar-Heuberg is characterized by relatively unfavourable conditions regarding the production of renewable energies. For example, even if the federal



state level data on radiation suggests that Baden-Württemberg has a relatively good potential in solar energy (ISE, 2022), the local climate and weather conditions of both Schwarzwald-Baar and Tuttlingen districts enable only a limited performance of photovoltaic (PV) energy production. Moreover, the geographical conditions come with suboptimal circumstances for wind energy. The so-called 'Energy atlas' of Baden-Württemberg (Figure 14) highlights this issue, depicting limited potential for both forms of renewable energy for Schwarzwald-Baar-Heuberg in the context of its overarching federal state.



**Figure 14: Renewable energy potential in Baden-Württemberg,**  
**source: own edition based on Energieatlas Baden-Württemberg, 2023.**

*Note: Green areas indicate wind energy potential, while shades from light yellow to red depict the solar energy potential, approximate position of Schwarzwald-Baar-Heuberg highlighted with a red circle*

However, this is not to say that there is nothing to be done about the issue regionally. Quite on the contrary. Given the industrial structure, it is vital to further increase the share of renewables. Therefore, Schwarzwald-Baar-Heuberg should draw on different sources and exploit potentials in the best possible way. Furthermore, better infrastructure and batteries can help to balance and import much needed energy (e.g., from Northern Germany with favourable conditions for wind energy). Moreover, awareness raising activities are of paramount importance at this stage of development, given the legitimacy problems we found in the region (see below).

Transition tasks of a large magnitude are not only found in relation to energy, though. The analysis has revealed that the region is also strongly challenged by the fact that **mobility is in transition: emission-free (public) transport and a regional automotive industry facing**

**decarbonization**, the second main issue identified. Indeed, one of the biggest challenges for the Schwarzwald-Baar-Heuberg region originates from the need to drastically cut emissions in transport and to fundamentally reconsider society's mobility needs to comply with decarbonization targets. This challenge manifests itself in the region in two essential ways. First, the strong automotive industry located in the region (see section on general conditions) is facing a deep-rooted transformation. Second, the high dependency on road traffic, a problem well-known in rural areas, poses a significant transition task in the light of demands for a 'Verkehrswende'.

Schwarzwald-Baar-Heuberg hosts a quite dynamic automotive cluster, with about 1,000 companies covering a large and comprehensive product range, particularly focused on the manufacturing of turned parts. While one of the backbones of the regional economy, the industry is facing a fundamental problem. Many parts produced in the region are in some way related to the combustion engine, which will be phased out over the next decade. Hence, it is not surprising that "*Developing new forms of mobility based on sustainability*" is one of the three development goals of the Regional Development Concept 2030.

In light of this problem, our interview partners agreed on the fact that large-scale transformation will be inevitable in the near and mid-term future. When asking one expert how well-prepared regional firms are to take on this challenge, it was answered that, on the one hand, there has been a change in mindsets recently, not least because things have normalized again after the pandemic. On the other hand, however, it was insisted that the transformation to come is indeed an enormous challenge for a large portion of the regional firms: "*But for many, because we have this distinctive structure of medium-sized and family-run companies here, it is a problem now.*"

Against this background, many in the region have placed high hopes in the application of hydrogen as a solution. This is demonstrated, for instance, by the so-called lighthouse project of the 'H2-Real & Testlabor SBH' and has been confirmed by our interview partners. However, there are also severe concerns about this transformative route, not least because leading scientists doubt that hydrogen will have a major role to play on tomorrow's road-based mobility, as the Fraunhofer-Institut (2022) summarized strikingly in a recent report:

*"Green hydrogen is a central energy carrier of the future. A dominant role in road transport seems less likely due to the technical development of batteries and fast charging as well as the overall costs according to the current state of knowledge. Nevertheless, fuel cell vehicles may have interesting applications in some markets [...]" (translated)*

So, while hydrogen might be or might not be a future avenue for the automotive industry in Schwarzwald-Baar-Heuberg, there is certainly room – maybe even a necessity – for other transformative activities in the region in relation to the automotive industry. The RIS4Danu project might be able to play a role in this regard.

However, not only is the regional industry confronted with transition challenges, but also the regional mobility system in general. The documents stress the high dependency on road traffic, but they also refer to ambitions concerning CO<sub>2</sub>-free mobility and new modes of transport like shared mobility (Regionales Entwicklungskonzept, Masterplan Tuttlingen, Industriestandort Schwarzwald 2030).

The fact that there is a necessity to rethink mobility patterns is demonstrated by the many commuters in the region. Indeed, Gosheim (which hosts one of the RIS4Danu sites), for instance, has higher relative commuter inflows (Commuter balance per 1,000 capita: 655) than the federal capital Stuttgart (562) (Statistical Office of Baden-Württemberg, 2022, 2022). While certainly an extreme case, this still demonstrates that the region suffers from an exorbitant high traffic burden. Further, a comparison of the modal split in different regions of Baden-Württemberg exhibits that Schwarzwald-Baar-Heuberg is the region most dependent on individual motorised transport (Figure 15).



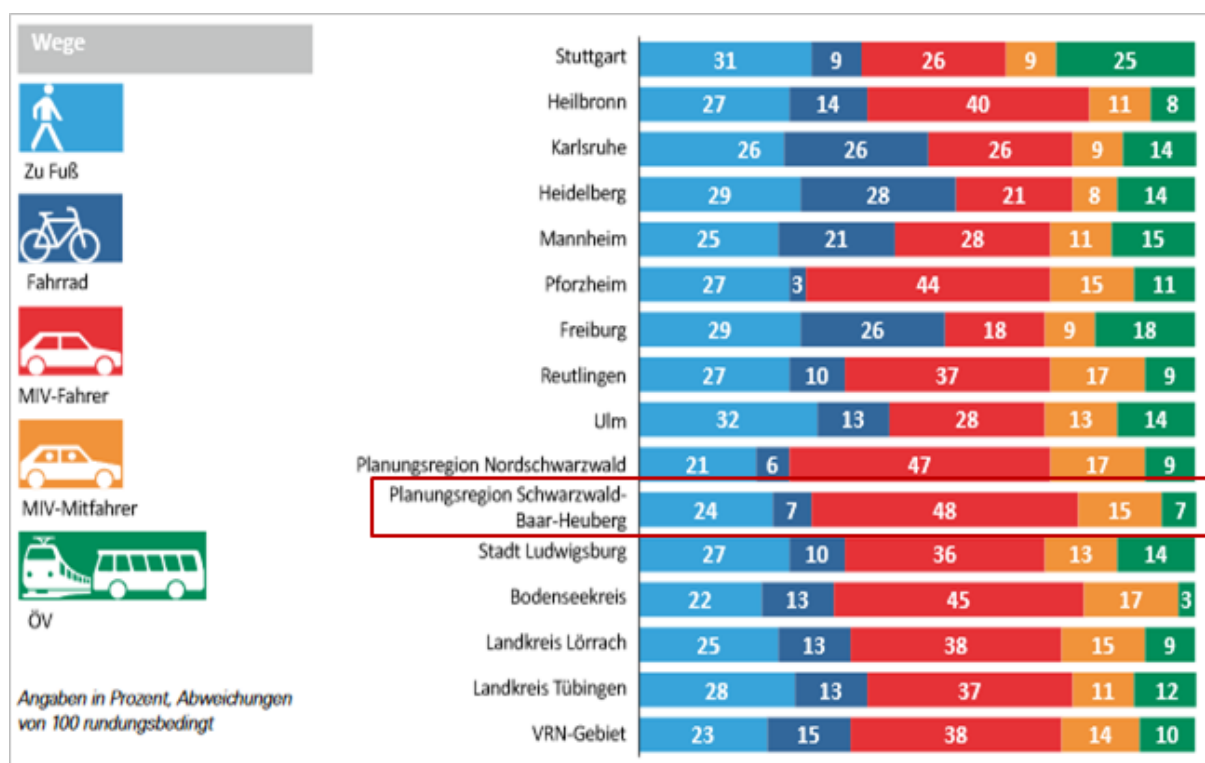


Figure 15: Modal Split in Baden-Württemberg a regional comparison, source: Ministerium für Verkehr Baden-Württemberg, 2017

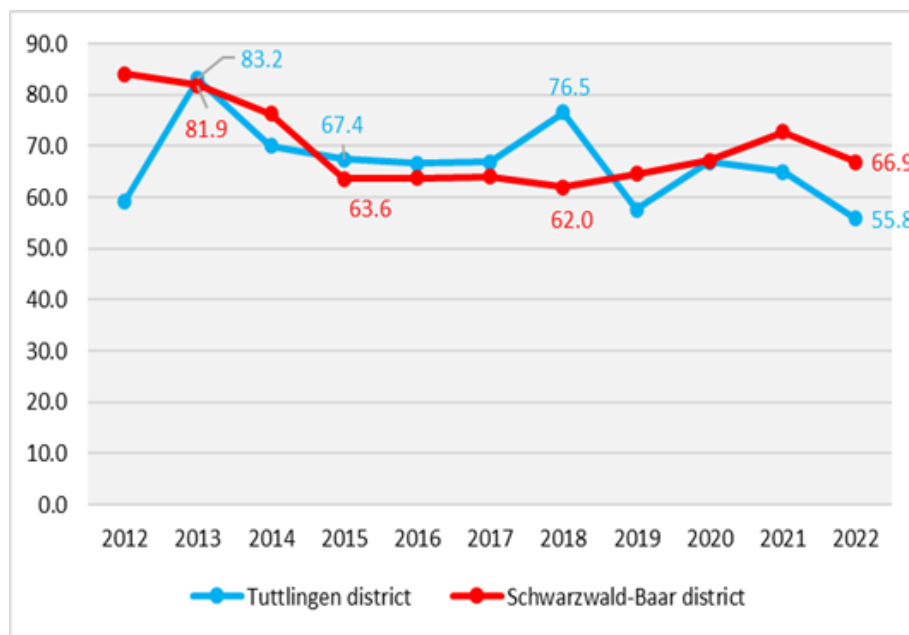
While there seems to be rising awareness about mobility needs and issues in the region recently – as is demonstrated by development strategies and interviewees alike – it is important to note that regional historically-grown decentralization, the sprawl of both housing and firms, creates difficult conditions for transformative activities in this field.

All in all, the Schwarzwald-Baar-Heuberg region faces a fundamental challenge in relation to transport and traffic. The region suffers from a high traffic load and is strongly dependent on motorised private transport. Public transport, on the one hand, does not get the attention and resources it would need to become an alternative. On the other hand, however, it is clear that regional structural conditions make a shift towards public transport (alone) hardly possible.

Apart from these challenges in the key socio-technical systems of energy and mobility, there are also societal problems due to **demographic change and its effect on the regional economy**. We consider this the third main challenge. The demographic trends of the Schwarzwald-Baar-Heuberg region show an ambivalent picture. On the one hand, there is an above-average growth of the population over the last few years and a positive net migration rate. On the other hand, the age structure of the region seems to be less favourable, and the region is also struggling with keeping students and young adults in the area.

Considering the age structure, the proportion of children (0-14 years old) within the total population is still above the federal state average value (even the Tuttlingen district has the highest value in this term). However, the rate of people over 60 years old is also higher than the federal state average, particularly in the Schwarzwald-Baar district. Contrary to this trend, the share of people in three age groups (15–29, 30–44 and 45–59 years old) lags behind the average value of Baden-Württemberg. Hence, despite having a relatively high share of children within the population, there seems to be a lack of people being in their active years. Moreover, the rate of the elder population (60–74 and 75+ groups) increases.

These demographic trends are beginning to leave their mark on the regional job market. For instance, the number of applicants for the job-training places has shrunk significantly over the last 10 years (Figure 16), meaning that from year to year there are more and more training positions that cannot be filled. Arguably, this predicts an even more severe problem in the future.



**Figure 16: Applications for apprenticeships in the Tuttlingen & Schwarzwald-Baar districts, per 100 positions,**  
**source: Statistical Office of Baden-Württemberg, 2022**

We also discussed this issue with regional experts. One person working at one of the regional universities confirmed and highlighted that the challenge is not only confined to the job market:

*“Due to demographic change, we have a massive problem with a lack of first-year students and declining numbers of first-year students. This is a big problem because, at the same time, we have a massive shortage of skilled workers for industry.”*

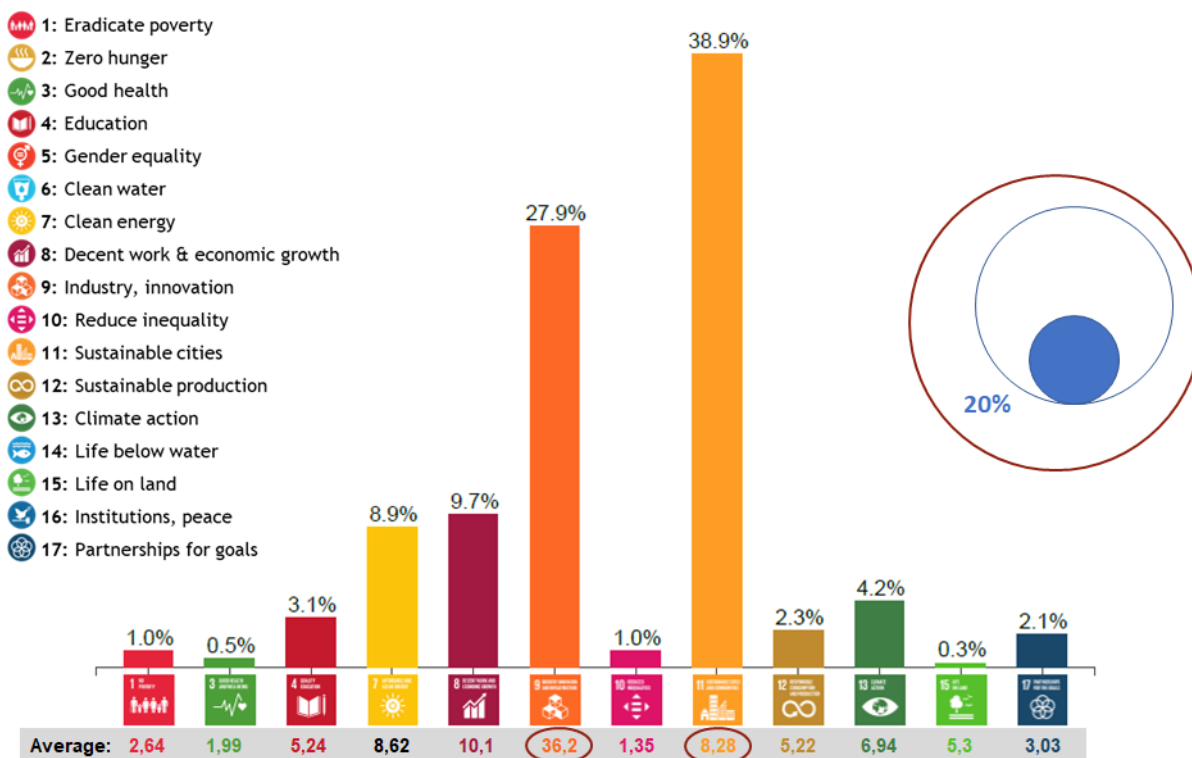
While it is certainly a difficult task to break this vicious circle described by our interview partner, transformative activity to tackle unfavourable demographic trends will be necessary.

The final challenge identified in this analysis is more horizontal in nature: a **missing awareness and ambition in relation to SDG issues**. Indeed, the document analysis has shown a strong awareness of the key strengths of the region (particularly in terms of the key industrial paths of the region) based on a smart specialisation logic (“intelligente Spezialisierung” is mentioned repeatedly). Moreover, current and upcoming challenges related to digitalization, industry 4.0 or artificial intelligence appear often and seem to be treated quite seriously. In contrast, concerns about the sustainability of current ways of doing things do not appear to be considered as important. While the key-words (like sustainability, transformation, etc.) appear (albeit less frequent than, for instance, digitalization), there seems to be some scepticism towards new green ways (energy production, transport system, etc.), hardly any directionality and few concrete projects.

Of course, we have discussed this first impression based on documents and the initial analysis comprehensively with regional experts during interviews. The impression has been confirmed unanimously by the interviewed experts, as the following, exemplary quote demonstrates well:

*“What we notice is that the topic [sustainability transformation, explanatory note] is not particularly popular with the people, with the local population, because people say: okay, we have full employment, we all have jobs, we are doing well. [...] And I don't think that only applies to our region. Yes, we are doing very well here in Baden Württemberg, but I personally lack the foresight to say, well, but what about the next generation or the generation after that?”*

Not only the interview partners have confirmed this impression, though. We also quantitatively investigated the most important development documents (according to our regional partners, see below) using the JRC's novel 'SDG-mapper' (see section on quantitative methods). As outlined above, we have analysed the documents of every RIS4Danu region this way (or its subordinate region for reasons of data availability).



**Figure 17: SDG-mapping of the Freiburg region (NUTS-2),**  
source: own edition based on SDG-mapper of JRC

There are a number of striking aspects worth noting in the SDG-mapping of the documents of the Freiburg region (NUTS-2) specifically (Figure 17). First, not a single hit has been found for a total of five of the 17 UN-SDGs. This is by far the highest number of SDGs missed-out in a comparison of all RIS4Danu regions. Second, the region is the only one among the participating the project regions where SDG9 ('Industry, innovation') is not in the first position. In fact, for all other regions in the RIS4Danu project, SDG9 is the most mentioned one, with 36.2% of all mentions on average. Instead, in this case, SDG11 ('Sustainable cities') ranks highest (which is presumably explainable by the strong profile of the city of Freiburg as a "Green City", which is mentioned repeatedly in one of the documents). Third and probably most importantly, the SDG-mapping for our German region is the least SDG-heavy one of all participating regions in the project with only 20% of "SDG-hits per page" of the most SDG-heavy region, as can be seen by the blue circles to the right, which indicates the 'SDG-intensity' of Schwarzwald-Baar-Heuberg compared to the most SDG-heavy region in the RIS4Danu project. It is important to be aware of the caveats mentioned in the 'methods' section though.

Hence, there are several indications underlining a lack of awareness and ambition in relation to sustainable development. Potentially, this poses a hurdle for the implementation and acceleration of any regional transformation (sub-)process. Thus, we argue that awareness raising initiatives should be considered highly important.

All of these four regional core challenges call for sustainability and challenge-led innovation. Following the core principles and conceptual underpinnings of the RIS4Danu project, these challenges should hence be seen as opening up future transformative avenues in the region.

Yet, not only challenges are connected to opportunities, but also **various assets**. These can be used, exploited and/or mobilized for transformative activities in the region. Accordingly, in what follows, the analysis turns to the regional asset base and identifies key regional strengths that offer entry points and a platform for the RIS4Danu project.

As mentioned before, the Schwarzwald-Baar-Heuberg region and its various potentials for and obstacles to sustainability transitions can only be understood against the backdrop of the region's **strong traditions in manufacturing branches**.

The area has solid industrial traditions, which are also proven by the employment data, as the share of employment in manufacturing is relatively high, particularly in the Tuttlingen district (see above). The structural analysis of the manufacturing branches and the interviewed experts confirmed that, indeed, the Schwarzwald-Baar-Heuberg region has a relatively strong specialisation in a few manufacturing branches (Table 6).

This specialization goes hand in hand with quality. Both, Schwarzwald-Baar and Tuttlingen districts host so-called “hidden champion”, companies which have a worldwide leading position within their fields of activity. These hidden champions are particularly found in the field of medical technology. Besides them, the different activities of machinery industry have also a significant role in the industrial structure of the area.

Moreover, the interview partners mentioned that the industries of the region proved capable of adapting new opportunities and products within a relatively short period after downsizing the watch-making industry.

*“Villingen-Schwenningen was strong in the watch industry. Sankt Georgen, i.e. the entire Schwarzwald Baar district, was actually always focused on this watch industry [...]. And then came the transformation and today we don't have watches made in Villingen-Schwenningen on our arms [...]. If you look at these, these great factories where the watches were made, they have all either been put to some other use.”*

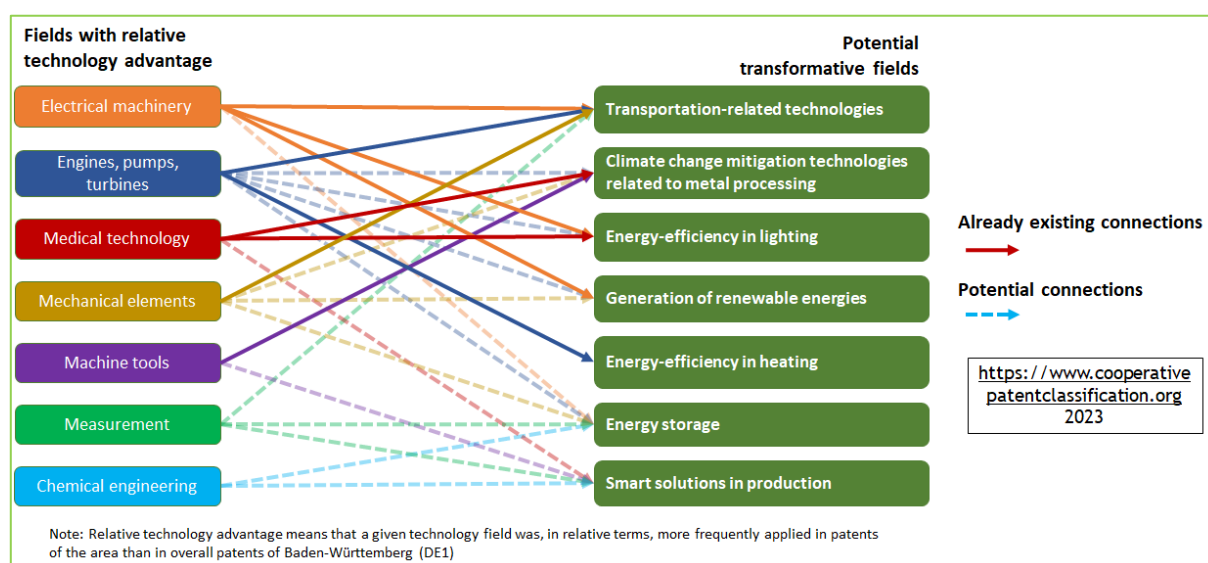
The interviewed experts also pointed towards a new wave of the transformations, the region is facing, in particular in relation to production processes within energy-intensive activities (see above). Therefore, the solid base in manufacturing and the experience of the previous structural changes might be significant assets during the transformation process to a greener way of production and the introduction of new climate change-related activities.

However, it is not only that. Change processes might rely on important **R&D impulses in the region – Patents, research institutes**, the second main asset of Schwarzwald-Baar-Heuberg according to our analysis. While some of the reviewed regional planning documents and reports also referred to the relatively low performance in research & development of the area, a closer look on the patents of the region reveals significant intraregional disparities. Moreover, in several thematic fields the region exhibits a quite high level of innovativeness.

Accordingly, we calculated the value of relative technological advantage of the districts, showing whether a given technology field was in relative terms more frequently applied in patents of the district than in overall patents of Baden-Württemberg. According to this calculation, the Schwarzwald-Baar-Heuberg region (Schwarzbald-Baar and Tuttlingen districts together) has relative technological advantages in the fields of

- medical technology,
- engines, pumps, and turbines,
- mechanical elements,
- machine tools,
- electrical machinery, apparatus, energy,
- optics and
- chemical engineering.

Spending a closer look on those technological fields, we also focused on those patents which include “technologies or applications for mitigation or adaptation against climate change” (based on the OECD Regpat database). Therefore, we checked which climate change-related technologies or applications might be combined with those technologies in which the area has competitive advantages (Figure 18). We reviewed the combinations that already exist in the region (continuous line) and extended the search with those climate change-related technologies or applications that might be related to the technology fields which have relative advantage in the area (based on data from other regions with the same technological advantage), but are not yet existent regionally (dashed line). In other words: the dashed lines indicate potential new developments towards transformative fields based on regional R&D strengths that have already been proved possible elsewhere.



**Figure 18: The existing and potential future combinations between fields with relative technology advantage and transformative fields in the Schwarzwald-Baar-Heuberg region, source: own edition based on the data of OECD Regpat Database**

According to the existing and potential combinations between the technology fields, energy storage, transportation-related technologies (including hydrogen-related applications or electromobility), climate change-related developments in metal processing and smart solutions in production (like smart factories) are those potential transformative fields which might be considered in the Schwarzwald-Baar-Heuberg region. Of course, there are also potential future fields like contributing to the generation of renewable energy or improving energy-efficiency in lighting or heating. A patent analysis also confirms the opinions of the experts interviewed that local innovation companies and their research and development activities are important to the local economy.

As such, it is hardly surprising that the interviewed experts emphasized the well-functioning regional innovation system, which – according to our analysis – is strongly based on the third identified asset: well-developed **local collaborations and support programmes**. Accordingly, there are several key cornerstones of this innovation system in place, guaranteeing and demonstrating its high functionality.

In collaboration with local companies, Furtwangen University of Applied Sciences (Hochschule Furtwangen) and its campuses play a significant role in research and development and human resources development. One example of collaboration is the university's advisory board, consisting of members who are working for important regional companies. Their role is to help adjust the study programme to the needs of the regional firms. Furthermore, the university provides grants and start-up support programmes.



The Hahn-Schickard Institute is another significant actor in the region's research and development landscape. Based in Villingen-Schwenningen, the institute conducts research in microsystem engineering and medical technology that is of great importance to the region. The interviewed experts revealed that it has a wide network of partners. Reviewing the Horizon2020 projects within the 2014–2020 period, this organization was the most active project participant from the region with 3 coordinated projects and altogether 13 project participations. The projects of the institute also contribute to creating new companies.

Moreover, there are two relatively large network of actors in the Schwarzwald-Baar-Heuberg region. One is an innovation network with the participation of 100 companies and organizations which also provides a platform for introducing new products and inventions. The other one is the network of enterprises dealing with medical technology. The Chamber of Industry and Commerce of the region is now working on the organization of a cluster for firms in the automotive industry. There are about 80 member companies in this network.

Besides the industrial clusters, there are also examples on collaborations about a specific topic like the initiation to create an alliance for skilled workers among the local companies driven by an alliance between the Chamber of Industry and Commerce and the Employment Agency. Furthermore, the foundation of Tuttlingen campus of the Furtwangen University of Applied Sciences serves as a great example. It is based on a German-wide unique public-private partnership. About 40 local companies participate in this collaboration, contributing half of the operation costs of the campus while the federal state covers the other 50%. What is more, regional start-ups and people with an entrepreneurial spirit are supported through the so-called "Gründergarage".

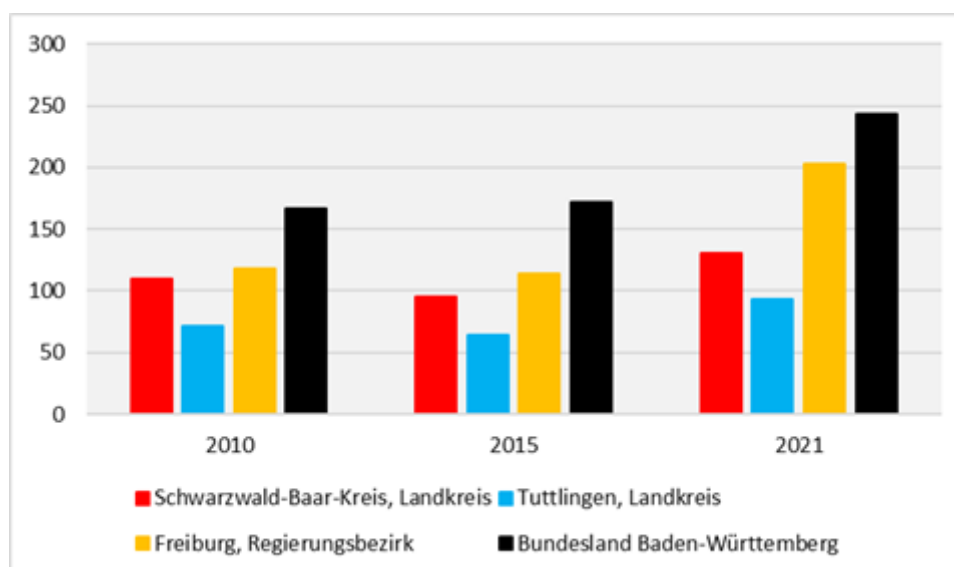
Seeing these cases, the alliances and the sectoral clusters can be considered as an asset of utmost importance for the region. They prove the willingness of collaboration among actors from different backgrounds (large companies, small and medium-sized companies, universities and intermediary organizations like the Chamber of Commerce and Industry of the region). A sustainable, green transition might hugely benefit from such collaborations of actors.

Besides the "hard" factors of a well-functioning regional innovation system, Schwarzwald-Baar-Heuberg also offers the right **soft factors – determinants of quality of life**, which should be considered another important regional strength (fourth asset).

For instance, in term of cost of living, the Schwarzwald-Baar-Heuberg region has an advantageous position since the rental fees and real estate prices are quite reasonable compared to other high industrialized districts or the agglomeration areas of Baden-Württemberg. When looking at the comparison of the average purchase values for building land, both Schwarzwald-Baar and Tuttlingen districts lag significantly behind the value of the federal state and of Freiburg NUTS-2 region (Figure 19). This combination of low level of living costs in an area with high level of manufacturing might make the region attractive.

Besides, the affordable costs of living, the rural landscape and leisure time opportunities can also be attractive factors of the region. The indicator values of Quality-of-Life project by the European Spatial Planning Observation Network (ESPON) underline this. The Tuttlingen district has been evaluated as the best, while the Schwarzwald-Baar district has a relatively good position (top 10 of 44 areas) among the districts of Baden-Württemberg in terms of the availability of and access to green spots which is key for health, sport and other activities.

Hence, the rural landscape, the affordable costs of living, and the leisure time opportunities as well as relatively favourable conditions in terms of the social infrastructure are soft factors that might be important to provide a relatively high quality of life and attract people (also new employees or specialists) to the area.



**Figure 19: Average purchase value of building land by districts in comparison to the federal state of Baden-Württemberg (EUR/m²), source: Federal Statistical Office of Germany, 2022**

Now, after having discussed Schwarzwald-Baar-Heuberg's most promising assets and most pressing challenges based on the in-depth analysis (Table 7), the final paragraphs of this section will briefly discuss these findings in relation to possible transformative development paths for the region that can be derived.

**Table 7: Summary of assets & challenges identified for the Schwarzwald-Baar-Heuberg region**

Assets	Challenges
Strong traditions in manufacturing branches	Topic "Energy": intensity, production, decarbonisation
R&D impulse in the region – Patents, research institutes	Mobility in transition: emission-free (public) transport and a regional automotive industry facing decarbonization
Local collaborations and support programmes	Demographic change and its effect on the regional economy
Soft factors – determinants of quality of life	Missing awareness and ambition in relation to SDG issues

Source: own elaboration

Despite being one of, if not the strongest region structurally in the RIS4Danu project (being the only region considered an 'innovation leader' according to the Regional Innovation Scoreboard, see above), Schwarzwald-Baar-Heuberg faces severe transformation challenges, particularly in relation to the socio-technical systems of energy and mobility.

In terms of the former, the region's strongest asset – its strong presence, traditions, expertise and quality in manufacturing branches – might be considered the biggest challenge at the same time due to the high energy-intensity. Clearly, this issue has gained tremendously in importance due to the war in Ukraine and the rising energy prices around the globe. Schwarzwald-Baar-Heuberg does not offer the ideal conditions for the production of its own renewable energy supply, either. However, as has been pointed out before, this is not to say that there is nothing to be done about the issue regionally. Regional stakeholders should seek to exploit potentials in the best possible way and invest in better infrastructure and batteries. Moreover, it should be noted that the climate protection act of the federal state of Baden-Württemberg has quite ambitious goals and might create further demand for the production and distribution of renewable energy-related products and services. What is more, R&D impulses in interesting domains, the strong innovation networks and experience gained in

previous structural changes might contribute to transformative activities towards greener ways of production.

The same holds true for transition processes in the mobility domain. Indeed, the situation is quite similar in different respects. The starting conditions might not be ideal, given the strong competencies in relation to the combustion engine and the unfavourable regional structure for public transport. At the same time, the region has proven to be capable of fundamental structural change based on innovation. Again, R&D impulses might play an important role for the transition tasks ahead for the regional automotive industry. It should be noted at this point, however, that an overly strong focus on hydrogen-related solutions alone might come with a severe risk of sunk costs and misdirected investments. What is more, in terms of the wider mobility field in the region, shared mobility concepts, but also emission-free transport in the form of active mobility should be considered key fields for the future.

Arguably, the lack of ambition and awareness in relation to SDG topics that has been revealed might become a fundamental challenge in all these future endeavours. Thus, awareness raising activities are of paramount importance at this stage. Arguably, this lack of ambition/awareness/projects/legitimacy, as well as the underlying dynamics and factettes revealed by our interview partners is something the RIS4Danu project (partly) addresses. One potential direction for future-proof activities in the region might be the establishment of a green innovation hub, complementing activities in relation to digitalization regionally.

Finally, the region is in need of activities that tackle the demographic change and its effect on the regional economy. Here, stakeholders are advised to develop strategies to retain a relatively strong young cohort in the region. Promising soft factors shouldn't be disregarded in this respect.

### 4.3 Hajdú-Bihar County, Hungary

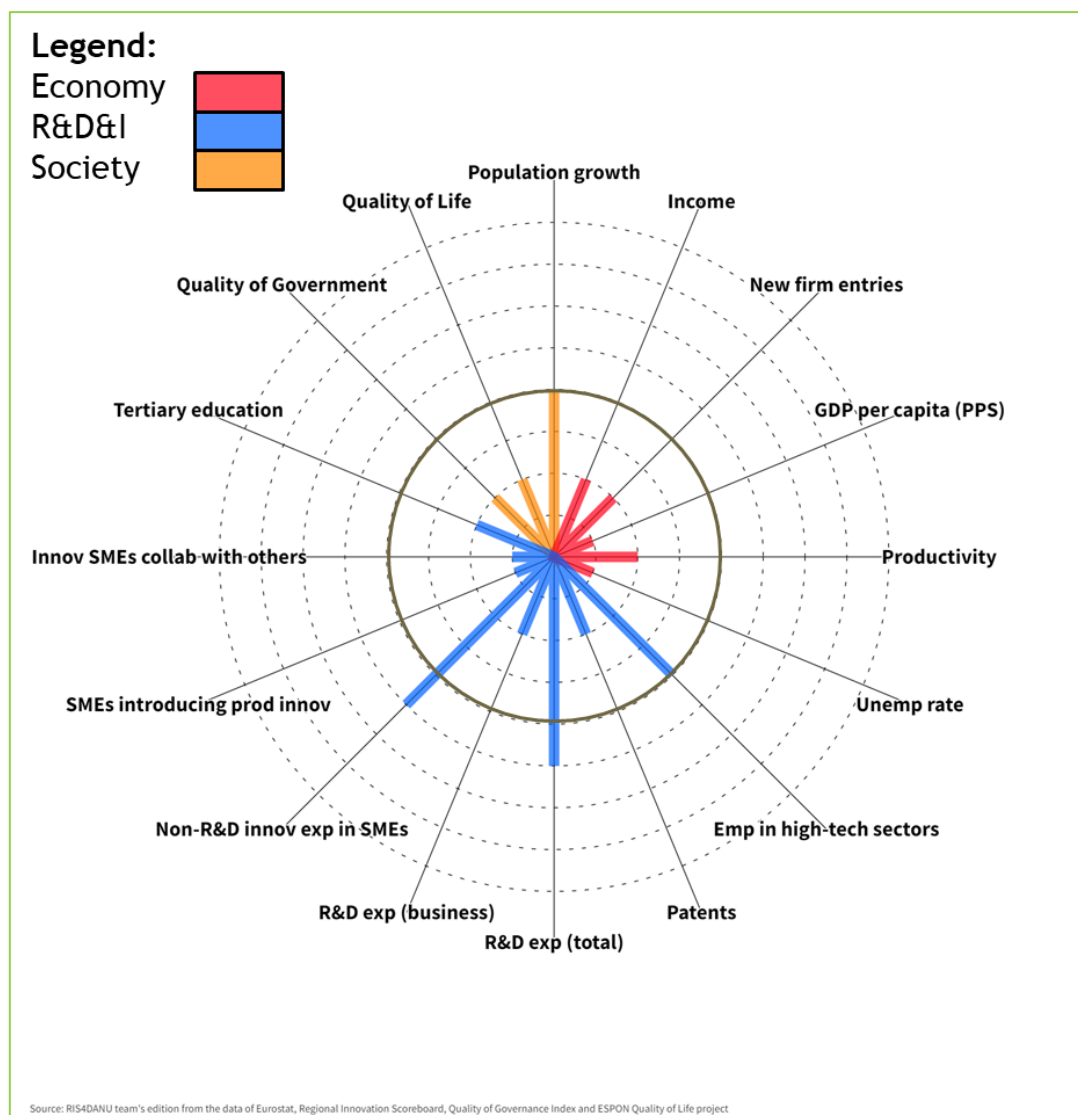
Hajdú-Bihar County is one of the 19 counties in Hungary. It is located in eastern Hungary, and its capital is the second most populated city of Hungary, Debrecen. The county itself has significant potential in agricultural production and tourism, while Debrecen serves as a major hub for research and development (R&D), in which the University of Debrecen has a considerable role. This background in R&D provides a proper basis for medical science, the pharmaceutical industry and developing new paths in the agriculture and the automotive industry (like electro-mobility). Despite these assets and strengths, Hajdú-Bihar County faces several challenges, as this initial analysis will show.

First, this summary of the regional analysis will cast light on the **general regional context**. Hence, in what follows, the scene is set and information on the wider regional conditions provided (e.g., development in key socio-economic indicators (Figure 20), recent innovation performance (Table 8) or key development fields identified in relevant documents (Figure 21)).

#### **The most important findings of the socio-economic and innovation analysis of the region**

- The level of regional economic development in terms of GDP per capita is the lowest in the Észak-Alföld region compared to other NUTS-2 regions of Hungary. The level of productivity (gross value added per worker) is only slightly better than the level of economic development but still lags significantly behind the Hungarian average value.
- Even though the level of unemployment is relatively low in Hungary in general, the region has a relatively unfavourable value in this field since it counts for the highest unemployment rate among the Hungarian NUTS-2 regions.
- The population of the region decreased on average by about 8% over the last 20 years. However, it ranks the Észak-Alföld region in a medium-level position since other Hungarian areas were facing an even higher drop in the population.

- The Észak-Alföld region shows a mixed picture in terms of innovation-related indicators. The region is close to or slightly above the median ranking in terms of total R&D expenditures, employment in high-tech sectors and non-R&D innovation expenditure in small and medium-sized enterprises (SMEs).
- However, the region was ranked in the second lowest place in terms of business R&D expenditures and patents, while it received the lowest ranking concerning the innovation activities of SMEs.



**Figure 20: The socio-economic analysis of the Észak-Alföld region,  
source: own edition based on different data sources**

As can be seen in Table 8, the Észak-Alföld region is categorised as an “Emerging innovator”. The region has a 50.9% relative innovation performance of the EU average in 2021. This performance is among the lowest within the whole EU and only slightly better than the weakest performing NUTS-2 areas of Hungary. This result might be a bit ambiguous since, despite this performance, one of the major Hungarian universities is located in the region with considerable research and development activity. Therefore, we have looked a bit closer at the RIS indicators. These data suggest that even if the region’s performance in public R&D is relatively good (see also Figure A), the area has the weakest or the second weakest values in terms of business R&D and the innovativeness of small and medium-sized enterprises. Hence, the innovation performance of the area shows a two-faced character with relatively high public R&D and low R&D performance in business. Regarding the development trap indicator, the

Észak-Alföld region has been categorised as a region not in a development trap or at risk (Diemer et al., 2022).

**Table 8: Hajdú-Bihar's innovation performance and development trap risk**

<b>Regional Innovation Scoreboard (2021)</b>	<b>Emerging innovator</b>
<b>Development Trap category</b>	<b>Not in development trap or at risk</b>

Source: Own edition based on data from Regional Innovation Scoreboard and Diemer et al. (2022)



**Figure 21: Key development areas defined by the Development strategy of Hajdú-Bihar County for 2014–2020, source: own elaboration**

These central transformative fields (see Figure 21), defined in one of the region's most important development strategies, offer some first insights into potential key economic development avenues. The goals to transform (into) these fields are assumed to be widely shared by regional stakeholders, hence we consider them highly relevant for the analysis and the workshops alike. As such, some of them will be taken up again, some complemented and some might be critically commented upon from a sustainability perspective in our investigation of Hajdú-Bihar's major challenges, assets and transformative opportunities over the following pages.

Adhering to a challenge-oriented innovation approach, the next paragraphs identify some of the **most pressing challenges the region is currently facing**. Addressing these challenges and, in particular, contributing to solving them is a key motive of the project.

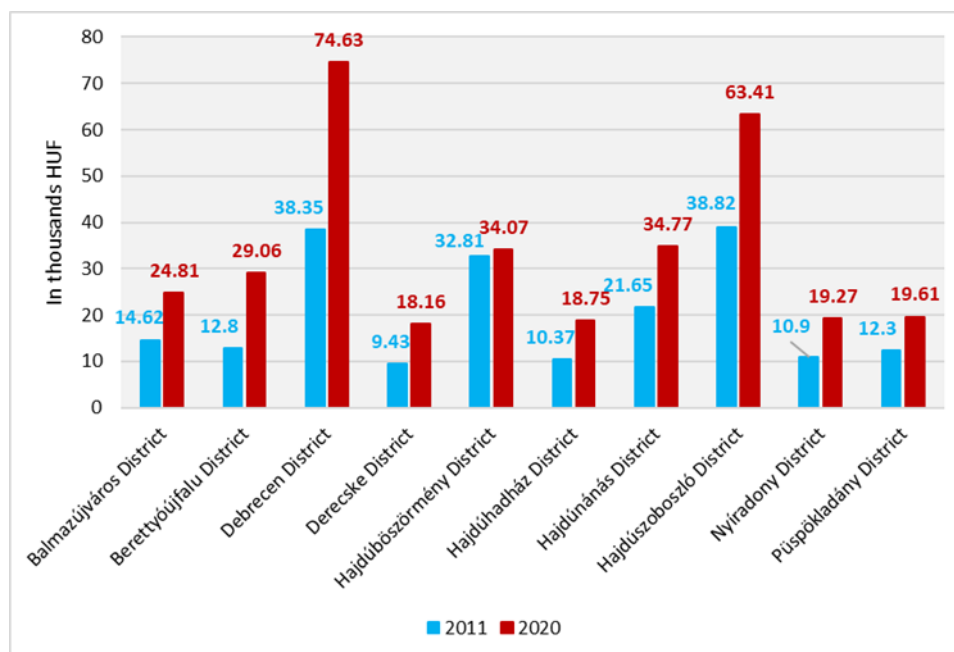
Starting from an overview of the county, the **intraregional disparities** and the dual character of the county are definitely important issues which can be detected in the background of many local challenges. On the one hand, Debrecen is the second most populous town in Hungary (with 200,000 inhabitants) where 40% of the county's population is living. It is serving as the most important economic, R&D and educational centre of Eastern Hungary and having attractive environment even for high value-added activities. On the other hand, the districts outside of Debrecen and its agglomeration are rather rural areas with a primary focus on the agricultural production (especially in the southern and eastern parts of the county) and partly on tourism.

The territorial disparities can also be seen in the labour market structure and the demographic trends. While the share of highly qualified occupations (managers and professionals) is about twice as high in Debrecen District, the highest share of elementary occupations (about 30% of all employees) can be observed in the weakest performing districts. Concerning the change of population, the highest population loss could be observed in the southern part of the county. The interviewed experts confirmed that there has been a significant outmigration of people (particularly the young people) to Budapest or to Western European countries. Only those districts around Debrecen could at least keep the level of their population and have been potential targets for those moving out from Debrecen to the surrounding settlements.

A notable example of this dichotomy is the business tax revenues of local governments which reflect well the intraregional disparities of the county. The second-ranked Hajdúszoboszló



District is outstanding in tourism. The medium-performing Hajdúnánás, Hajdúböszörmény and Berettyóújfalu Districts are characterized by different manufacturing activities. The Eastern and Southern parts (Derecske, Hajdúhadház, Nyíradony and Püspökladány districts) of the county are rather declining areas in terms of economic performance. Furthermore, the gap between the leading districts and the lagging areas have grown over the investigation period (2011–2020). (Figure 22).



**Figure 22: The business tax revenues of local governments per inhabitant in the districts of Hajdú-Bihar County (2011–2020),**  
*source: National Regional Development and Spatial Planning Information System of Hungary*

The above-mentioned dichotomic characteristics of the county might also determine further challenges. Not surprisingly, the low economic performance of certain districts are coupled with a **relatively weak entrepreneurial activity**. Reviewing the population-related number of operating and new firms, Debrecen has been found to have the highest values by far. The county seat has significant research potential which provides a suitable base for industrial activities like pharmaceutical industry or biotechnology. The weakest performing districts are the same which have the lowest income from local business tax. Considering the entries of new companies, a very similar pattern can be seen which suggests that the recent intraregional economic disparities might be preserved for at least the next few years (Table 9).

The interviewed experts also shed light on the performance differences among small companies, medium-sized companies and big companies. The big (and dominantly multinational) companies have leading roles in exporting products and services and supporting innovation and also the medium-sized companies serve as significant actors of the local economies. However, most of the small and micro companies show a relatively weak performance and have a lack of skilled personnel. It has also been emphasised that there is a missing culture of innovation among the small and medium-sized companies and the specific management knowledge is also lacking in many cases.

Table 9: The number of firms in the districts of Hajdú-Bihar County

Area	Operating firms per 1,000 people	New firms per 1,000 people
<i>Hungary</i>	89.61	9.72
<i>Hajdú-Bihar County</i>	78.99	9.84
Balmazújváros District	59.46	7.11
Berettyóújfalu District	57.73	7.01
Debrecen District	107.12	12.82
Derecske District	55.83	7.42
Hajdúböszörmény District	74.91	8.98
Hajdúhadház District	51.19	7.79
Hajdúnánás District	58.02	5.94
Hajdúszoboszló District	77.96	10.66
Nyíradony District	48.72	8.04
Püspökladány District	51.92	7.23

Source: Hungarian Central Statistical Office

Related to the entrepreneurial activity, the in-depth analysis of the region revealed that certain socio-political phenomena like the **lack of cooperation, lack of trust or a missing vision for a sustainable future** might also explain the relatively weak output of the regional innovation system. As the interviewed experts noted, most of the companies hardly know potential collaborators. The interviewed experts argued that the lack of trust, in the sense that people do not like to share any kind of information with each other, is a generational inheritance in the Central European history. This lack of cooperation and fragmentation has far-reaching consequences and makes the implementation of solutions to common issues like irrigation in agriculture more complicated. Of course, there are also positive examples on collaborative companies but most of them can be observed in and around Debrecen. Still, one of the experts stressed that of actors see the advantages of collaborations, they can be convinced:

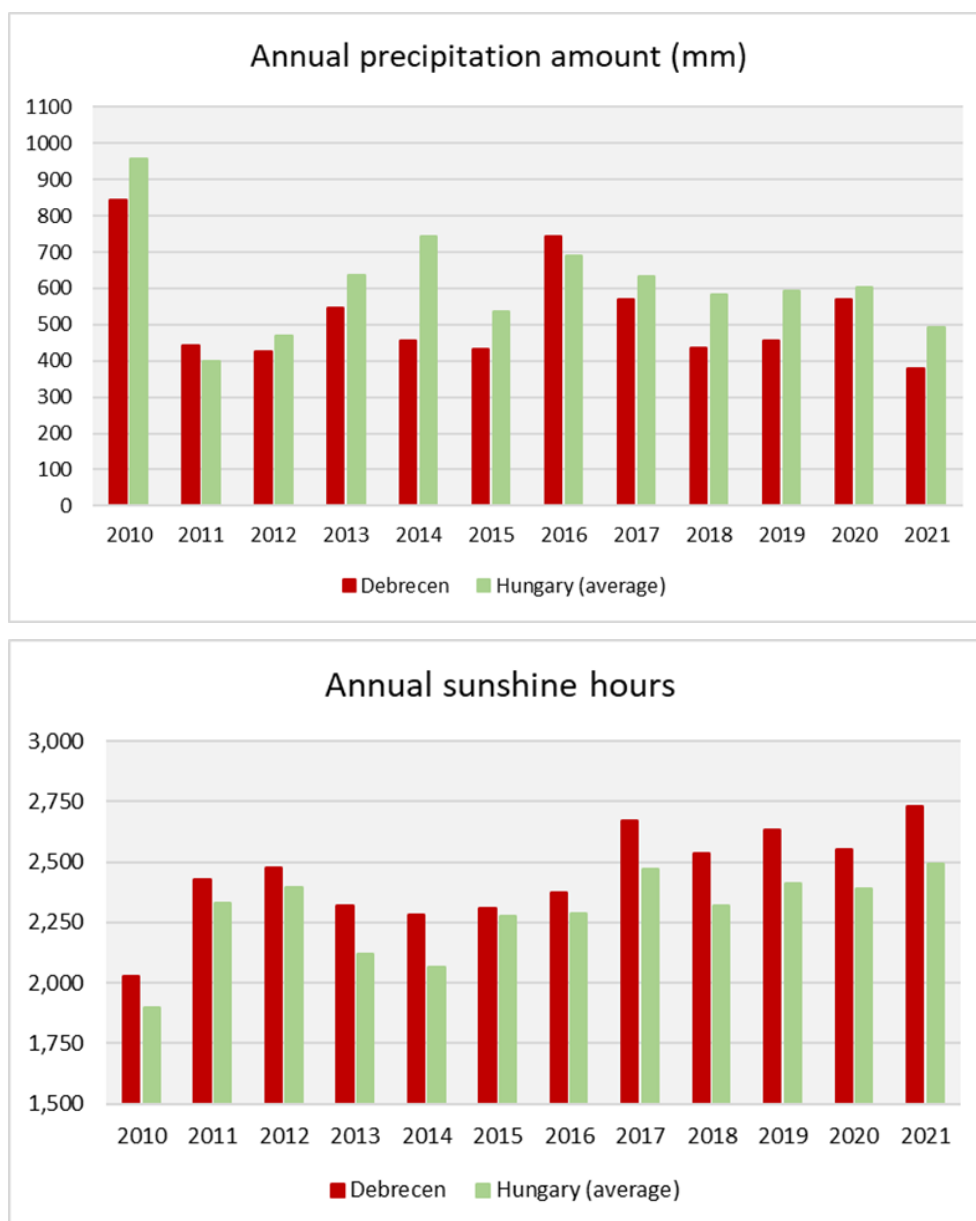
*“I think that what is still missing, to bring people together in small groups to meet and greet each other, to find the potential of others and also themselves, and then they can see how collaboration works. And if you show them a way about trust as the core issue in the collaboration and in everyday living, they are more open for further steps.”*

Concerning the preparation for transformative changes, it is a considerable point to encourage the creation of a sustainable vision as the experience of the experts confirmed that the clear visions and long-term targets were missing in many previous projects. According to the opinion of the experts, it would be essential to convince the leaders of the municipalities (mayors and representatives) to think in the long term. In this regard, the continuously changing legal circumstances and institutional environment in the background has had a negative impact on the lack of long-term visions as it has made harder to prepare plans for more years in advance.

Besides the modification of the institutional framework, the **centralised decision making and the supremacy of economic goals** over the social and environmental issues may also hinder the preparation of a sustainable vision. The interviewed experts agreed that current development plans emphasize economic development at the expense of other challenges. Furthermore, the experts mentioned the centralised decision-making process in the case of several highlighted development projects like the foreign direct investments of automotive or battery companies as examples. Of course, the state has also a significant role in attracting such actors to the country. But it has also been suggested that the foreseeable

impacts of the plants on the regional (and even the national) economic development undermined the social and environmental aspects of the investments, which, ultimately, may affect primarily the life of local inhabitants.

Still, improving the sustainable vision and the cooperation among the actors would be necessary as Hajdú-Bihar County is among the areas of Hungary which have already seriously hit by the **manifestations of the climate change** and projections for the future period expect that these trends will continue. The decreasing amount of precipitation, the longer dry periods and the rising average temperature together have made Hajdú-Bihar County even more vulnerable over the last decade (Figure 23). As such, innovative action to adapt to these new circumstances seem to be vital for regional development.



**Figure 23: Meteorological trends over the period 2010–2021 in Debrecen and Hungarian average, source: Hungarian Central Statistical Office**

*Note: The graphs refer to the data points of the meteorological station in Debrecen*

Although several counties of Hungary are affected by the increasing hazard of being exposed to drought, Hajdú-Bihar County serves a specific case since it is among the few areas of Hungary, where both drought hazard and the projected change in tropical nights and heat wave

days have above average scores according to the analysis of the European Climate Risk Typology. As the agricultural production is an outstandingly important economic sector of Hajdú-Bihar County (Bánóczki & Csorba, 2020), the interviewed experts agreed that it seems to be unavoidable to find proper responses and tools for preparing agricultural production for these changes, particularly in terms of irrigation over the dry and hot summer periods. A significant example of a comprehensive project to improve the water supply of the Debrecen area is the Civaqua Programme which is currently in its implementation phase.

Not only challenges are connected to opportunities, but also **various assets**. These can be used, exploited and/or mobilized for transformative activities in the region. Accordingly, in what follows, the analysis turns to the regional asset base and identifies key regional strengths that offer entry points and a platform for the RIS4Danu project.

The **agricultural base** and production are definitely important assets for Hajdú-Bihar as they have a determining role on the economy of the whole county. The share of agricultural employment (also including forestry and fisheries) of total employment is 8.7% in Hajdú-Bihar County, which is significantly above the national average value. The favourable location in the Great Hungarian Plain is highly beneficial for agriculture and it has also been mentioned by the relevant development documents of the county. At the same time, as it has already been touched upon before, agriculture is particularly vulnerable to extreme weather changes, and they pose significant economic risks (Bánóczki & Csorba, 2020).

Moreover, the sector currently finds itself at a crossroads. On the one hand, the sector is currently seeking to follow a high-road strategy, moving towards more productivity and knowledge-intensive forms of agriculture. On the other hand, a more environmentally-friendly agriculture should be developed, not least because energy prices are so high currently. According to a regional development expert, the EU funds might serve as financial sources for a transformation to a more sustainable agriculture.

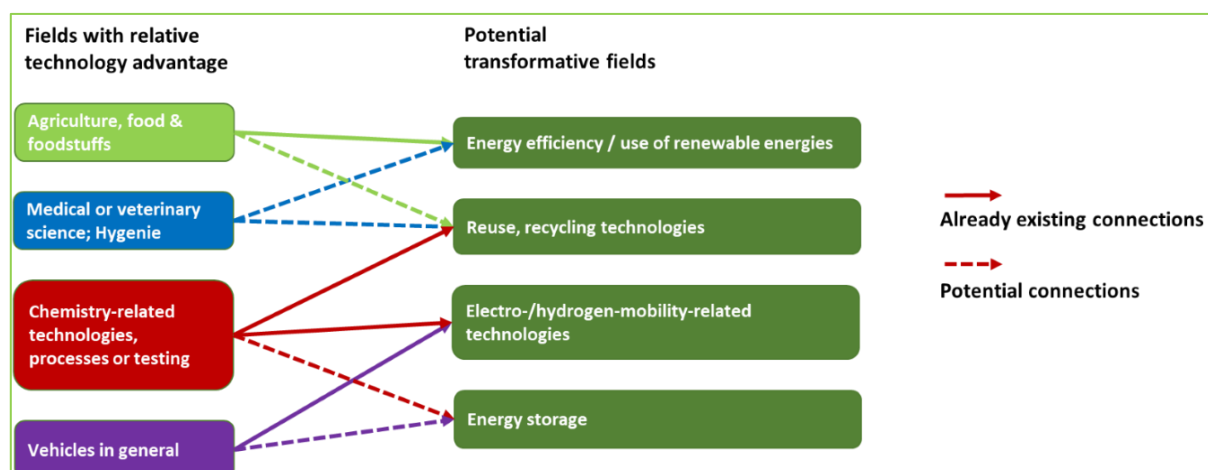
The experts confirmed that the University of Debrecen has a crucial role in this transformation process of agriculture. It provides a practical education for knowledge-intensive agriculture, conducts and, more importantly, disseminates R&D, especially for those farmers who are too small and lack the resources to do it themselves. Moreover, it offers challenge-oriented education to find solutions for challenges like the irrigation problems in the region. The ongoing generational shift might accelerate these processes as younger farmers are eager to learn more efficient ways of doing agriculture according to interviewees. Our experts summarised the potential ways to develop and make the agricultural production of Hajdú-Bihar County more resilient to the challenges:

*“How to manage those areas which are not good for intensive agriculture because of the soil quality, because of the water supply and so on. So our ruminants like sheep, goats and cattle, especially those which can tolerate these extreme weather conditions. [...] Organic agriculture, not just because of the European Union directive, a green deal, but also because of the low input and because of the awareness of the population of chemicals and the chemical and the antibiotic resistance and so on. And the third is that food industry. [...] But I think the food industry must be the primary in the list or first in the list, because we have to develop to process the raw material and supply it to our population. It is kind of a political or strategic issue also. What if, and we saw it in in COVID, what if no import of food is getting to Hungary. What happens to us? Can we sustain ourselves? [...] they wanted to build up self-sustainability. [...] And the fourth one is to reuse the byproducts. Like a circular economy. There is no waste, there are byproducts. And everything which is getting out of the food processing plant should be reused. [...] In this way, you can decrease the costs and also help the environment.”*

Moreover, the experts added that renewable energy in which the region has an above-average potential, and the application of digitalization in agriculture might enable new forms of agriculture or tackling the shortage of workers.

In handling the above-mentioned challenges, the **R&D, education and scientific activities** of the University of Debrecen are serving as a proper local source of knowledge and inventions. Having currently about 27,000 students, the university is the biggest one in the Eastern part of Hungary. Besides the university, the seat of the Institute for Nuclear Research (ATOMKI) is also in Debrecen. Both organizations have been relatively active in the H2020 projects over the period 2014–2020, primarily in topics of energy efficiency, medical science and healthcare, developments in agriculture and rural policy. Furthermore, the reviewed S3 analysis of the county revealed that Hajdú-Bihar County absorbed the second highest amount of support, a total of about HUF 38.8 billion which gives 9.02 % of the total amount of R&D subsidies financed by the EU in Hungary in the 2014–2020 period.

Not surprisingly, the patenting activity of the county is very much concentrated in Debrecen. Even though most of the patent applications belong to the university, it is worth mentioning some local pharmaceutical and nanotechnological companies which have considerable role in submitting patents. Reviewing the patents, the most important technological domains in the patents of the region are the following fields: agriculture, food and foodstuffs, medical science and hygiene, chemistry-related technologies and vehicles-related technologies. Besides the technological fields which have relative technological advantage in the region, we also checked which climate change-related technologies or applications might be combined with those technologies in which the area has competitive advantages. We reviewed the combinations that already exist in the region and extended the search with those climate change-related technologies or applications that might be coupled with the technology fields having a relative advantage in the area (even if a given combination of technologies still cannot be found in the region but can be found elsewhere in the country). In this way, we can observe that the knowledge in chemistry or vehicle-related technologies might open up new opportunities for energy storage, but as discussed above, one should also mention recycling technologies in agriculture as a potential sustainable and innovative direction (Figure 24).



**Figure 24: The existing and potential future combinations between fields with relative technology advantage and transformative fields in Hajdú-Bihar, source: own edition based on the data of OECD Regpat Database**

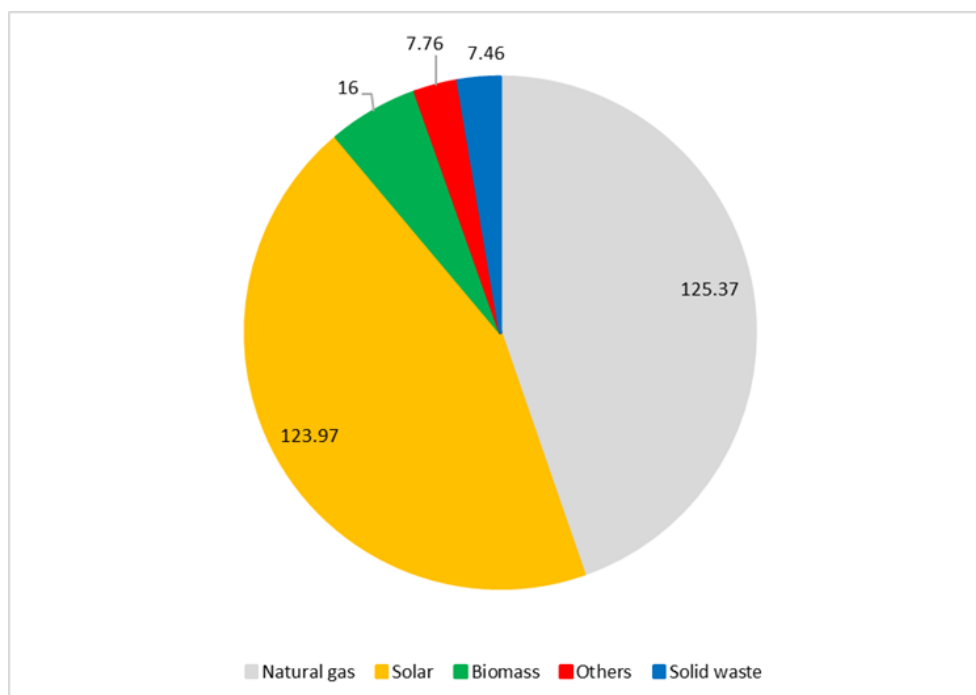
Considering the need for transformations in agriculture and the relatively significant dependence of Hungary on energy imports, **the renewable energy potential** of Hajdú-Bihar County might be an outstanding asset on the way to higher levels of sustainability. The interviewed experts agreed that this question has become even more challenging since the beginning of the war in Ukraine, due to the increasing energy prices. Therefore, the locally available renewable energy sources can support the diversification of the energy supply and decrease the dependence on (fossil) energy sources outside the county, as has also been confirmed by an expert:

*“[...] The solar capacity moved a lot into power dimensions. [...] We also had a very huge step of geothermal energy, but of course investment cost did much more than*



*a solar panel and we also have some geothermal solar are most important ones. But [...] I think we are moving to the right direction, fortunately. [...] On the other hand, of course, they are still relying on gas support from Russia. [...] We have much more potential to achieve the basically defined targets.”*

Indeed, the available data confirm that Hajdú-Bihar County has relatively good positions in terms of solar energy, bio-based energy sources and geothermal energy. Reviewing the installed capacities of power plants of Hajdú-Bihar County, natural gas still has a significant role, but renewable sources, especially solar energy, have a growing importance in energy production (Figure 25).



**Figure 25: Installed capacities of power plants in Hajdú-Bihar by primary energy carriers (in MW, 2021), source: National Regional Development and Spatial Planning Information System of Hungary**

As for solar power, there are considerable installed capacities of ground-mounted solar power plants particularly in the southern part of the county (Berettyóújfalu, Derecske and Püspökladány Districts). Furthermore, the use of solar power in individual homes and houses has become more and more popular over the last few years. Both the number of small household solar power plants and their installed capacities have had a more than twofold increase between 2019 and 2021, which is also serving as a proof for the growing awareness of the population.

Besides solar power, the county has considerable potential in geothermal and bio-based energy. The sources of geothermal energy are related to the local thermal water sources. Therefore, the reuse of thermal water for other purposes (like heating) would be a potential sustainable application. The interviewed experts explained concerning bio-based energy sources that the by-products of agriculture have an outstanding role, and this direction also fits well with potentially new and more sustainable paths of agricultural production as discussed above. As agriculture plays a significant role in the economy of the county, energy production from biomass might provide an option for re-using agricultural waste. Of course, investing in renewable energy production depends primarily on the willingness of site or plant owners. Therefore, the experts agreed that informing them about the financial options and technical possibilities might be a key issue in the further development of renewable energy use.

The interviewed experts highlighted that both the developments in the use of renewable energy sources and the recent manifestations of climate change (particularly the extreme drought in

2022) have had positive impacts in relation to a **growing awareness on sustainability issues**. It has also been revealed that this is a change going through large parts of the society. The rising energy bills further contributed to changes in mindsets. One expert explained:

*“People started to understand the impact of climate change. And it is especially linked to Hungary, and particularly my region, my county, because the drought we experienced last year was the worst one in my whole life. It hit our agriculture in a very, very serious way. And those people who never believed that climate change exists started to think about it in another way. And they read articles. They heard a lot of very good interviews in the media, even in national media. They started to understand. It is something everybody has to deal with. We have our own responsibility in this issue, and this was the first time they understood the link between climate change and drought periods. We also had some serious issues, for example, we with the public supply of water.”*

Moreover, this rising awareness has already led to changes in the strategies and priorities of different agencies like for economic development. Following these considerations, one would expect a trend reversal in the data in the years to come. It should also be mentioned that – according to one expert – much depends on the concrete topic. While action in relation to agriculture or water supply seem to be supported by legitimacy of the local population, other topics such as circularity or waste management might require more awareness raising activities.

Generally, the experts highlighted the **favourable regional assets for the creation of new development paths**, underlining the relatively low labour costs for skilled workers, good cooperation between key stakeholders, good accessibility and favourable taxation and subsidies. The reviewed strategical documents (see above) have also confirmed that there is a strong consensus about the key fields of the future regional development, which are seen in agriculture & food, health and tourism, renewables, electronics and ICT. More specifically, two fields to focus on have been particularly emphasized. First, tourism has been mentioned by the regional experts, given the potential to draw on regional strengths such as the natural beauty, national parks, other natural assets or the gastronomic heritage. Second, health and healthcare-related activities have been emphasized as a “*core sector for future development*” based on its innovation potential. Moreover, health and healthcare might have common points with several other activities already existing in the region, such as agriculture, the pharmaceutical industry, balneology and, of course, tourism in general. Finally, concerning the creation of new development paths, the ongoing implementation of foreign direct investments in and around Debrecen should be mentioned. The goal to develop batteries there might open up the opportunity to develop a wider e-Vehicles ecosystem in the region.

**Table 10: Summary of assets & challenges identified for Hajdú-Bihar County**

<b>Assets</b>	<b>Challenges</b>
Agricultural base with new opportunities	Manifestations of climate change
The R&D activity in Hajdú-Bihar County	Weak entrepreneurial activity, unfavourable industry and labour market structure
Renewable energy potential	Legitimacy problems of transformative action: emphasis on economic catching-up and policy centralization
New path development potential: tourism, health and e-Vehicles	Socio-political challenges: Fragmentation, a lack of trust and a missing vision for a sustainable future
Growing awareness	Regional disparities

Source: own elaboration

As a summary of the analysis on Hajdú-Bihar County, we provide some potential development paths which are based on the available assets and the challenges of the region (Table 10).

Probably, the most crucial challenge of the county is the impact of climate change on the region's most important asset: its agricultural potential. The analysis showed that the local experts are aware of this issue and there are initiatives to adapt to the situation like the use of renewable energy or the circularity of the agricultural by-products. The University of Debrecen serving as the source of knowledge has a crucial role in both education and R&D activities in agriculture. Furthermore, it seems that there is a willingness by the younger farmers to implement more sustainable ways into production processes. However, there are still many things to do in this area and they require a vital cooperation of stakeholders.

New transformative activities in agriculture, which could be realized with the support of projects like the RIS4Danu (such as the reuse of by-products for instance in producing sustainable materials for construction) might also open up potential paths for new companies to follow and couple their activities with the ones that have already been realized. In this way, a new dynamism in agriculture might contribute to developing more sustainable practices, employing the local workforce and diminishing regional disparities in the long term. However, this option also requires the need to support these companies in creating a sustainable vision.

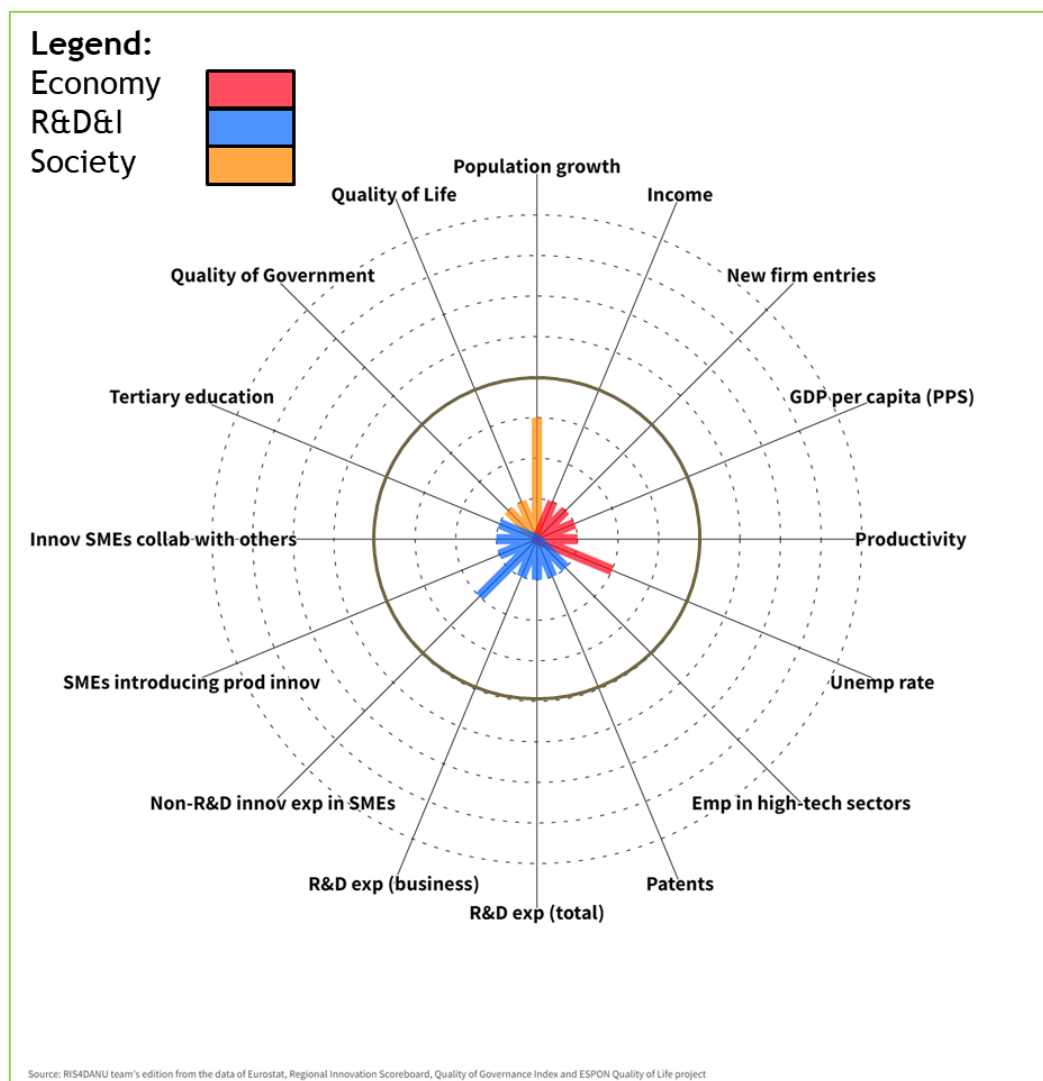
Besides agriculture, the renewable energy potential of the county could serve as a considerable asset for transformative activities. Building on the growing awareness of people, the more comprehensive exploitation of renewable energy can help to decrease the energy dependency on external sources. However, the highly centralized decision-making system and the changing legal and institutional environment might hinder the implementation of new renewable energy power plants according to the regional experts.

Finally, the county has a relatively good potential for new path development which is based on existing assets, such as the cultural heritage (like the gastronomy and folklore) and the natural assets like the thermal springs and the natural environment. In addition to activities like the exploitation of the renewable energy potential and the R&D activities of the university (particularly in the field of e-vehicles and healthcare), new paths could provide substantial opportunities for the region. In this way, the entrepreneurial activity of the county could be improved, which might contribute to create new jobs and help keep the (younger) population in the region.

#### 4.4 Ústí nad Labem region, Czech Republic

The Ústí nad Labem region (Ústecký kraj) is one of the 14 regions in the Czech Republic. It is located in the northwestern area of the country at the southern part of the Ore Mountains, which also serves as a natural border between the Ústí nad Labem region and the German Federal State of Saxony. The region is characterized by its past economic orientation towards heavy industry and mining and highly vulnerable to phasing-out policies. The region can be described as a troubled one, facing not only economic but also societal and ecological challenges. The analysis has revealed a strong awareness of the key issues facing Ústí nad Labem region, in particular concerning needed economic transformation efforts. In addition to this impressive dedication, the region offers several interesting assets and more possible avenues for transformative activities, as this analysis will show.

First, this summary of the regional analysis will cast light on the **general regional context**. Hence, in what follows, the scene is set and information on the wider regional conditions provided (e.g., development in key socio-economic indicators (Figure 26), recent innovation performance (Table 11) or key development fields identified in relevant documents (Figure 27 and 28)).



**Figure 26: The socio-economic analysis of the Severozápad cohesion region, source: own elaboration based on different data sources**

### The most important findings of the socio-economic and innovation analysis of the region

- There is not a single indicator in which the Severozápad cohesion region would reach at least a median ranking among the Czech cohesion regions.
- In most of the analysed indicators related to economy, R&D and innovation and society, the area has unfavourable positions. Usually, the Severozápad ranks lowest of all Czech regions.
- The overall economic performance in terms of the analysed indicators is the lowest compared to other NUTS-2-level regions in Czechia except for the unemployment rate in which the area has the second-lowest value.
- Looking at the analysed society-related measures, the Severozápad cohesion region has a slightly better position in terms of population growth (which refers rather to a relatively slower decrease in population than to the last ranked regions), but lags behind in terms of the Quality of Government and Quality of Life indicators.
- Concerning the R&D and innovation related indicators, the only exception is the “Non-R&D innovation expenditures in SMEs”, in which the region does not hold the last position compared to its peer regions from Czechia.

As can be seen in Table 11, the Severozápad cohesion region is categorised as an “Emerging innovator”. The Severozápad cohesion region has a 47.8% relative innovation performance of the EU average in 2021. This performance is among the lowest within the whole EU and the weakest performing NUTS-2 area of Czechia by far. For comparison, the NUTS-2 level region with the second-lowest score in Czechia is Střední Morava, having a 73.6% relative innovation performance of the EU average). Moreover, the Severozápad cohesion region was the only region in Czechia whose relative innovation performance has decreased by 2021 compared to its score in 2014. Regarding the development trap indicator, the Severozápad region has been categorised as a low-income region having high risk of being considered in development trap (Diemer et al., 2022). Accordingly, there are several warning signs which may confirm this categorisation: the high level of unemployment, the low level of economic performance (both the level of economic development and productivity) and its slower growing trend compared to other Czech regions. Also, the industrial structure of the region might have an influencing effect as it relies primarily on energy-intensive industry branches like chemical industry and manufacturing of metal products. Therefore, the region should find new industrial opportunities and development paths based on its assets to avoid slipping in a development trap.

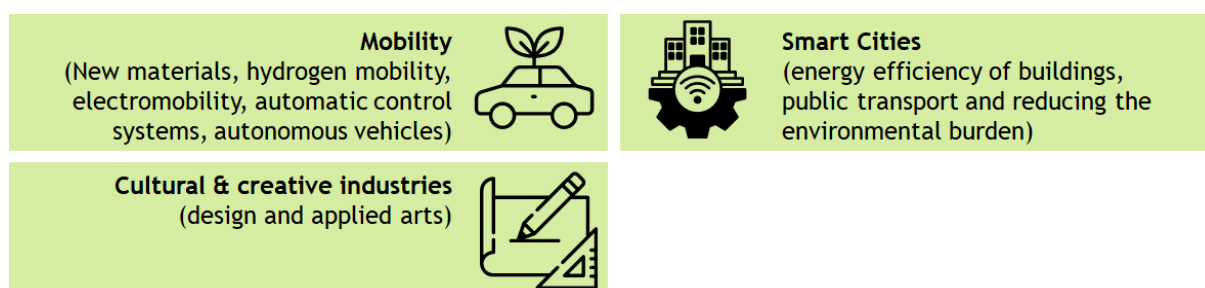
**Table 11: Severozápad's innovation performance and development trap risk**

<b>Regional Innovation Scoreboard (2021)</b>	<b>Emerging innovator</b>
<b>Development Trap category</b>	<b>High risk at low-income</b>

Source: Own edition based on data from Regional Innovation Scoreboard and Diemer et al. (2022)



**Figure 27: Key transformative fields defined in: S3-Czechia: Usti region (2021) – “Traditional areas”, source: own elaboration**



**Figure 28: Key transformative fields defined in: S3-Czechia: Usti region (2021) – “Emerging areas”, source: own elaboration**

These central transformative fields (see Figure 27 and 28), defined in one of the region's most important development strategies, offer some first insights into potential key economic development avenues. The goals to transform (into) these fields are assumed to be widely shared by regional stakeholders, hence we consider them highly relevant for the analysis and the workshops alike. As such, some of them will be taken up again, some complemented and some might be critically commented upon from a sustainability perspective in our investigation of Usti's major challenges, assets and transformative opportunities over the following pages.



Adhering to a challenge-oriented innovation approach, the next paragraphs identify some of the **most pressing challenges the region is currently facing**. Addressing these challenges and, in particular, contributing to solving them is a key motive of the project.

Without doubt, the Ústí nad Labem region is among the most troubled regions within the RIS4Danu project, characterized by **high vulnerability and enormous transformation needs** in various key domains. Ústí nad Labem region is among only a few regions in Europe considered as being at a high-risk of a development trap at low-income, based on data on GDP, productivity and employment. A recent academic paper by Blažek et al. (2023) described the region as follows:

*“Widely considered the most affected region in Czechia suffering from economic, social and environmental problems. The Ústecký region is typified by a long-standing orientation towards heavy industries, including the large-scale strip-mining of brown coal, which has resulted in vast environmental degradation and profound alteration of the original landscape.”*

The roots of these problems go back to the long-standing orientation towards heavy industries and a focus on coal mining and power production. Reviewing the current industrial structure of the region (and even of the Severozápad NUTS-2 level region), the energy-intensive industrial activities like the manufacture of paper and paper products, chemicals and chemical products or non-metallic mineral products still have a leading role. Therefore, the region faces high risks in relation to phasing out policies or and substantial transformation tasks.

However, these problems are not confined to the economic structure. Some of the interviewed experts mentioned that the landscape has been destroyed by the past industrial activities and it requires a considerable effort to recultivate. It has also been revealed that the Ústí nad Labem region still lags behind also in terms of environmental indicators, for instance in air quality (Table 12).

**Table 12: The area-related emission of selected pollutants in Ústí nad Labem region & Czechia**

All stationary sources ("mobile sources" like traffic are not included)	Ústí nad Labem region				Czechia	
	2015	2015 rank (among the CZ regions)	2020	2020 rank (among the CZ regions)	2015	2020
<b>Particulate matter (in tonnes / km<sup>2</sup>)</b>	1.3	1 <sup>st</sup> / 14	1.0	2 <sup>nd</sup> / 14	0.7	0.6
<b>Sulphur dioxide (SO<sub>2</sub>, in tonnes / km<sup>2</sup>)</b>	6.5	1 <sup>st</sup> / 14	3.0	1 <sup>st</sup> / 14	1.6	0.8
<b>Nitrogen oxides (NO<sub>2</sub>, in tonnes / km<sup>2</sup>)</b>	5.4	1 <sup>st</sup> / 14	4.1	1 <sup>st</sup> / 14	1.6	1.2
<b>Carbon monoxide (CO, in tonnes / km<sup>2</sup>)</b>	5.9	10 <sup>th</sup> / 14	5.2	10 <sup>th</sup> / 14	9.1	8.9

Source: Czech Statistical Office

This environmental burden goes hand in hand with mindsets of inhabitants still strongly influenced by the past. The interviewed experts pointed out the changing these “industrial” mindsets might be a crucial point for a successful transformation.

The impacts of above-mentioned structure weaknesses and economic challenges are also reflected in the **societal issues of the region**. Indeed, the region faces severe issues in relation to demography, outmigration, and other challenges. Both the statistical data and also the interviewed experts confirmed that young people who intend to have a university graduation or have already graduated often leave the region and move to the bigger urban

centre of Czechia, primarily to Prague or its agglomeration. The experts, unisono, highlighted outmigration as a key barrier to the development of more knowledge-intensive activities:

*“Our region is very narrowly connected with energy, with coal mining, with power plants and in all these sectors were employed very a huge number of people. And these people usually didn't have much education. They were, as I said, blue collar workers and people who get more education and who are more ambitious. They rather leave to Prague because it's quite close for them. So, young people are not staying after study so they rather go study somewhere else.”*

Besides the outmigration of highly qualified people, the region has a **high unemployment** rate which permanently exceeds the national average. The statistical data also revealed that this issue particularly affects the lower-educated parts of the regional population (having no education, only primary education or secondary education without a final exam), which also reflects the negative effects of past industrial activities.

The nature of the social challenges can also be captured by the data of Eurostat. The rates of early leavers from education, young people who are neither working nor studying or people who at risk of poverty are still quite high in the Severozápad region (Table 13), even if some indicator values have been decreased over the last about 20 years. Although these numbers refer to the NUTS-2 level Severozápad region, these patterns appear in both regions (Karlovy Vary and Ústí nad Labem region), which are involved in this NUTS-2 region.

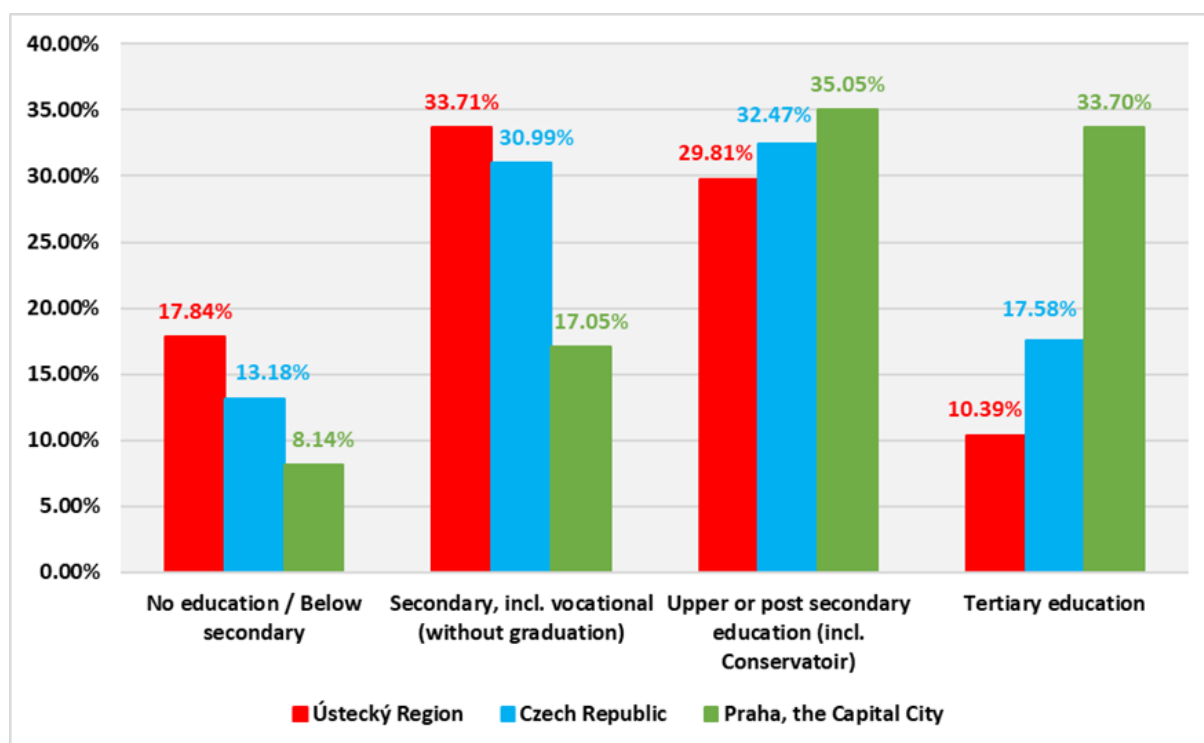
**Table 13: Selected social challenges of Ústí nad Labem region**

Indicator (latest data in the brackets)	Severozápad				Czechia			
	2005	2010	2015	Latest	2005	2010	2015	Latest
Early leavers from education and training (% from 18 to 24 years, 2021)	10.3	11.3	14.5	14.1	6.2	4.9	6.2	6.4
Young people neither in employment nor in education and training (% from 15 to 29 years population, 2021)	24.6	20.6	19.6	18.6	16.9	12.9	11.8	10.9
Persons at risk of poverty or social exclusion (in % of population, 2020)	28.4	21.3	21.7	17.8	19.6	14.4	14.0	11.9

Source: Eurostat

The traces of the social challenges can also be observed in the disenchantment of people, which is also reflected in the participation in the elections and the very high shares of populist votes cast in Ústí nad Labem region. Clearly, this is reminiscent of recent debates in Economic Geography about the ‘revenge of places that don’t matter’, linking long-term regional economic decline and dissatisfaction of inhabitants of such places with a strong populist turn (Rodríguez-Posé, 2018).

According to the interviewed experts and the recently published data of the Census 2021, the low-level educational attainment of the population is among the most pressing social challenges. We have already referred to the early leavers from education among young adults. The value of the Severozápad NUTS-2 level region is more than twice as high as the national average and it has grown from 10.3% to 14.1% over the last 20 years. Focusing on the Ústí nad Labem region, it has the second-highest value in the share of people having no education or only below secondary education and it clearly exceeds the national average. The data also reveals that about 51.5% of the population aged 15 years and over have up to secondary education, while only 10.4% graduated in tertiary education (Figure 29).



**Figure 29: Population aged 15 years and over by the highest educational attainment in the Ústí nad Labem region (2021), source: Census 2021 data by the Czech Statistical Office**

The highest rate of people having no education or only below secondary education is in the Most and Chomutov districts (slightly below 20%), where mining was among the core economic activities. Considering the other end of the scale, the share of tertiary educated people is relatively high in Ústí nad Labem and Litoměřice districts (about 12–13%) but these values still lag behind the national average. Our interviewed experts emphasised that there is a mismatch between the educational supply and labour market demands:

*"In general, education level for our region is the lowest in the Czech Republic and the education system here in our region [...] is not focused on this. [...] For example, [...] there is no quite strong technical faculty or industry which is focused on the new challenges in this sphere. [...] We have seven faculties and each of them is quite small, and even [...] separated in many small teams. So, they have nice ideas, but they are quite small. Another problem is that that historically is very strong chemical industry in our region, but [...] the job and to work there is not so attractive for youngsters is a great problem in factories [...]."*

As this quote also underlines, the educational attainment of the population also reflects the economic structure of the region. The local companies are operating typically in industrial activities (including manufacturing and construction), transportation and logistics (especially in the districts along the transport corridor between Prague and Dresden) and accommodation and food services. Still, the overall picture on **entrepreneurial activity is relatively unfavourable** and the Ústí nad Labem region has one of the weakest values in terms of the population-related number of operating companies and new firms. The interviewed experts explained these results primarily by the industrial characteristics of the region, like the dominance of big factories, heavy industry and that most people have been employed in these plants. Therefore, tradition of being an entrepreneur and entrepreneurial thinking has been missing. However, here are recently launched programmes to support students to get the know-how to manage a company and, in general, learn about the entrepreneurial mindset.

Moreover, the region is characterized by its **weak absorptive capacity**, which is also related to the low-level entrepreneurial activity and refers to problems to turn development impulses into concrete (transformative) activities. The low absorptive capacity has historical roots in the fact that the Ústí nad Labem region is often placed relatively low in global value chains:

*"This transformation historically was focus on inviting foreign investors. Yes, it was a very important topic for us, and we financed many new green greenfield where we established new industrial sites for new foreign investors from all walks from Japan to America. But mostly what they bring to us, where some of the factories connected with some completing of components, not so much advanced business. And this is this this period is ending now because it doesn't create a high productivity in the future."*

Generally, our interview partners pointed out that the regional innovation system has weaknesses in the realization stage, hence good ideas exist but are often not implemented for various reasons. This is particularly the case for the lack of skilled workers and entrepreneurial minds according to our interviewees. The interviewed experts also highlighted the fragmentation of networks as an underlying cause hindering the realization of ambitious projects. This fragmentation is deep-rooted and can be observed in the R&D sector and at the public authorities. The low quality of government further underlies the importance of this issue as it has already been mentioned related to the vulnerability and high transformation needs of the region. The experts also expressed the danger of what could be called 'incumbent capture' of financial resources (such as the JTF):

*"Yeah, these programs are very important because I think this is the first situation when our region gets great sources for transformation. Historically there were some in other sources, but not in such amount like now. So, this is great challenge for us to use the source effectively. And what can be problem is to specify the ideas and, especially, to choose the appropriate project. We are in a time of negotiation about which project will be the best and it is quite difficult because there are many other interests, of course. Everyone wants to be chosen as a winner. So, I think this is going to be complicated to go through this process, because it can be influenced by some great actor. [...] That's possible. For example, [a large firm in the energy sector] is interest in these sources. And they have some great projects [...]. But the point is that that the greatest project can get all the money for them only and some other actors. And the small project, which can be used for development of the cities and communities in the cities, will lose the sources. Because their voice is weak here in comparison with this main actor, the great company."*

Arguably, this might be a key barrier to the implementation of truly transformative activities in the region, as incumbents often seek to protect their vested interests in existing development paths (Baumgartinger-Seiringer, 2022). All in all, the weak absorptive capacity of the Ústi nad Labem region is complex and multi-dimensional. Yet, solving (or at least improving) the problem is of high significance in the light of new opportunities for change for the region.

Besides the weak absorptive capacity, the Ústi nad Labem region still seems to be **struggling with the development of new ideas and a common vision** that counters the trend of decline. The paper by Blažek et al. (2023, p. 15) stated that *"the region does not have a vision"* and *"ordinary people do not believe that the region is capable of change"*. This illustrates a severe stage of disillusionment, but also the absence of a jointly developed visions which has also been confirmed by the interviewed experts:

*"What is barrier is that sometimes it's difficult to reach the common idea for development on the on the level of politicians and in the regional authority and the great cities to get some agreement. What we want to do. Yes, Typical example is the development of [...]. This is the city which is at the edge to be ruined because some old building which has been built in time of Joseph the second the emperor now in collapsing or in the ruins because there is not plan how to renovate to present them, how to use them in the future. And this is the affected by a politician because they are not able to reach some common idea."*

Another aspect that is mentioned in the interviews and the literature is the persistence of the prevailing (employee) mindset which mainly focuses on big companies and thus overlooks

other industrial development potentials. This 'locked-in mindset' might be seen as a barrier to the development of the region and the dissemination of more transformative agendas.

In summary, our experts emphasized that ongoing and future transformation processes need to be just and inclusive in order to break the downward spiral. However, this can only succeed with funding and resources from extra-regional sources. In these circumstances, the RIS4Danu project might be able to provide much needed impulses towards sustainable development in economic, ecological and societal terms in the Ústí nad Labem region through a S4 logic. A connection to the EU's Just Transitions Fond is one potential way.

Not only challenges are connected to opportunities, but also **various assets**. These can be used, exploited and/or mobilized for transformative activities in the region. Accordingly, in what follows, the analysis turns to the regional asset base and identifies key regional strengths that offer entry points and a platform for the RIS4Danu project.

One thing that has become very apparent during investigation of the Ústí nad Labem region is that the region currently finds itself at a critical juncture of development based on an ever-growing awareness that its main fields of economic activity, especially mining, cannot continue for much longer. This view has been confirmed by the interviewed experts and the reviewed documents:

*"I think that what's the problem of this region are the coal mines that are, you know, very huge or very huge and large. And now, when we are talking about limiting of the coal mining, we are also talking about the sustainability and building up a new environment after these activities. And mainly we are beginning to look at the region in a different way. We start to think what shall we do about it? How shall we work with these places?"*

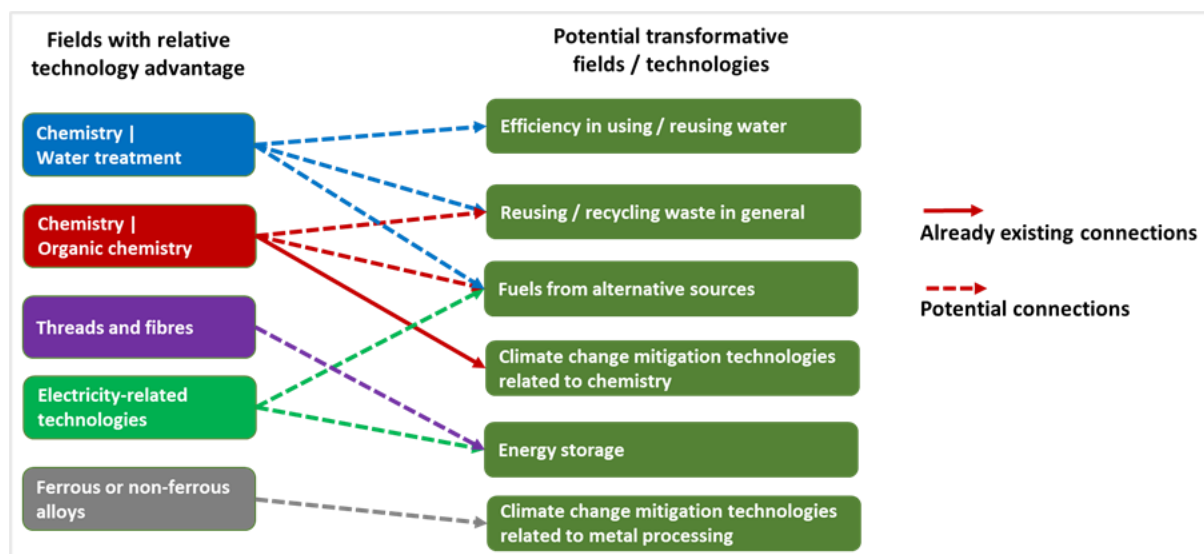
Hence, the region is very open to new trends and provide the **right conditions for deep-rooted adaptations to the region** in terms of willingness. Moreover, there is a reorientation of innovation and development strategies observable currently in the Ústí nad Labem region, moving from exogenous-driven regional development based on FDIs as the main development impulses towards endogenous and knowledge-driven forms of change based on SME and innovation support. An example for this direction is the installation of the ICUK innovation centre, which has the role to increase the potency of the innovation system and boost the absorptive capacity of the region.

In terms of resources for the transformation activities, the **research and development activities** of the Ústí nad Labem region can be considered as a crucial point. The local university has several ongoing research projects which includes such sustainability-related topics as bio- and environmental technology, nanotechnology, material science, the revitalisation of mining areas and the impact of the closure of old industrial sites. Among the regional actors, the university also has a significant role in international research projects (Horizon 2020) and cross-border collaborations. Besides the university, there are a few other research centres in the region whose profiles are related to chemistry and material science, coal mining and renewable energy production.

As for the patenting activity of the region, the city of Ústí nad Labem serves as the most significant location in this respect and, of course, the local university (University of Jan Evangelista in Ústí nad Labem) has an outstanding role in patenting. Reviewing technology fields of the patents, the region has a relative advantage in water treatment with chemistry-related technologies, organic chemistry, threads and fibres, electricity-related technologies and metallurgy. Besides the fields with relative technological advantage, we also revised which climate change-related technologies or applications might be combined with those technologies in which the area has competitive advantages. We reviewed the already existing and potential combinations with those climate change-related technologies or applications that might be related to the technology fields which have a relative advantage in the area (even if a given combination of technologies still cannot be found in the region but can be found elsewhere in the country). For instance, the knowledge in organic chemistry might open up



new opportunities for the region to diversify into sustainable fields of activity, such as the reuse of waste (Figure 30).



**Figure 30: The existing and potential future combinations between fields with relative technology advantage and transformative fields in Ústí nad Labem region, source: own edition based on the data of OECD Regpat Database**

*Note: Relative technology advantage means that a given technology field is in relative terms more frequently applied in patents of the region than in overall patents of the Czech Republic*

As mentioned before, the Ústí nad Labem region has a history of being the industrial powerhouse of the Czech Republic and of superior industrial importance even in the wider Central and Eastern European region. While its industrial importance has been declining since the end of the socialist period, it seems adequate to say that the Ústí nad Labem region is **rich in industrial heritage**. The most obvious aspect regarding the orientation of the RIS4Danu project is the high number of brownfields which are considered by the experts as land reserve for future corporate developments or cheap and suitable sites for carrying out various projects. Also, some ideas have come up that the old industrial sites, particularly of the chemical and energy sectors, might be very valuable for adapting innovative activities.

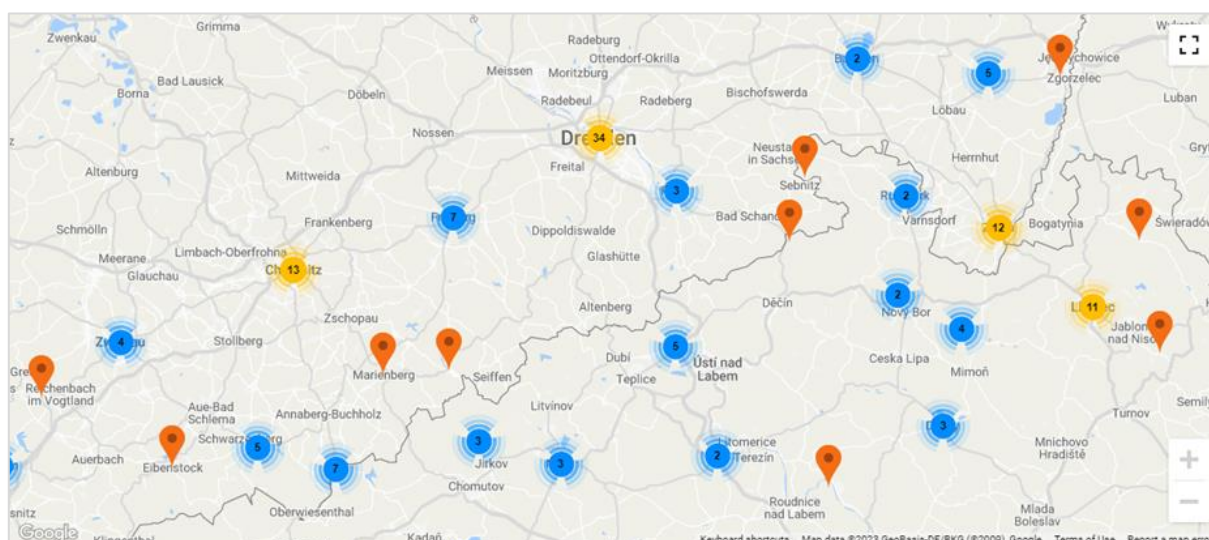
Concerning skills and know-how as an intangible form of industrial culture, the interviewed experts underline the importance of not only considering developments towards high-tech sectors:

*“Our mining industry it's not deep mining, it's surface mining. Our employees are usually electricians, locksmiths, drivers, [...] in the mines or power stations, there are a lot of people with this, let's say, not only university level, but those high school level. And for example, concerning artificial intelligence, we have now in the region a Notification Center, Czech university, about 30 students from university is working there. So, it's not only a question of high tech, but also supporting services.”*

The overall picture suggests a favourable time for re-industrialisation. However, it should be stated that the notion of industrial heritage should not be used to idealize the current situation of the Ústí nad Labem region. Still, certain features of the industrial culture can be a burden or barrier, e.g. destroyed landscapes or a lock-in of mindsets. Therefore, it remains to elaborate more precisely how the industrial heritage of the Ústí nad Labem region is comprised and which features can be renewed.

Regarding transformative activities, the **international relations** might also have a significant role in terms of finding partners, exchanging experiences and collecting good examples among

others. The cross-border relations of the Ústí nad Labem region with the neighbouring German region, Saxony, has been primarily facilitated by the financial tools of the EU in the frame of the Interreg programme. During the last two decades, this EU programme funded numerous projects aimed at tackling joint challenges and developing the whole cross-border area. The project participants of the latest (2014-2020) Interreg programme concentrated in Dresden on the German side and more or less equally dispersed among the medium-sized cities on the Czech side (Figure 31). The specific objectives of the latest and current Czechia-Saxony Interreg programme involve the improvement of education, climate change adaptation, supporting tourism and enhancing institutional cooperation. Besides these objectives, enhancing sustainable growth and competitiveness has appeared as a new topic in the current (2021-2027) Czechia-Saxony Interreg programme, which might be also interesting from the aspect of transformative activities.



**Figure 31: The project partners of the Czechia-Saxony 2014–2020 Interreg programme by their location,**  
**source: <https://keep.eu/>**

The interviewed experts unambiguously confirmed that the **geographical position** of the Ústí nad Labem region is a key advantage for the area as it is close to metropolitan areas, while offering affordable living conditions.

*"[...] people who want to start to work in Prague or Central Bohemia, they mostly move also. But now when the prices in the real markets, new flats, for example, are quite higher in Prague [...] people prefer to stay here and to [commute] to Prague each day."*

Due to the gateway position of the area, significant rail and road transport corridors between Czechia and Germany run across the region, and it provides suitable opportunities for companies which are active in transportation and storage. Furthermore, the region might also be attractive for firms which would like to be close to both Prague and Dresden, for example, because of their universities and R&D capacities.

Both the existing and the **still untapped assets of the region** might provide opportunities for creating new, more sustainable development paths. Regarding the latter, the interviewed experts the region might have the potential to move towards tourism, as it offers quite a lot of "nice places" (interviewed expert). As such, this natural beauty could be considered untapped potential. However, the bad image of the region, specifically in Czechia itself, might be a substantial barrier to fulfil this potential.

Also, the region might have the opportunity to stay loyal to its history as an energy producer but do it in a more future-proof and sustainable way. The reviewed statistical data suggest that Ústí nad Labem region has some potential relative to other Czech regions for renewable

energy production, in particular in the hydropower and geothermal heating. These energy sources were also mentioned by the interviewed experts. Moreover, they mentioned wind and solar energy. However, each of the different energy sources comes with its own hurdles and difficulties:

*“I think that these plans are really ambitious because they want to solve the problem of these two regions, not only Ústí region, also Karlovy Vary region in, in complex way, I can say, because in the past there are some strategies or plan how to reduce the mining industry, how to reactivate some areas of to support the social transformation. [...] It means that we want to replace the type of energy sources because the traditional coal plant, our power plants, will be closed in the nearest future. And because we have quite deep tradition in energy productivity, we will replace them by some new energy sources [...]. I think, one of the deepest changes in the nearest future that we will absolutely replace the energy sources of our region. And this is also connected with industry. For example, one firm strategy is that we want to create from our region because our region looks like great valley close between the mountainous areas and want to name this area as a hydrogen valley. Yeah. So great change ahead.”*

In addition to tourism and energy producing, one more topic mentioned in the interviews has been the production of green hydrogen using these different renewable energy sources. On the one hand, the potential seems to be substantial, not only because industries like automotive and chemistry might profit significantly, but also because some experience with handling hydrogen exists in the region. However, on the other hand, the interviewed experts also draw the attention on the concerns that hydrogen is hard to handle, expensive, unlikely to be used in transport, and the production potential limited as the Czech Republic as a whole is lacking natural resources for abundant clean energy production. Thus, the expert warned against focusing only on producing hydrogen.

**Table 14: Summary of assets & challenges identified for the Ústí region**

Assets	Challenges
University and R&D activity	Vulnerability & high transformation needs
Industrial heritage in its tangible and intangible forms	Low educational attainment, lack of entrepreneurial activity
Exploiting untapped assets and reconfiguring existing assets towards new sustainable paths	Social challenges: Outmigration, brain drain, unemployment and demographic problems
The right conditions & resources for change are in place	Weak absorptive capacity: challenge to turn impulses into concrete activities
Geographical location – Accessibility and cross-border cooperation	Lack of common vision

Source: own elaboration

As a summary of the analysis on Ústí nad Labem region, we now provide some potential development paths which are based on the available assets and the challenges of the region (Table 14).

Building on the industrial heritage is definitely a potential direction for implementing transformative activities in the Ústí nad Labem region. It might include the reshaping of local industrial activities in a more sustainable way, based on a more extended usage of renewable energy. The local university has a crucial role, both in developing environment-friendly methods (e.g. in chemical or textile industry) and training the local workforce for the subsequent application. This might also help decrease the unemployment rate as well as keep the workforce in the region. This process can also be related to the relatively advantageous

geographical location of the region as the potentials of research conducted in Prague or Dresden could also be used.

The role of the region's geographical location might be an important asset to attract qualified people and companies to the region. If the region can take successful steps into this direction, it might also bring new ideas and concepts to the area. Moreover, the in-migrated people might create demand for certain services which could increase the entrepreneurial activity.

New paths based on the untapped and existing assets might also provide potential development directions. Even though Ústí region is considered primarily as an industrial region, tourism based on the natural assets of the area might serve as an alternative path, which can also help diversify the economic structure and decrease the vulnerability of the Ústí region. Of course, the sustainable and renewable solutions should be preferred when creating such a development path. In the preparation of such an alternative way, the expertise of the local university in rural development issues can be helpful. Furthermore, this direction might also have positive impacts on decreasing the unemployment and enhancing the entrepreneurial activity.

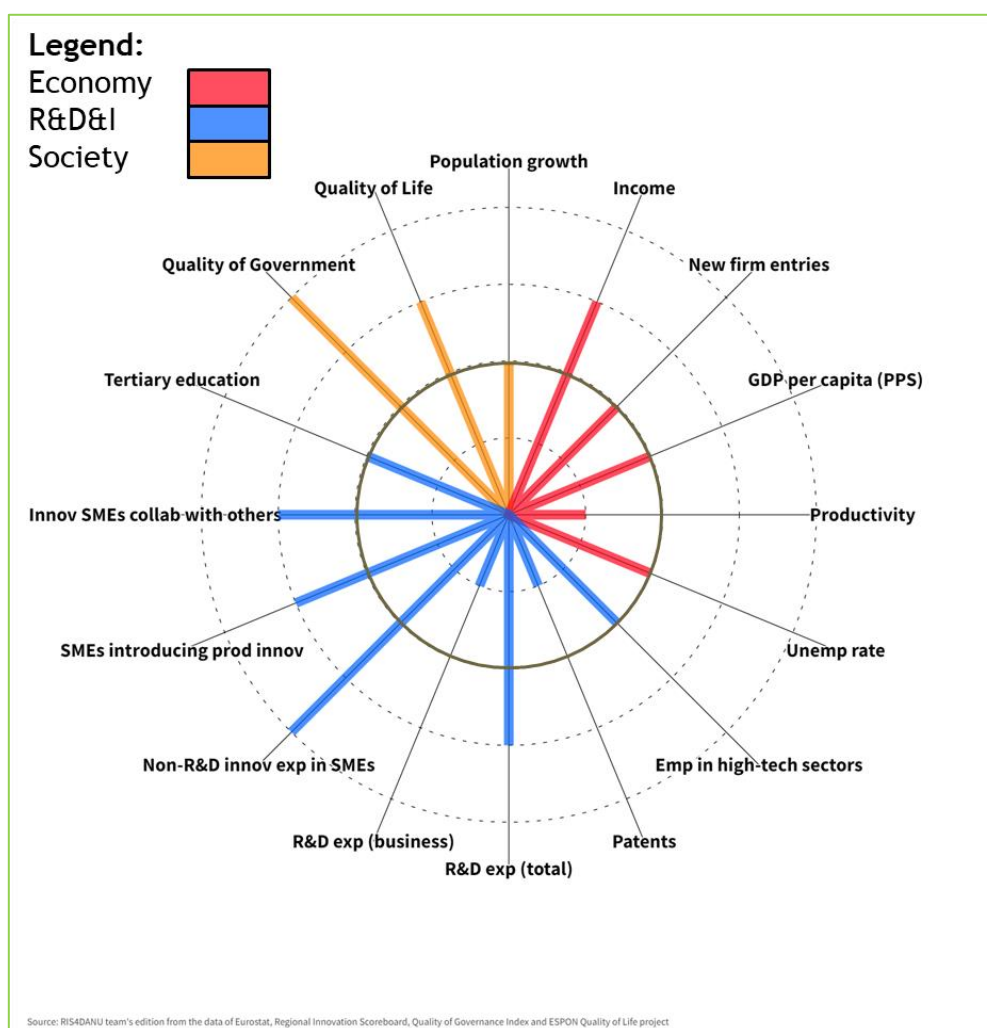
Finally, setting up a new local platform dealing specifically with sustainable transformation of old industrial areas could provide important development impulses. During the analysis, it became clear that the impacts of the past industrial activities are highly complex issues which call for creating visions involving stakeholders from different domains like business, academia, public authority and civic organizations, precisely as the methodology of entrepreneurial discovery workshops suggests. Moreover, it would be essential to involve independent external experts who might help bring new perspectives to the region. Such a collaborative platform could also support determining the transformation needs, ranking the feasibility of various development projects and matching the available resources to the challenges.

#### 4.5 Banská Bystrica region, Slovakia

The Banská Bystrica region (Banskobystrický kraj) is one of the 8 regions in Slovakia. It is located in the mid-south part of the country, having a wide variety of natural features, from the mountain ranges in the northern to the plains in the southern part. A relatively long section of the region's southern border serves also as the national border between Slovakia and Hungary. The Banská Bystrica region is characterized by a relatively high level of intra-regional inequalities. While some parts of the region (especially its northwestern area along the highway to Bratislava) offer more favourable conditions in terms of economic development, other quite hard accessible districts of the region (primarily the ones in the southeastern part of the area) are among the most deprived Slovakian regions, having country-wide the highest unemployment rate. Even though the Banská Bystrica region has relatively long industrial traditions, which root back to the 18th and 19th centuries, many of the local industrial activities have been reshaped or ceased over the last decades. Despite these challenges, the region offers interesting assets and possible avenues for transformative activities, as this section will show.

First, this summary of the regional analysis will cast light on the **general regional context**. Hence, in what follows, the scene is set and information on the wider, NUTS-2 level, regional conditions provided (e.g., development in key socio-economic indicators (Figure 32), recent innovation performance (Table 15) and the key development fields identified in relevant documents (Figure 33)).





**Figure 32: The socio-economic analysis of the Stredné Slovensko NUTS-2 region, source: own edition based on different data sources**

### The most important findings of the socio-economic and innovation analysis of the region

- Looking at the values of the Stredné Slovensko NUTS-2 region has a moderate overall performance in terms of the analysed indicators.
- Regarding the economic indicators, the area performs rather weak as it has a median or even lower ranking among the four Slovakian NUTS-2 regions. The only exception is the income per capita in which the Stredné Slovensko region has the second-best position.
- The region's ranking within the R&D and innovation-related indicators suggests an ambiguous picture. While there seems to have a relatively favourable position in terms of overall R&D expenditure and even in "Non-R&D innovation expenditures in SMEs", the regional performance in patents and business R&D are the weakest among the Slovakian NUTS-2 areas.
- As for the society-related indicators, both composite indicators (Quality of Life and Quality of Governance) outperform the national average, while in population change lags slightly behind the country's mean value.

As can be seen in Table 15, the Stredné Slovensko NUTS-2 region is categorised as an "Emerging innovator +". The area has a 57.5% relative innovation performance of the EU

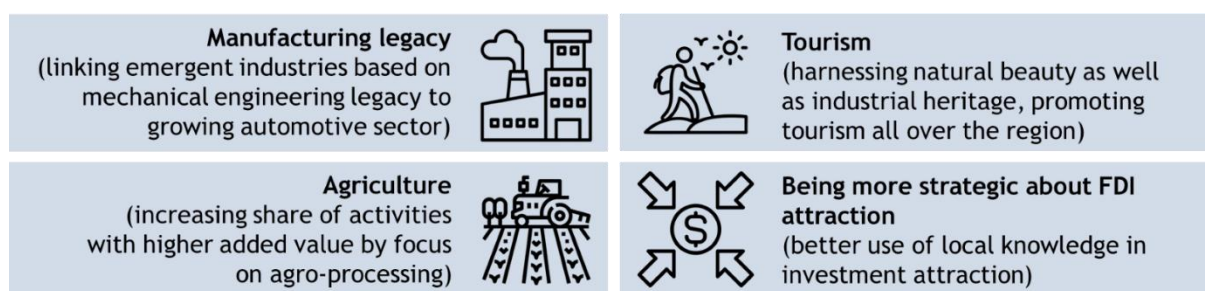


average in 2021. The region has a relatively modest performance within the EU, but it is the second-best performance among the Slovakian NUTS-2 regions after Bratislava. The Bratislava region highly overperforms the other three Slovakian NUTS-2 region whose performance levels are relatively close to each other. The Stredné Slovensko region kept its position over time: while in 2014 its relative innovation performance to EU average was 56.1%, this value has become 57.5% by 2021. Regarding the development trap indicator, the Stredné Slovensko NUTS-2 region has been categorised as a region not in development trap or at risk (Diemer et al., 2022). This result suggests that the region has similar growth trends as other regions of Slovakia in terms of productivity, employment and development level in the NUTS-3 level. However, the reviewed statistical data also refer to severe intraregional disparities among the districts of Banská Bystrica region. Some districts are struggling with a considerably high level of unemployment, the low level of economic development and productivity and abandoned brownfield areas. Therefore, the region and particularly some of the districts should find new industrial opportunities and development paths.

**Table 15: Banská Bystrica's innovation performance and development trap risk**

<b>Regional Innovation Scoreboard (2021)</b>	<b>Emerging innovator +</b>
<b>Development Trap category</b>	<b>Not in development trap or at risk</b>

Source: Own edition based on data from Regional Innovation Scoreboard and Diemer et al. (2022)



**Figure 33: Key transformative fields defined in: Slovakia Catching-up Regions. Banská Bystrica Region: Key development dynamics (2020), source: own elaboration**

These central transformative fields (see Figure 33), defined in one of the region's most important development strategies, offer some first insights into potential key economic development avenues. The goals to transform (into) these fields are assumed to be widely shared by regional stakeholders, hence we consider them highly relevant for the analysis and the workshops alike. As such, some of them will be taken up again, some complemented and some might be critically commented upon from a sustainability perspective in our investigation of Banská Bystrica region's major challenges, assets and transformative opportunities over the following pages.

Adhering to a challenge-oriented innovation approach, the next paragraphs identify some of the **most pressing challenges the region is currently facing**.

To begin with, the Banská Bystrica region is seriously affected by **demographic change** as its population is shrinking and aging, like many peripheral regions in Europe. This development dynamic is to be considered as intertwined with the overall situation of economic hardship as it is reflected in a high share of people in danger of social exclusion and a high dissatisfaction with the overall economic situation in the region: The 2018/19 data of the European Social Survey shows that in the Banská Bystrica region only 20.26% of the respondents are rather satisfied with the present state of the economy – it is the lowest value among the Slovak regions, significantly lower than the national average of 34.26% (ESS 2017/18). Furthermore, the rate of unemployment in the Banská Bystrica region remains substantially higher compared to the Slovakian average, although it has halved between 2010 and 2021 (see Table 16).

**Table 16: District level unemployment in the Slovak Republic (2010–2021)**

	2010	2015	2019	2021
Slovak Republic	12.46	10.63	4.92	6.76
Banská Bystrica (region)	18.86	14.94	6.69	9.01
District of Banská Bystrica	8.95	8.00	3.30	4.57
District of Banská Štiavnica	17.10	16.00	6.06	7.41
District of Brezno	18.00	12.52	4.42	6.70
District of Detva	16.16	12.92	4.90	6.22
District of Krupina	19.95	12.18	5.09	7.09
District of Lučenec	23.20	17.53	8.31	11.00
District of Poltár	22.06	20.87	10.01	12.29
District of Revúca	28.83	19.97	12.58	18.00
District of Rimavská Sobota	33.64	27.42	15.14	19.90
District of Veľký Krtíš	23.71	18.45	6.40	9.11
District of Zvolen	9.24	9.32	3.48	4.69
District of Žarnovica	20.23	14.46	6.45	8.09
District of Žiar nad Hronom	14.39	10.86	4.58	5.59

Source: Statistical Office of the Slovak Republic

**Table 17: Educational attainment of the 15–64 years old population in 2021 by districts in Slovakia**

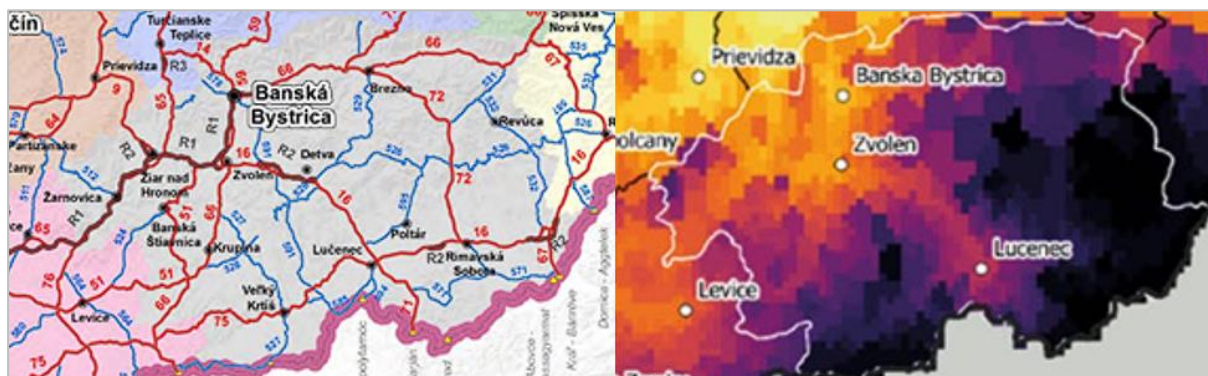
Area	Without education		Primary		Secondary without school-leaving exam		Secondary with school-leaving exam		University		Unknown	
	M	F	M	F	M	F	M	F	M	F	M	F
Slovakia	2.74	2.54	11.31	11.79	24.52	16.14	35.84	36.91	19.82	28.51	5.78	4.11
Banská Bystrica (region)	3.44	3.39	13.55	14.40	24.35	16.33	36.50	37.61	16.65	24.25	5.51	4.03
District of Banská Bystrica	1.33	1.13	7.88	7.43	17.03	11.11	40.50	39.83	28.28	37.31	4.97	3.19
District of Rimavská Sobota	6.58	6.80	22.97	25.40	25.19	16.15	29.53	31.82	9.74	14.95	5.99	4.89
District of Veľký Krtíš	3.34	3.56	12.85	15.44	32.28	22.45	35.42	37.68	10.93	17.04	5.18	3.84
District of Žarnovica	1.92	1.75	9.73	10.62	27.81	17.97	40.44	41.96	15.40	24.88	4.70	2.81

Source: Census 2021 data by the Statistical Office of the Slovak Republic; note: M – males; F – females

In addition, the data on unemployment reveals persisting **intra-regional disparities**: the districts of Banská Bystrica and Zvolen show lower rates than the national average, while the figures of the Rimavská Sobota district exceed the country-level average by at least 10 percentage points. The statistics about the national elections in 2020 show particularly low

voting turnouts for those districts where the unemployment rate is above the national average (Statistical Office of the Slovak Republic, 2020). The relatively high unemployment rates are also in line with the educational attainments of the districts as the southern districts are marked by a lower level of education compared to the regional average (see, e.g. the example of Rimavská Sobota district). In terms of the patterns of educational level, high contrast can be observed between the Banská Bystrica and Rimavská Sobota districts. (see Table 17).

Adding to the social challenges, Banská Bystrica region has the second-lowest road density in Slovakia and as Figure 34 suggests, the southern and south-eastern parts of the region are particularly poorly linked and hold a disadvantaged position in terms of accessing urban areas. This disparity in connectivity is considered to further exacerbate the challenges faced by these areas, limiting their economic and social integration with the rest of the region.



**Figure 34: The accessibility of the Banská Bystrica region,**  
**source: Banská Bystrica Region: Key Development Dynamics and Slovak Road Administration**

Regarding the conditions for innovation and investment attraction, the southern parts are once more lagging behind the north of the Banská Bystrica region. However, according to one expert, a significant challenge that affects the entire region is the lack of trust and interaction among stakeholders:

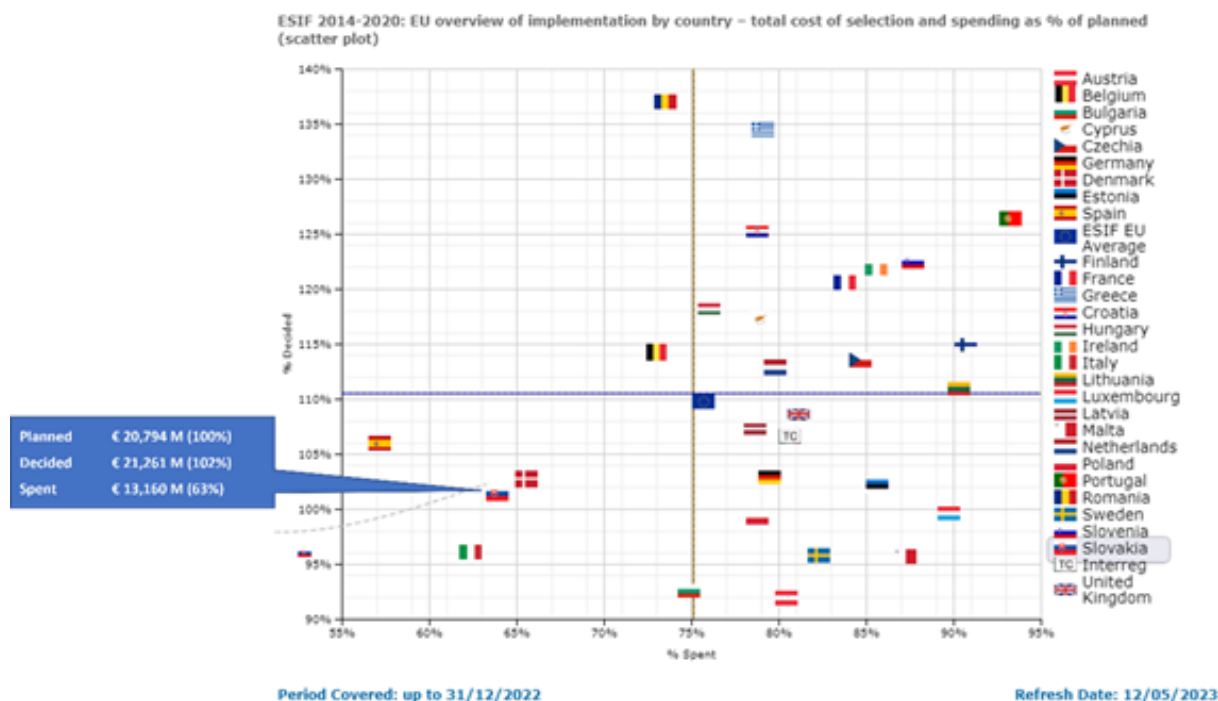
*“It’s the real relationship and interaction in the innovation ecosystem. You know, we have stakeholders, but there is no interaction, there is no common communication, cooperation and everything is because of a lack of trust. So, we have to build it.”*

Additionally, according to the report on the key development dynamics, the Banská Bystrica region lacks a regional access point for the **innovation support system** (World Bank, 2020, p. 31). Yet, attracting investments and promoting innovation are matters dealt with on the national level in Slovakia. One interviewed expert suggested that regional authorities should seek more active participation in these activities in order to contribute their local knowledge and harness regional assets:

*“This is more discussion on national level and how the money is going to be used. It’s more dependent on the conditions that will be set up by the national government. The problem of Slovakia is that most of this kind of things is on the national level, and the regional governments don’t have enough money to finance for. And also, the competences lie on national government that is not very willing to let the regions decide for themselves. Also, that the EU money, EU funds are mostly distributed from Bratislava. Big issue and big problem in Slovakia. Because if the money were on the regions and the regions themselves could decide what they will finance that then we can have a quite different story in Slovakia.”*

The insufficient capacities and missing involvement of regional authorities are furthermore reflected in the **distribution and use of EU funds**. These are considered “the biggest underutilized resource” (World Bank, 2020, p. 58) of the Banská Bystrica region. Similarly, Figure 35 illustrates that Slovakia is lagging behind other European countries in terms of spending the cohesion funds. In our experts’ views, regional authorities are important

actors for inducing effective spending of EU funding and should be equipped with resources to support regional companies that seek to attain EU funding. Thus, enhancing the capacities of the regional authorities' and further intermediary activities are needed in order to facilitate cooperation and counteract fragmentation.



**Figure 35: The rate of decided and spent EU Funds of Slovakia in comparison with other EU countries 2014–2020, source: Cohesion Open Data Platform**

Finally, a significant challenge arises from the mismatch of the presence of **energy-intensive industrial activities and the limited energy generation potential** of the Banská Bystrica region. The main industrial branches of the region are the manufacture of wood, the metal industry, metal production and recycling, engineering in general, but also the automotive industry and the production of construction materials, whereas some of these industrial branches are connected to a high energy demand. The northwestern part of the region is characterized by the manufacturing of paper, pharmaceuticals, chemicals, and iron and steel, while the production of construction materials (brick and clay, lime, ceramics and refractories) is rather concentrated in the less developed southeastern part of the region (Figure 36).

Given the limited number of power plants in the Banská Bystrica region, industries in the area currently depend on external energy sources, primarily fossil fuels. However, experts who were interviewed highlighted the importance for these companies and the region as a whole to reassess their energy supply strategy. This recommendation stems from the escalating prices of energy and the growing urgency to explore alternative, sustainable options, such as expanding the utilization of renewable energy sources. One expert summarized the issues as follows:

*"[...] In our region, we have very traditional companies, [highly] very oriented on eastern markets with very much energy consumption. So, [...] our companies [...] are in big trouble now because of the high energy prices, and also because of the war in Ukraine [...] A lot of our companies were exporting to Russia and so on. [...] But on the other hand, it is [...] an opportunity for our company to change now. [...] If our companies do not change themselves, then they will just go bankrupt. There is no other way. So, they have to think [about] how to lower their energy consumption, how to use renewable energy sources for their production, how to*



*make their production greener. [...] We are trying to [raise their] awareness [...]and] explain to them that this is the only way how to survive in this competitive world."*



**Figure 36: Location of energy-intensive industrial activities in Banská Bystrica region (selection), sources: Map: Atlas Krajiny Slovenskej Republiky; Activities: Energy & Industry Geography Lab by JRC;**

*Notes: Darker areas have higher performance in industrial activities; Marked industrial activities: iron and steel production; production of cement; production of glass; lime production; production of brick and clay; ceramics and refractories; pharmaceuticals; chemical products; manufacturing of paper*

To sum up, the cumulative impact of these factors further reinforces the perception of Banská Bystrica as a peripheral region characterized by significant disparities within its own borders. The combination of high-energy intensity with limited energy supply, the underutilization of EU funds, weaknesses of the innovation support system, the lack of trust and interactions, and the inadequate transportation infrastructure solidifies the image of the region as one facing notable intraregional inequalities. Addressing these challenges is crucial in order to overcome its peripheral status and foster a more equitable and inclusive development across the region.

Yet, not only challenges are connected to opportunities, but also **various assets**. These can be used, exploited and/or mobilized for transformative activities in the region. Accordingly, in what follows, the analysis turns to the regional asset base and identifies key regional strengths that offer entry points and a platform for the RIS4Danu project.

As previously described, the Banská Bystrica region hosts a wide range of industrial activities and looks back on a **strong industrial tradition**. Reactivating this legacy is considered a suitable strategy since necessary assets such as trained people, infrastructure, knowledge, training centres and traditions are still in place:

*"Mechanical engineering, for example, was traditionally very strong here. After the fall of communism, it fell apart a bit, but then it started to pick up again. I think I see the potential not only in the companies, but also in the population, because traditionally there are also a lot of people who are trained in this field. Then there are also the training centres that are still doing it. Yes, I think that just the engineering industry, that could be the third sector. We also had very many consultations with the companies. I know, for example, that in Lucenec there are now companies again that deal with waste disposal and waste processing. And a green industry is emerging there, so to speak. Absolutely, that could perhaps also be something"*

When it comes to upgrading these assets and aligning with current challenges, the adoption of a circular economy approach is seen as a promising direction for transforming traditional industries into more resource-efficient and environmentally friendly practices. Some of



the region's industrial features, such as material-intensity and the potential for reusing waste (Table 18), provide positive circumstances for implementing circular economy initiatives. Although there is still a lack of cooperation among companies, the Chamber of Commerce and Industry is taking steps to bridge this gap by connecting various actors and advocating for the adoption of circular economy principles.

**Table 18: Percentage of materials recycled, reclaimed for composting and landfilled by regions in 2017 and 2021 by districts in Slovakia**

In % of all wastes	Recycling materials		Reclamation of organic substances and composting		Landfilling	
	2017	2021	2017	2021	2017	2021
Slovakia	14.47	21.61	14.85	27.27	61.43	40.68
Bratislava (region)	11.19	16.30	16.89	31.19	34.97	20.61
Trnava (region)	14.28	19.14	12.76	34.50	72.96	43.77
Trenčín (region)	13.45	22.20	14.39	28.08	72.16	48.09
Nitra (region)	12.72	21.37	19.75	29.03	67.48	48.24
Žilina (region)	20.47	26.12	12.51	25.30	67.01	47.08
Banská Bystrica (region)	18.67	24.80	16.49	24.72	64.67	49.47
Prešov (region)	12.48	22.92	12.94	24.70	74.57	44.07
Košice (region)	13.60	22.98	11.79	16.47	44.51	31.00

Source: Statistical Office of the Slovak Republic

Thus, several key sectors such as metallurgy, mechanical engineering or manufacturing of paper products could contribute to a renewed regional economic composition. In the view of one expert, a key issue to revitalize these traditional fields can be found in the educational domain:

*“So, in our region there are two very strong industrial fields. Engineering industry is the biggest one and the second is wood industry. Both fields are very strong for education to industry. You know, I think it works. It still works. But what is missing is maybe there are two things. The first thing is we need to improve this connection between education and industry. You know, the enterprises need the people need employees. And there is a special fashion in Slovakia. The people are persuaded that vocational education schools are not the best one for kids. So, we prefer to go to school. Yeah. Secondary school you know, the general education. And so, the region tries to highlight the opportunity of the vocational education and training schools because these the graduates from these schools, specialised technical schools have no problem with jobs after finishing.”*

While there are good training opportunities available, the alignment between education organisations, engineering and wood industry should be improved according to this expert. Furthermore, it is observed that many students still prioritize secondary schools over vocational schools, despite the favourable employment prospects upon graduating from the latter. Therefore, it becomes crucial to focus on improving the reputation of vocational schools

Regarding the future viability of these industrial sectors, energy supply is becoming a pressing question. Yet, there is also **potential to generate renewable energy**. In the assessment of different sources of renewable energy, solar energy, bio-based sources and geothermal heat seem to be the most promising forms of renewable energy in the Banská Bystrica region (see Table 19).

**Table 19: The ranking of Banksá Bystrica by its potential in different fields of renewable energies in a Slovakian comparison**

Indicator	Ranking of Banksá Bystrica region
Potential for electricity generation by land area of wind onshore (MWh/km <sup>2</sup> , 2018)	7 <sup>th</sup> / 8 Slovakian regions
The technical potential of electricity generation per land area by small hydropower (<10MW) (GWh/km <sup>2</sup> , 2018)	7 <sup>th</sup> / 8 Slovakian regions
Potential for electricity generation by land area of solar photovoltaics (MWh/km <sup>2</sup> , 2018)	5 <sup>th</sup> / 8 Slovakian regions
Primary energy potential per land area of biodegradable wastes and biogas – projection for the year 2030 (GWh/km <sup>2</sup> , 2018)	2 <sup>nd</sup> / 8 Slovakian regions
Primary energy potential per land area of biofuels from agricultural products – projection for the year 2030 (GWh/km <sup>2</sup> , 2018)	8 <sup>th</sup> / 8 Slovakian regions
Primary energy potential per land area of forestry products and forestry residues (excluding material use projected for the year 2030) – projection for the year 2030 (GWh/km <sup>2</sup> , 2018)	6 <sup>th</sup> / 8 Slovakian regions
Primary energy potential per land area of geothermal heating – projection for the year 2030 (ktoe/km <sup>2</sup> , 2018)	5 <sup>th</sup> / 8 Slovakian regions

Source: The dataset of the ESPON “Locate” project

Energy production from biodegradable waste and biogas offer the second highest potential within all Slovakian regions, while solar energy and geothermal heat have a moderate potential in the Banksá Bystrica region. Furthermore, the potential in terms of geothermal energy is being explored. A pilot project for geothermal energy production has been conducted in this area as a geothermal power plant has recently been established in Žiar nad Hronom (Euractiv, 2022).

**Table 20: Forest area and wood stock in Slovak regions (2021)**

Region	Area in ha	Stocks in m3
Bratislava	72,749	17,317,551
Trnava	62,521	15,325,698
Trenčín	215,816	60,016,995
Nitra	93,073	19,639,181
Žilina	368,054	95,705,537
<b>Banská Bystrica</b>	<b>454,914</b>	<b>116,337,866</b>
Prešov	424,828	98,771,104
Košice	260,809	64,200,764

Source: Database of National Forest Centre

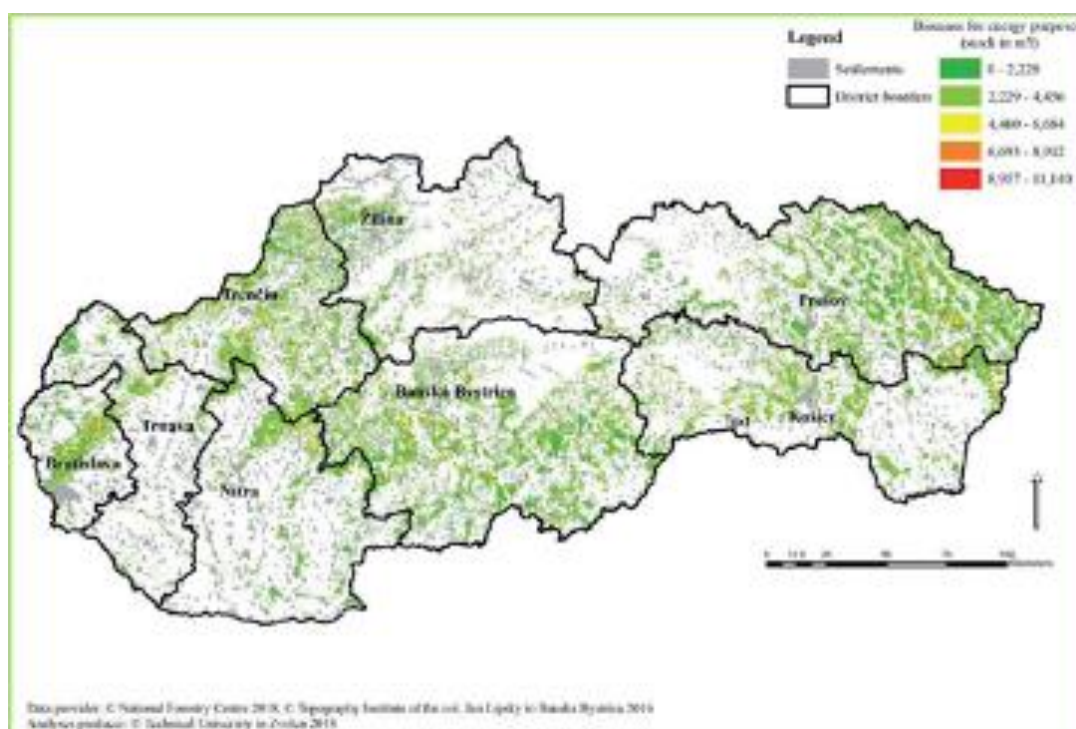


Figure 37: Wood-based biomass stock of the Slovakian forests, source: Majlingová et al. (2020)

In terms of natural geographic conditions, the Banská Bystrica region possesses moderate potential for renewable energy production compared to other regions in the country. However, it benefits from available resources like woody biomass, which can be utilized for energy generation. There are emerging initiatives and efforts aimed at harnessing these resources and promoting their use as a sustainable energy source (see Table 20 and Figure 37).

Wood and forest are in many ways meaningful to the region. Besides the industrial sectors described above, forestry and agriculture are traditional economic activities to the region. One expert highlighted the region's natural resources as its economic potential:

*“And the potential is really, I think, in the natural resources, that's the forest and the industry that's part of it and that's the agriculture and the industry that's part of it and that's the ecosystem services, because that's not only related to the food and to the furniture or to the wood products. But that is also related to the other forest or ecosystem services and services of in the region and that is of course also related to climate change. But nature conservation could be a good strategy with the tourism that goes with it. I think there is a big potential there.”*

**Agriculture is of especially great importance** for the less developed southern parts of the region and there is a firm belief that upgrading this industry will help tackle several key regional challenges – from unemployment to the integration of minorities (World Bank, 2020). While there is no clear direction yet for the transformation of the agricultural sector, there are now financial resources and political incentives in place (e.g. European Green Deal) that support a transformation in these key sectors with potential to contribute to wider regional sustainable development. Thus, the timing is favourable to rethink agriculture and forestry and adapt to the current challenges.

In the view of an expert, the potentials of the region are of national significance in wood-related research and economic activity:

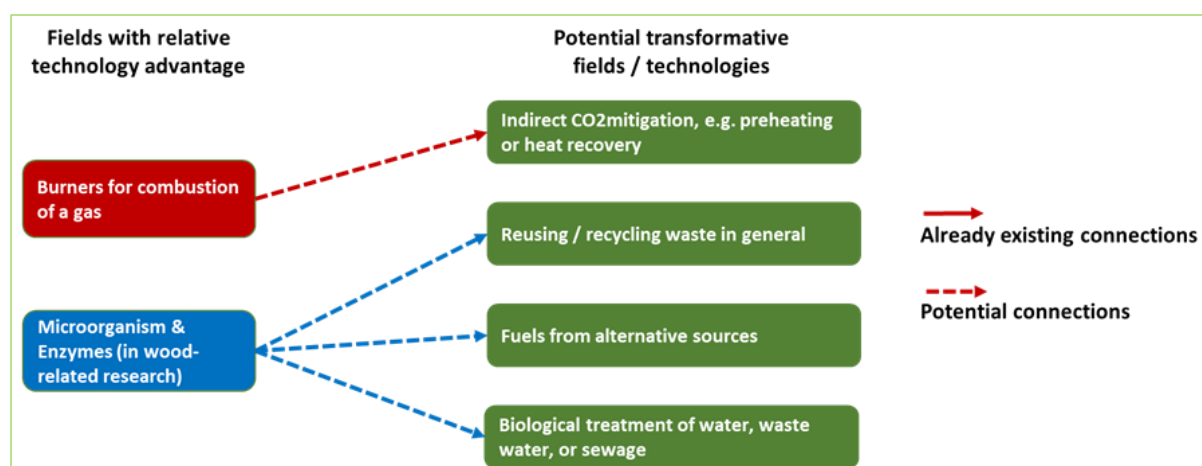
*“We see the potential [...] for the whole Slovakia even. I would say also for the whole region, because the concentration of companies, employees and training centres for wood and forestry is unique, I think, in the whole of Europe. [...] fortunately, the people from the self-governing regions see it the same way”*

What is more, key stakeholders of the region seem to agree on the importance and see **potential in the region's specialisation on forestry and wood**. Thus, there are already plans to implement a wood innovation centre to take advantage of the critical mass in the region and to bundle the knowledge in one place. An expert summarized the idea in the following way:

*"We have a very strong wood faculty here. That's not really common in Europe. It's also a bit of a legacy from socialist times, that's true. But I think the potential in research in this area is very high for the whole Central and Eastern European region. And it's our turn to make something out of it, because we are doing research in the chemical processing of wood, from mechanical to furniture to design and so on. And I think that's very important"*

Considering the **R&D impulses** in general, these activities show a high concentration in the two biggest towns (Banská Bystrica and Zvolen) of the Banská Bystrica region. They are mainly carried out by public research organizations: the Matej Bel University in Banská Bystrica, the Technical University of Zvolen, but also the National Forest Centre and the Institute of Forest Ecology (both of them based in Zvolen). As it can be also seen from the list of the local research organizations, the scientific competence of the region stands out in one specific topic: the orientation on forestry, forest management and wood-related research. The Technical University of Zvolen has been involved international projects on forest management and forest soils, among others.

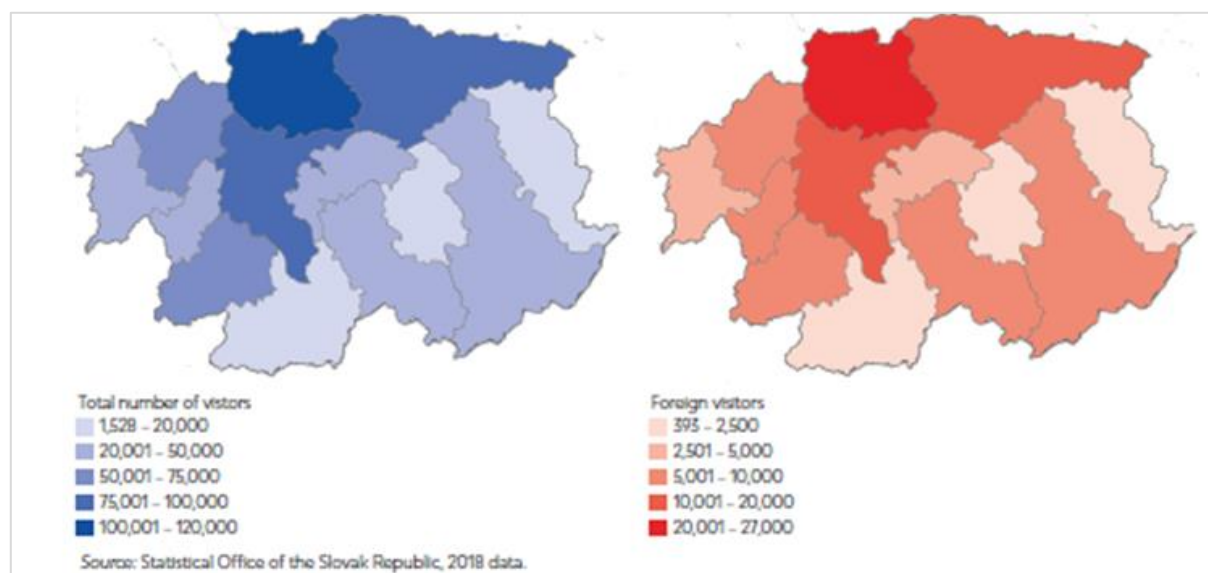
The patent statistics of the last 10 years also suggest that the Banská Bystrica region has a relatively weak innovation performance. The experts explained these results primarily with the lack of cooperation between the universities and the companies. The patent analysis has revealed that the regional fields of relative technological advantage are microorganism and enzymes (particularly in wood-related research) and burners for combustion of gases (particularly related to magnesite processing). Besides the technological fields which have relative technological advantage in the area, we also checked which climate change-related technologies or applications might be combined with those technologies in which the Banská Bystrica region has competitive advantages. We revised the combinations that already exist in the region and extended the search with those climate change-related technologies or applications that might be related to the technology fields which have a relative advantage in the area (the examples were also collected from other regions of Slovakia or Czechia). For instance, the knowledge in microorganism and enzymes might open up new opportunities for the region to diversify into sustainable fields of activity, such as in general recycling of waste or the biological treatment of water and sewage (see Figure 38).



**Figure 38: The existing and potential future combinations between fields with relative technology advantage and transformative fields in Banská Bystrica, source: Own edition based on the data of OECD Regpat Database**



Finally, the rich industrial history, the abundance of forests and natural beauty, as described earlier, form another asset that the Banská Bystrica region has to offer – **its tourism potential**. It is a rather new, yet dynamic economic sector in the region. However, the touristic activities are currently concentrated in the northern part of the region which is also the economically stronger area of the Banská Bystrica region (see Figure 39). While this part offers a variety of cultural heritage attractions and mountainous areas, one expert considers the southern part to be viable to promote nature-focused tourism.



**Figure 39: Number of visitors and foreign visitors to the Banská Bystrica region by districts, 2018, source: World Bank (2020)**

The report on the Banská Bystrica region as a catching-up region suggests aiming for an extension of the touristic areas to the southern parts (World Bank, 2020). A difficulty lies in the fact that touristic attractions in the south are not as well-known and accessible as their counterparts in the northern part of the Banská Bystrica region. Hence, the improvement of the transport infrastructure and connectivity could also enhance the tourism activity in the southern part of the region. One key advantage of the tourism sector is that this opportunity is acknowledged and strongly supported by the regional government as an interviewee expressed:

*“I have to say that our present regional government is very much, you know, supportive for tourism. So, they do a lot of initiatives, activities. So, I mean, now, because our region wasn't very developed as for the tourism facilities and so on, but it's changing, and we can see a lot of regional money was used or a lot of project management implemented from this cross-border cooperation program. So, this area is improving.”*

All in all, tourism can be considered a rather new development path for the region. Yet, it finds institutional support and builds upon the traditional assets of the region. Thus, tourism can present a sustainable way of using them in a transformative way.

As a summary of the analysis on the Banská Bystrica region, we provide some potential development paths which are based on the available assets and the challenges of the region (Table 21).

First of all, the Banská Bystrica region is marked by high intraregional disparities which is reflected throughout almost all assets and challenges discussed. While some parts of the region (especially its northwestern area along the highway to Bratislava) offer more favourable conditions in terms of economic development, other quite hard accessible districts of the region (primarily the ones in the southeastern part of the area) are among the most deprived



Slovakian regions. For future developments, reducing these inequalities should be a prime goal.

**Table 21: Summary of assets & challenges identified for the Banská Bystrica region**

Assets	Challenges
Industrial heritage	Social challenges: from demographic change to populist votes
R&D impulses	Regional disparities within the region and the national frame
Geothermal heat and biomass	Fragmentation and lack of trust
Conditions to rethink agriculture and forestry	Planning issues and underutilization of EU funding
Tourism potential	High energy intensity with limited energy generation potential

Source: own elaboration

Whilst providing significantly fewer fields of technological specialisation compared to other RIS4Danu regions, the Banská Bystrica region nevertheless stands out with its research focus and potentials on forestry and wood. In this field, several forward-looking directions have emerged. One such direction is the application of nanotechnology in wood-based materials, which holds potential for expanding their range of applications. Additionally, the construction of low-energy buildings using renewable raw wood materials is gaining traction, contributing to sustainable construction practices. Furthermore, digital technologies are being explored for sorting, grading, and processing wood, enabling more efficient and precise utilization of this resource.

To consolidate and further develop the region's specialization, plans are underway to establish a wood innovation centre. It aims to bring together various actors, competencies, promote collaboration, and drive advancements in wood-related research and development within the region.

Another transformative pathway could be the establishment of a circularity hub for wood products, combining the expertise in wood-related activity as well as moving towards the required more resource-efficient practices. Furthermore, the knowledge in microorganism and enzymes might open up new opportunities for the region to diversify into sustainable fields of activity, such as in general recycling of waste or the biological treatment of water and sewage.

Finally, the region also recognizes opportunities in reviving the local industrial heritage and enhancing culture- and nature-oriented tourism. These initiatives have the potential to contribute to the preservation and sustainable management of the precious natural and cultural resources of the Banská Bystrica region, while simultaneously help tackle social challenges the region is currently facing.

#### 4.6 Podravje region, Slovenia

The Podravje region is one of the 12 statistical regions in Slovenia and hosts the country's second biggest city Maribor. It is located in the North-East of Slovenia and borders Austria to the North and Croatia to South. This particular location between important and dynamic centres (especially Graz, Zagreb and Ljubljana) and the region's accessibility is a recurring theme when investigating the Podravje region, related to both, opportunities and threats for regional development. Furthermore, this area has a longstanding legacy in traditional industries which are characterized by the dominance of the small- and medium-sized enterprises (SMEs) and circumstances that are connected to a number of challenges in times of crises. At the same time, the region offers highly interesting assets. Both, regional

challenges and assets provide interesting possible avenues for transformative activities, as this section will show.

**Table 22: Key indicators used for the socio-economic and innovation analysis of the Podravje region**

Indicator	Value for the Vzhodna Slovenija NUTS-2 region	Value for the Zahodna Slovenija NUTS-2 region	Relative performance of the Vzhodna Slovenija region compared to the Zahodna Slovenija region (if Zahodna Slovenija = 100%)
Population change (2000–2021; 100% = 2000)	101.02	111.4	90.7%
Quality of Life indicator (2019)	0.490	0.558	87.9%
Quality of Government (z-score; 2021)	-0.221	0.283	79.4%
Net disposable annual income per capita (in PPS; 2020)	14,600	15,200	96.1%
New firms per 1000 people in all sectors (2020)	6.282	10.439	60.2%
GDP per capita (PPS EUR, 2020)	22,000	31,600	69.7%
GDP per capita related to EU average (% where EU=100, 2020)	74	106	69.7%
GVA per employed person (EUR, 2019)	37,592	42,997	87.4%
Unemployment rate (%; 2021)	5.0	4.5	111.1%
Employment in high-tech sectors (%; 2021)	5.2	8.5	61.2%
Total R&D expenditures (in % of GDP, 2020)	1.59	2.57	61.9%
Business R&D expenditures (in % of GDP, 2020)	1.47	1.65	89.1%
Non-R&D innovation expenditures of SMEs (2021; normalised value)	0.172	0.160	107%
SMEs introducing product innovation (2021; normalised value)	0.700	0.816	86%
Innovative SMEs collaborate with others (2021; normalised value)	0.502	0.633	79%
Percentage of tertiary educated people within the 25-64 years old population (2021)	35.3	46.0	76.7%

Source: Own edition based on different data sources

First, this summary of the regional analysis will cast light on the **general regional context**. Hence, in what follows, the scene is set and information on the wider, NUTS-2 level, regional conditions provided (e.g., development in key socio-economic indicators, recent innovation performance (Table 22) or key development fields identified in relevant documents (Figure

40)). It should be noted here that the specific case of Slovenia, namely that there are only two NUTS-2 level regions, required an alternative approach to this analytical step. Accordingly, instead of using the stellar graph that is found in all other regional analyses, we investigated the relative performance in each indicator between Vzhodna Slovenija (NUTS-2 region in which Podravje is located) to the, in general, better performing Zahodna Slovenija region (= 100 in each indicator), in which Ljubljana is situated (Table 22).

### The most important findings of the socio-economic and innovation analysis of the region

- In terms of the investigated statistical indicators, the values of the Vzhodna Slovenija NUTS-2 region usually lag behind the other Slovenian NUTS-2 region (Zahodna Slovenija).
- Comparing the values of the two regions, the values of Vzhodna Slovenija in terms of society-related indicators varies between 80 and 90% of the values of Zahodna Slovenija.
- A relatively big gap can be observed in the field of the economic performance (GDP per capita), the number of new firms and the GDP-related R&D expenditures (although the values of business-based R&D expenditures are relatively closer to each other). In these domains the values of the Vzhodna Slovenija region do not reach even the 70% of the values of the peer region.
- Despite these relatively big gaps in the economic performance, the average disposable income per capita in Vzhodna Slovenija lags only slightly behind the value of Zahodna Slovenija (96.1%)
- There are only two indicators in which The Vzhodna Slovenija region has higher values, these are the unemployment rate and the non-R&D innovation expenditures of SMEs. Of course, higher values do not necessarily mean more advantageous positions as we can see here with the example of unemployment rate.

As can be seen in Table 2, the Vzhodna Slovenija NUTS-2 region is categorised as a "Moderate innovator -". The area has a 79.8% relative innovation performance of the EU average in 2021. Hence, the Vzhodna Slovenija significantly underperforms the other Slovenian NUTS-2 region (Zahodna Slovenija) whose relative innovation performance (98.1) is only a slightly below the EU average. Considering the time series of the relative innovation performance, it suggests that the relative innovation performances of both Slovenian regions declined in the last years. While in 2014 the relative innovation performance of the Vzhodna Slovenija region to EU average was 87.1%, this value has become 79.8% by 2021. Still, this region is positioned among the best performing Central and Eastern European regions in terms of relative innovation performance. Regarding the development trap indicator, the Vzhodna Slovenija NUTS-2 region has been categorised as a region not in development trap or at risk (Diemer et al., 2022). This result implies that the region has similar growth trends as the national level in terms of productivity, employment and development level in the NUTS-2 level. However, the results of Diemer et al. (2022) suggest that the other Slovenian region (Zahodna Slovenija) has a relatively high-risk of slipping into a development trap at a high-income level.

**Table 23: Podravje's innovation performance and development trap risk**

<b>Regional Innovation Scoreboard (2021)</b>	<b>Moderate innovator -</b>
<b>Development Trap category</b>	<b>Not in development trap or at risk</b>

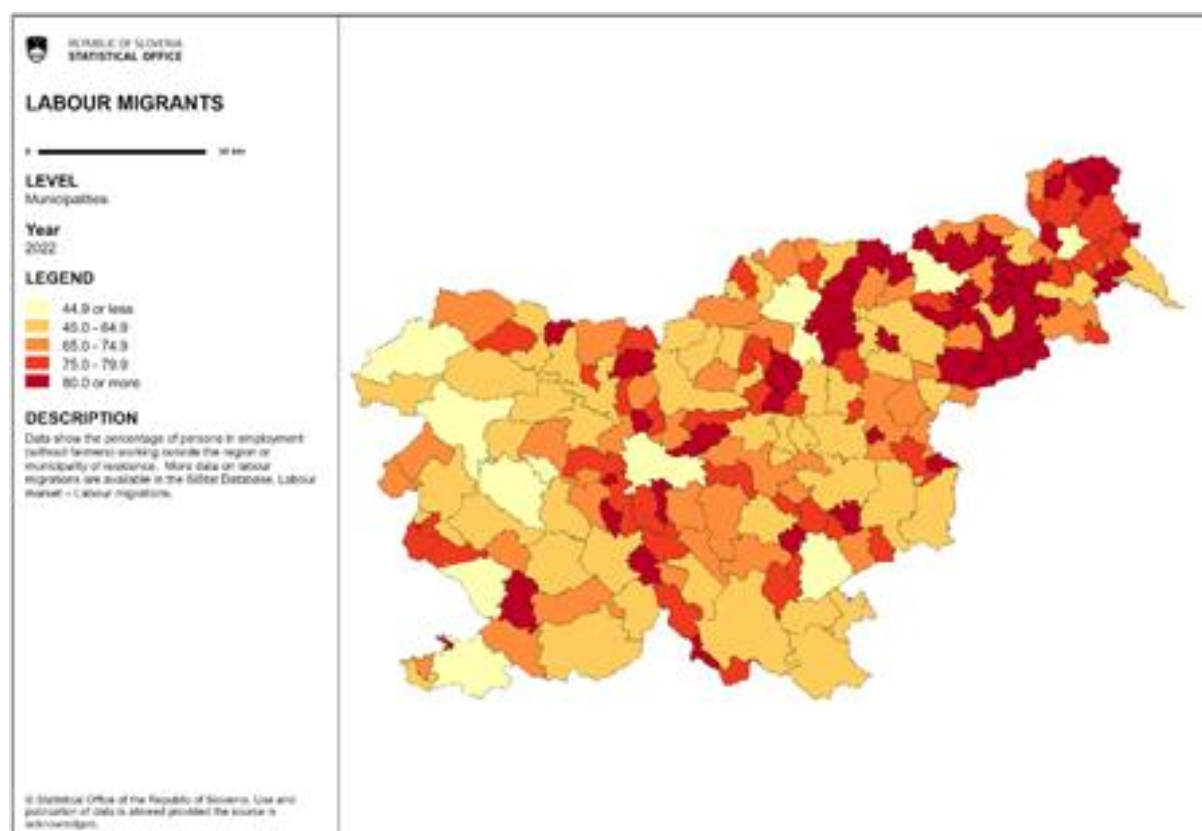
Source: Own edition based on data from Regional Innovation Scoreboard and Diemer et al. (2022)



**Figure 40: Key transformative fields defined in: Regional development programme of the development region Maribor–Podravje 2021-2027 (2021), source: own elaboration**

These central transformative fields (see Figure 40), defined in one of the region's most important development strategies, offer some first insights into potential key economic development avenues. The goals to transform (into) these fields are assumed to be widely shared by regional stakeholders, hence we consider them highly relevant for the analysis and the workshops alike. As such, some of them will be taken up again, some complemented and some might be critically commented upon from a sustainability perspective in our investigation of the major challenges of the Podravje region, assets and transformative opportunities over the following pages.

Adhering to a challenge-oriented innovation approach, the next paragraphs identify some of the **most pressing challenges the region is currently facing**. Addressing these challenges and, in particular, contributing to solving them is a key motive of the project.



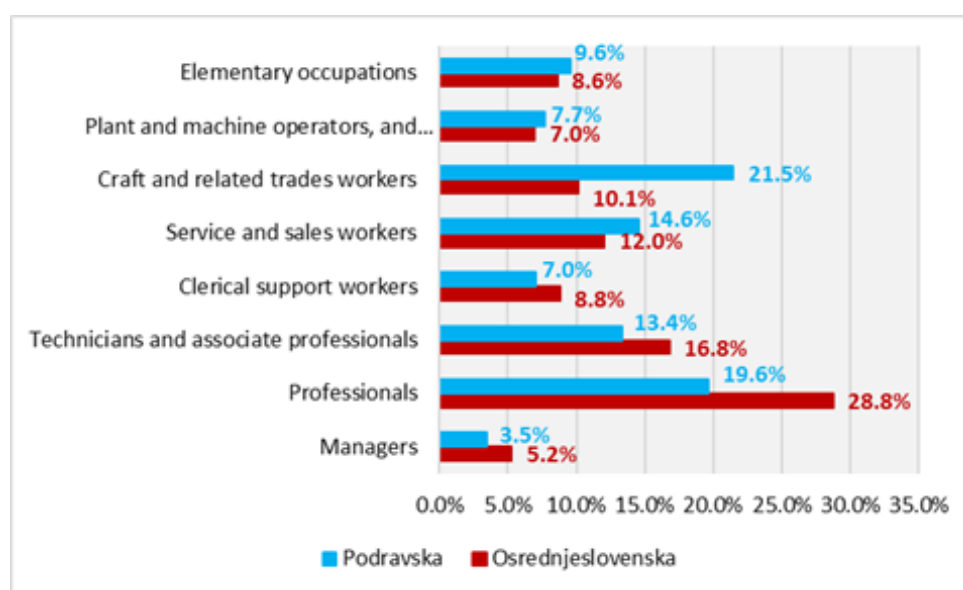
**Figure 41: Labour migration in the Slovenian municipalities in 2022, source: Statistical Office of the Republic of Slovenia**

First of all, as the region is located in neighbourhood to booming centres such as Graz, Zagreb and the Slovenian capital city Ljubljana, the investigation showed, that the regional development in the Podravje region cannot be fully comprehended without considering the **region's location which leads to various implication**. Outmigration and brain drain as well

as the ageing society are considered the most pressing challenges of the region. While these can be regarded as social challenges, they have tremendous effects on economic activity as the following paragraphs will show.

Figure 41 reveals that the country's northeastern part is particularly affected by labour migration, highlighting that people working outside their residence municipality exceeds 80% in many cases there.

Comparing the Podravje region to the capital region Osrednjeslovenska, Figure 42 shows pronounced differences in the occupational structure. Rather than high-tech departments, the region predominantly accommodates branch plants and lower-tier suppliers, which create dependence on foreign companies. This situation is deemed unfavourable in numerous documents as it is obstructing the upgrading to activities with higher added value. The contrasting levels of high-value and knowledge-intensive economic activity contribute to an outflow from the Podravje region to the more economically developed centres around as the interviewed experts and reviewed documents confirmed.



**Figure 42: Comparison of occupational structure of Podravka & Osrednjeslovenska, source: Statistical Office of the Republic of Slovenia**

Additionally, there is a lack of large companies that could drive the establishment of networks, clusters, and ultimately regional development. An expert summarized the situation:

*"[...] the lack of critical mass, because a lot of good, talented young people, they just leave. So, this is something that we have seen. For example, our university is very technically oriented. And I would say that it's very positive. So we do train our students very well. But what happens when they enter the labour market, they see the companies that are here. And they just look for better opportunities."*

Thus, when the young and educated individuals leave the region and seek employment opportunities in neighbouring centres, the issue of lacking critical mass is exacerbated and subsequently the conditions of low added value activities further reinforced.

Furthermore, a notable challenge is the **absence of systemic cooperation**, which can be (partly) attributed to the country's lack of federal states. Without an intermediary level of governance, regional cooperation becomes difficult. According to an expert, this condition is highly unfavourable as most mayors tend to prioritize their own electorate district, often neglecting regional development opportunities that extend beyond their municipal borders. As a result, administrative fragmentation poses challenges in implementing regional strategies. The spatial planning of the region has only recently been integrated into the planning system of Slovenia and is yet to showcase its effectiveness and impact.

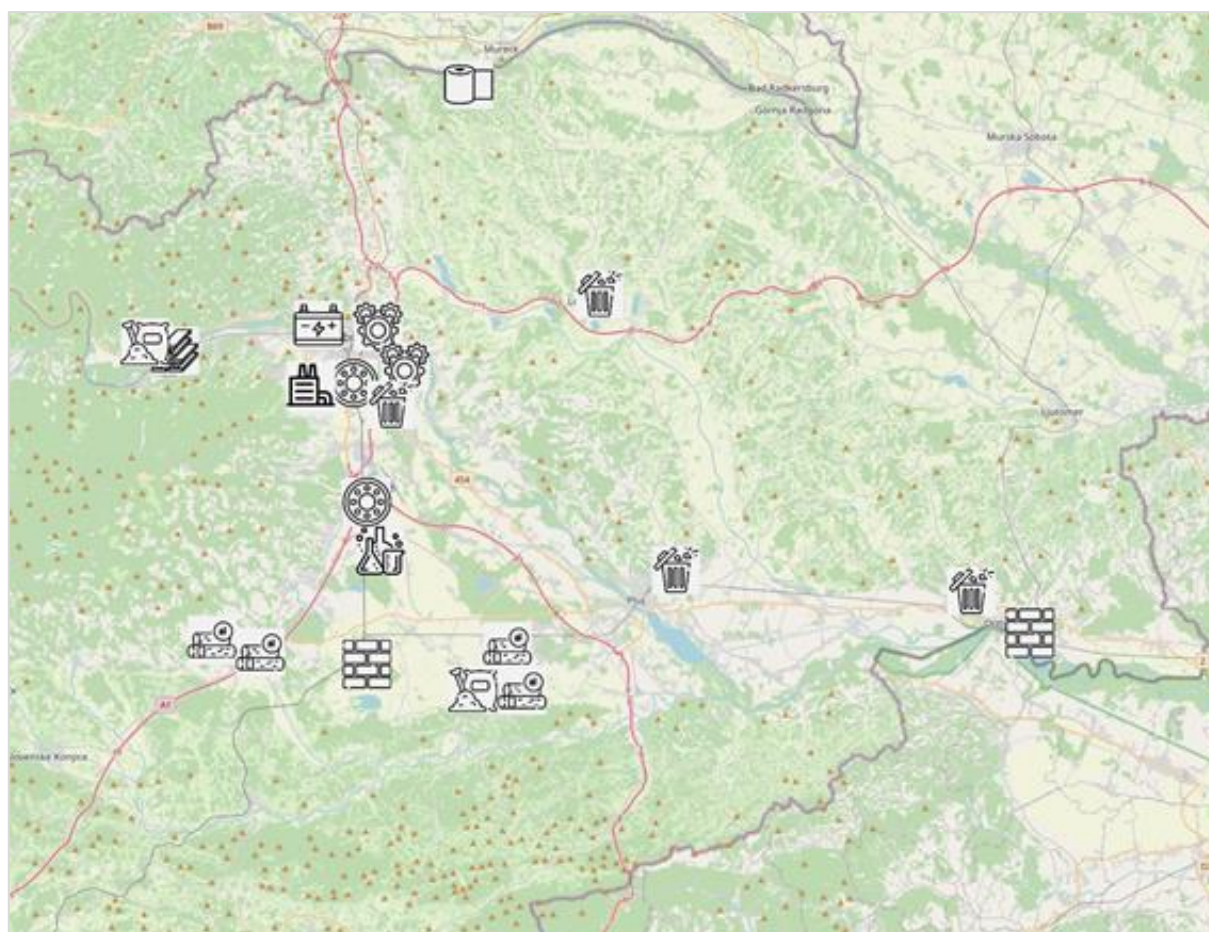


The issue of regional fragmentation can also be related to the **traffic situation**: While there are large transport axes crossing the Podravje region and connecting the neighbouring countries, the regional public transport network is sparse. There are two important international transport corridors running across the Podravje region from the north (Austria) and east (Hungary) which connect to each other close to Maribor and run further to the southwestern direction (Ljubljana and Italy). While this is an advantageous situation for the Podravje region in terms of commerce and international connectivity it also creates burden due to increasing traffic amounts and very high greenhouse gas emissions.

**Table 24: The share of transport modes by passenger kilometres per year in 2017 and 2021 in Podravje region**

Podravje region	2017	2021
Mode of transport - TOTAL	100.00%	100.00%
Passenger car - total	85.25%	85.06%
Bus - total	5.16%	3.57%
Cycling	1.24%	1.11%
Walking, running	3.07%	2.19%
Other (taxi, van, train, motorcycle)	5.28%	8.06%

Source: The Statistical Office of the Republic of Slovenia



**Figure 43: Location of energy-intensive industrial activities in the Podravje region (selection), source: Activities: Energy and Industry Geography Lab by JRC**

Note: Marked industrial activities: iron and steel production; production of brick and clay; chemical products; manufacturing of paper; aluminium production; machinery; production of vehicle components; production of batteries; treatment of waste

Apart from the road network, the public transport connections to Ljubljana and within the region are standing back. Comparing the share of passenger kilometres travelled by certain modes of transportation, the car has absolute dominance with an about 85% share of all passenger kilometres in the Podravje region (see Table 24). Improving public transport networks on the regional level would be a considerable issue, hence, connecting better the municipalities of the Podravje region and lowering traffic-related emissions.

Yet, another major source of GHG emissions in the region is the **energy-intensive industrial activity**. These include iron and steel production, production of brick and clay, chemical products, manufacturing of paper, aluminium production, machinery, production of vehicle components, production of batteries and treatment of waste (see Figure 43).

While hydropower facilities along the Drava River are in place, the fossil energy source still have a considerable share in the energy supply of the Podravje region. The increasing oil and gas prices can be challenging both for supplying the households and maintaining the relatively energy-intensive industrial activities. But the region also offers rather high renewable energy potentials, especially in hydropower, solar power and geothermal heating as Table 25 shows.

**Table 25: The ranking of the Podravje region in terms of potential in selected renewable energy sources**

Indicator	Ranking of Podravska region	Regional value	National average
The technical potential of electricity generation per land area by small hydropower (<10MW) (GWh/km <sup>2</sup> , 2018)	2 <sup>nd</sup> / 12 Slovenian regions	0.088	0.057
Potential for electricity generation by land area of solar photovoltaics (MWh/km <sup>2</sup> , 2018)	1 <sup>st</sup> / 12 Slovenian regions	194.55	107.04
Primary energy potential per land area of biodegradable wastes and biogas – projection for the year 2030 (GWh/km <sup>2</sup> , 2018)	11 <sup>th</sup> / 12 Slovenian regions	0.58	0.87
Primary energy potential per land area of biofuels from agricultural products – projection for the year 2030 (GWh/km <sup>2</sup> , 2018)	3 <sup>rd</sup> / 12 Slovenian regions	0.12	0.09
Primary energy potential per land area of forestry products and forestry residues – projection for the year 2030 (GWh/km <sup>2</sup> , 2018)	2 <sup>nd</sup> / 12 Slovenian regions	0.49	0.18
Primary energy potential per land area of geothermal heating – projection for the year 2030 (ktoe/km <sup>2</sup> , 2018)	1 <sup>st</sup> / 12 Slovenian regions	0.06	0.01

Source: The dataset of the ESPON "Locate" project

However, despite the potential and will to increase the use and generation of renewable sources of energy, there are various obstacles in terms of regulations and missing infrastructure that need to be tackled:

*"I think [...] the infrastructure for electricity is not prepared for that kind of change of demand and change to put the electricity in. So, for example, if we are talking about small solar plants on the houses, you know, you have to get a legal permission of electric company. And if electric company says to you that the*

*infrastructure is not prepared [...], you can't get a legal permission. So [...] if you want to have a solar plant on the house, you have to have also batteries. [...]"*

Finally, over the last years, the **manifestations of climate change** have become more and more noticeable in the Podravje region by an increasing annual temperature average and decreasing amounts of precipitation (see Table 26).

**Table 26: Key meteorological data from of Maribor Airport station (2010-2022)**

Year	Average air temperature at 2 m (°C)	Average maximum temperature at 2 m (°C)	Average minimum temperature at 2 m (°C)	Rainfall (mm)	Duration of solar irradiation (h)	Number of days with precipitation above 0.1 mm
2010	10.1	14.8	5.6	986.2	1773.3	146
2011	10.8	16.4	5.6	729.9	2201.7	109
2012	11.2	16.9	5.8	928.7	2267.7	128
2013	10.9	15.7	6.1	923.7	1910	148
2014	11.9	16.7	7.3	1238.4	1787.9	171
2015	11.4	16.9	6.1	846.4	2089.1	110
2016	11.2	16.7	6.2	1006.2	2073.9	136
2017	11.0	16.9	5.4	961.1	2277.3	131
2018	11.6	17.0	6.9	927.6	2018	139
2019	11.9	17.4	6.7	1023.6	2115.5	130
2020	11.2	17.1	5.9	916	2177.7	125
2021	10.6	16.3	5.5	820	2300.6	134
2022	11.6	17.5	6.3	742.4	2316.4	123

Source: Environment Agency of the Republic of Slovenia

According to the results of the European Climate Risk Typology, the region has a below-average amount in precipitation which reflects to a foreseeable risk for drought hazard in the region (Carter et al. 2018). As the Podravje region has a relatively strong performance in the agricultural production, it might be particularly vulnerable to the manifestations of climate change. Therefore, prioritizing the preparation of local agricultural production to cope with the growing risk of drought should be a top priority.

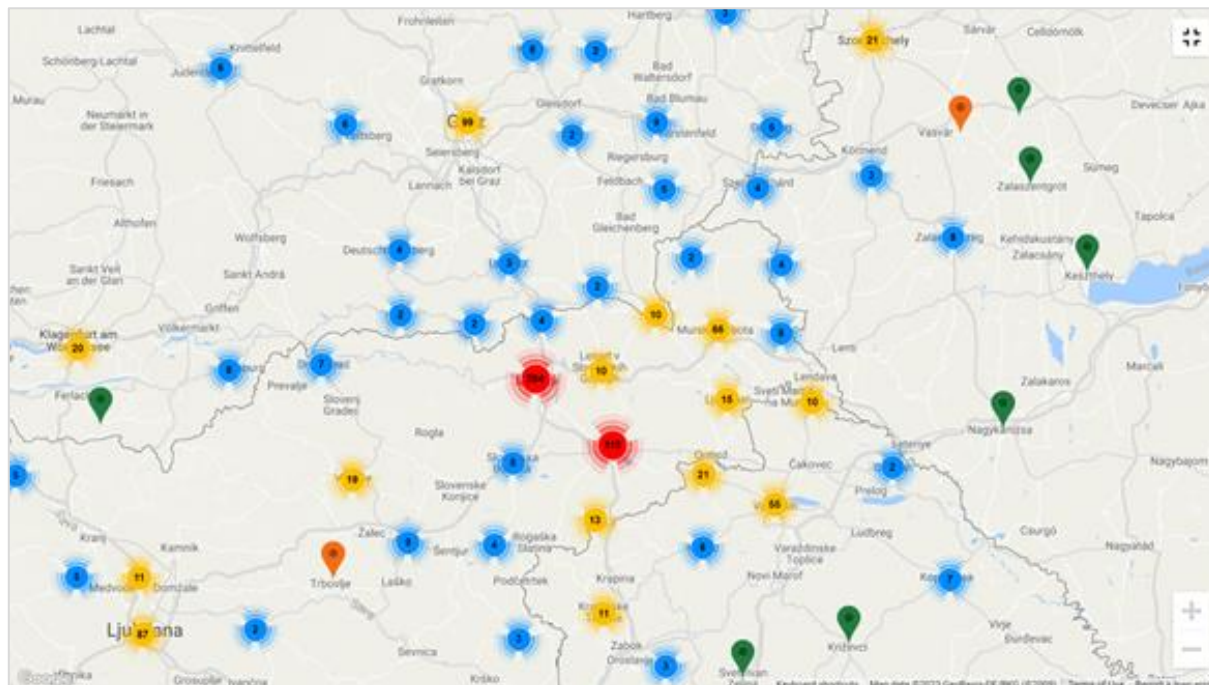
Not only challenges are connected to opportunities, but also **various assets**. These can be used, exploited and/or mobilized for transformative activities in the region. Accordingly, in what follows, the analysis turns to the regional asset base and identifies key regional strengths that offer entry points and a platform for the RIS4Danu project.

Coming back to the region's particular location, we now adopt a different perspective and shed light on the bright side: the **high accessibility and strong** connectedness to neighbouring economies has proven to be an important means of development for the Podravje region. As such, it is hardly surprising that the S3 of Slovenia also has taken a pronounced outward looking approach, highlighting that (p. 30):

*"Considering Slovenia's small size establishing links with the neighbouring regions and complementary development of capacities are of great importance for Slovenia. The existing cross-border cooperation programmes have already promoted cooperation in the field of research, development and innovation which means that foundations already exist."*



Statistical data based on participation in INTERREG projects shows that cross-border cooperation with Austria, in particular with Styria, seems to be very significant, but there are also many links to Hungarian, Croatian und Italian partners. To illustrate the intraregional cooperations, Figure 44 shows the location and number of partners of all cross-border programmes from the Podravje region.



**Figure 44: The partners of all cross-border programmes located in Podravska region, source: keep.eu**

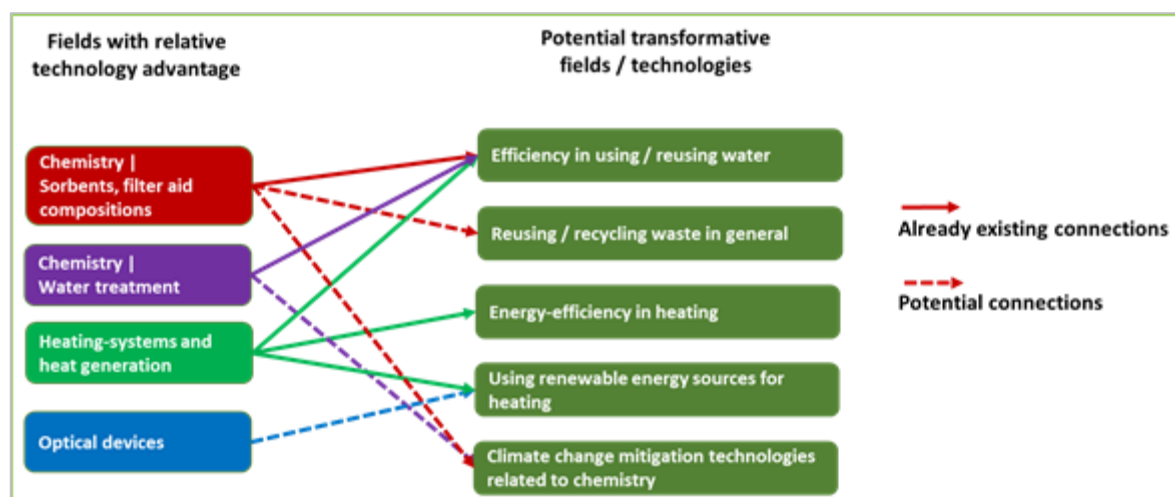
*Note: locations with the highest number of participants: Maribor – 284, Ptuj – 115, Graz (A) – 99, Ljubljana – 87, Murska Sobota – 66, Varazdin (HR) – 55.*

While the proximity of the border has its previously described negative impacts, the experts acknowledged several positive aspects of the region's location and interregional cooperation. These include the establishment and maintenance of strong relations with neighbouring regions and countries, the importance of openness for a small and young economy like Slovenia, the inflow of new ideas and the valuable learning opportunities.

Furthermore, these aspects of cross-border cooperation are very likely to be of relevance in regard of the **region's research and development impulses**. The R&D activities of the Podravje region are concentrated in Maribor which is also home to the second-biggest university of Slovenia with about 14 000 students enrolled. Besides the University of Maribor, there are other significant research institutes in Maribor, Institute of Agriculture and Forestry Maribor, Institute of Environmental Protection and Sensors and National Laboratory of Health, Environment and Food. The listed research organizations have been active participants in H2020 projects from the Podravje region. Reviewing the ongoing research projects of the university and the local research institutes from a sustainable transformation aspect, projects related to the water management and water treatment, waste management, circular economy, renewable materials, renewable energy sources and climate change-related development of the agricultural production provide potential knowledge and experience for developing new transformative paths. Summarizing the technologies used in the patents registered in the region, we found that the region has a relative technological advantage in the following fields: preparing sorbents and filter aid compositions, water treatment, heating-systems and heat generation and optical devices.

Besides the technological fields which have relative technological advantage in the area, we also checked which climate change-related technologies or applications might be combined

with those technologies in which the Podravje region has competitive advantages. We also reviewed the combinations that already exist in the region and extended the search with those climate change-related technologies or applications that might be related to the technology fields which have a relative advantage in the area. It should be emphasised the application of renewable energies in heating systems and heat recovery can be already found among the applied technologies in the region. According to our analysis, building on the relative technological advantage, using filtering solutions in the general recycling of waste or using optical devices in renewable energy production might provide further potential ways for transformative activities (see Figure 45).



**Figure 45: The existing and potential future combinations between fields with relative technology advantage and transformative fields in Podravje region, source: Own edition based on the data of OECD Regpat Database**

Matching the previously defined potential transformative fields, this leads to **two transformative directions that already have a foothold in the region**: first, the Podravje region can be seen as a frontrunner regarding the transition to a **circular economy**. It hosts the 'Strategic Research and Innovation Partnership' (SRIP) on circular economy which is of national relevance. Furthermore, the Wcycle Institute in Maribor published the 'Strategy for the Transition to Circular Economy in the Municipality of Maribor' in 2018. The documents underline the ambition to initiate cross-sectoral cooperation in handling, processing, re-using and developing resources, to create green jobs and new value added. According to an expert, there is quite some activities in this regard:

*"I think we are pretty good because our region is also now one of the pilot regions for circular economy. So, we have also in the past the Institute for Circular Economy that is now part of our regional world and you see. We have a lot of projects that are helping our companies to be more green and more circular. And I think in terms of Slovenia, we are one of the best regions."*

While the general ambitions towards a higher level of circularity are cross-sectoral, **sustainable construction** is a more sector-specific direction. With the growing importance of renewable resources and energy, it comprises the development of low energy building systems as well as the construction based on wood which is one key strategic raw and industrial material in Slovenia. Sustainable construction has already gained momentum and is seen as a major opportunity for the region. Especially, as it touches upon various objectives: job creation in a future-proof field, improvement of resource and energy consumption, more independence from fragile global value chains. Therefore, it is supported by the regional authorities that initiated demonstrative projects by planning public buildings in the sustainable construction method.



Considering that the two vacant sites are situated in the urban environment of Maribor, **alternative economic activities** could also offer a potential development direction. Particularly increasing the tourist attractiveness and harnessing the cultural value of the industrial heritage are considered viable options. One interviewee described its vision followingly:

*“A district that is alternative because there is much also listed as heritage site because there is this textile factory, and Hutter (note: founder of the textile factory) that was a big industrialist with us and that you have to somehow preserve and make this combination of culture, life, smart city opportunities and a combination between young and old. So, it's a built-up field where you can integrate all that now. And that's maybe the biggest opportunity. Very exciting to mix all of that and have the perception of a qualitative district.”*

Revitalizing the Drava River, implementing a cultural hub and supporting the creative sector can contribute to the revitalization of industrial spaces while improving soft location factors. To sum up, although Maribor already has initiatives in place to enhance tourism and liveability, there is untapped potential for developing alternative economic activities that not only bring economic benefits but also address social needs in the Podravje region.

Finally, another major asset of the Podravje region is the **fertile ground for transformative activity**. The relevant documents considered in the document analysis proved a high degree of challenge awareness and orientation. The experts largely confirmed that there is broad awareness of that sustainability transitions are of key importance, a fact that is widely reflected both in the regional and national strategies. At the same time, however, they highlighted that implementing these strategies is still a difficulty. In regard to sustainability, one expert stated:

*“[...] this is an issue which everybody sees is there, but nobody knows exactly how to make next steps. We are very good in preparing the strategies and the strategical documents, but implementation...”*

Accordingly, it is important to recognize that actions speak louder than words and regional experts have expressed valid concerns about the actual realization of these goals. However, we interpret these documents as indicating a fertile ground for transformative activities.

**Table 27: Summary of assets and challenges identified for the Podravje region**

Assets	Challenges
Double-edged sword of inter-regional (cross-border) relations: the bright side	Double-edged sword of inter-regional (cross-border) relations: the dark side
A fertile ground for transformative activity	Traffic & transport
R&D impulses	Lack of critical mass and fragmentation
The right momentum to reform traditional economic activity in two transformative directions	Energy-intensive industrial structure and its challenges
Conditions to (further) develop alternative activity	Manifestations of climate change: vulnerability to droughts

Source: own elaboration

Now, after having discussed most promising assets and most pressing challenges of the Podravje region based on the in-depth analysis (Table 27), the final paragraphs of this section will briefly discuss these findings in relation to possible transformative development paths for the region that can be derived.

Despite its advantages in terms of accessibility, educational opportunities, and natural beauty, the Podravje region is experiencing a severe impact from brain drain and a lock-in situation in low added value activities. While addressing emigration and brain drain is a complex and long-

term process, there are potentials that can be awakened in order to counteract these processes.

Given the region's relative technological advantage in heating systems and heat generation, Maribor can further extend its expertise in sustainable construction and renewable energy. As already described, this could involve promoting low-energy building systems, utilizing renewable energy sources in heating and electricity generation, and incorporating energy-efficient practices in the construction sector. It seems to be worth further consolidating this transformative path as the regional authorities already have proven to support this activity. What is more, the provision of high-quality housing options can also aid to improve the liveability of Maribor and help keep the young and talented people in the region.

Furthermore, it appears fruitful to bring together the research on water management and water treatment with the agricultural sector. Given the potential water scarcity in the context of high drought risk also the exploration of systems to enhance the reuse of water promises valuable insights. This can also be seen as an extension/ continuation of the region's forerunner position regarding circular economy.

On top and finally, social innovation in order to tackle the severe fragmentation and lack of trust within the society seems to be instrumental, as this challenges – which, from a certain perspective, could be considered important RIS deficiencies – stand in the way of all sorts of transformative activity.

#### **4.7 Key findings from a preliminary cross-regional comparison**

After this overview of the six regional analyses conducted so far, this penultimate section will now offer some preliminary findings from a cross-regional comparison between the cases outlined above. It should be noted, though, that a more thorough cross-regional analysis will be provided at a later stage of the project in the final report (M22).

When focusing on the identified assets, challenges and the opportunities to be derived from them, there are seven important points worth mentioning from a cross-regional and comparative perspective.

##### *Industrial structure: source of challenge and opportunity alike*

First, all methods applied and many different data points underline the importance of the industrial heritage and culture in many of the RIS4Danu regions investigated so far (see, for instance, Figures 7, 27, 36 or 43). While connected to much of the regions' previous or current economic prosperity, the historically-developed industrial structures have come under severe pressures. In some regions, like Podravje, Usti or Banska Bystrica, these pressures – mostly market dynamics – have cumulated over time, sometimes decades (e.g., since the fall of the Iron Curtain) and led to many closures over the years. In other places, like Lower Austria or Schwarzwald-Baar-Heuberg, more recent developments in relation to sustainability transitions are particularly decisive. Nowadays, all RIS4Danu regions analysed so far face substantial transformative challenges in relation to their industrial structures. The imperative to move towards greener industrial processes to combat climate change, but also the energy hikes in the aftermath of the Russian attack on Ukraine have left no RIS4Danu region untouched. Dependencies on Russian fossil energy complicate the situation immensely in many places. Hence, it is imperative for all regions investigated so far to find ways towards green structural change.

In this respect, the industrial heritage is also connected to various opportunities. To begin with and somewhat counterintuitively, the high energy-intensity associated with the industrial structures found in many regions has fuelled interest in new (or old) forms of renewable energy production (see, for instance, quote on re-activating small hydropower in the industrial valleys of Lower Austria on page 23). However, the geography of renewable energies is highly unequal

and every region faces its own specific challenges and/or holds its own specific potentials in regards to renewables, many of which have been discussed in the course of the analyses conducted (e.g., limited potential in Schwarzwald-Baar-Heuberg or expensive exploitation of geothermal energy in Banská Bystrica). What is more, the strong industrial footprint of many RIS4Danu regions has sparked interest in circularity principles, not least due to the many byproducts like waste or exhaust heat. Indeed, the analyses have shown that several regions (e.g. Lower Austria, Podravje, Banská Bystrica) offer interesting assets for the implementation of a circular economy based on regional industrial structures, R&D impulses and already ongoing initiatives. Various workshops have taken up on these findings (e.g., in Lower Austria or Banská Bystrica). Finally, many interviewed experts pointed to the opportunity to revitalize industrial activities in sustainable ways based on geopolitical changes. In fact, the COVID crisis has demonstrated the fragility of global production networks and value chains. Hence, re-shoring tendencies could indeed spark re-industrialization processes, offering interesting transformative avenues for many RIS4Danu sites (see quote on new opportunities arising in Lower Austria based on a combination of re-shoring and renewable energy on page 22). Here, the workshop in the former hemp mill in Hajdú-Bihar provides us with a good example. Based on an EDP process, the stakeholders there developed the transformative goal of bringing back hemp production in a more efficient and sustainable way.

#### *Regional climate change manifestations: the need to adapt to changing circumstances*

Second, regional climate change manifestations play an increasingly important role. This has been demonstrated by various regional analyses. In this regard, work done based on the European Climate Risk Typology (Carter et al., 2018) has been particularly imperative to pinpoint (future) regional challenges. While every region is increasingly confronted with implication of a warming planet, the challenge - rather unsurprisingly - is most severe for regions most affected, while simultaneously highly vulnerable. We found this to be the case particularly in Podravje and Hajdú-Bihar, but also Lower Austria (see Figures 9, 23 and Table 26). In these regions, a strong agricultural profile meets strong manifestation of climate change (e.g., in relation to water balance). Hence, these places are called upon to initiate and accelerate transformative change in this domain. R&D, e.g., in relation to more efficient irrigation, room for experiments, but also social forms of innovation in agriculture can be considered key. Again, links to circularity as well as to renewable energy production are further interesting future routes for agriculture in such places. Here, RIS4Danu can play an important role.

#### *R&D impulses: new development opportunities based on technological innovation*

Third, on a more general note, R&D impulses are unsurprisingly crucial in all case studies conducted so far. We found interesting transformative roads in all regions based on ongoing regional research at universities and other organisations (see Figures 11, 18, 24, 30, 38 and 45). In particular, the various patent analyses we conducted show interesting potential links to “technologies or applications for mitigation or adaptation against climate change” (based on the OECD Regpat database). Hence, transformative change in every RIS4Danu project region might strongly profit from R&D activity nearby. However, the investigation has also shown that some regions are provided with many more opportunities than others. In other words: the breadth of the ‘transformative corridor’ based on research capabilities varies substantially between regions. Clearly, this divide is strongly linked to the size and quality of the regional research infrastructure as well as the innovation capacities of local private organizations. Moreover, in many regions we found barriers and deficiencies in the regional innovation system that might hinder the realization of this potential (see, for instance, first quote on page 64 and down below). Despite the vast differences in possibilities and obstacles, the analyses of R&D capacities have been instrumental in pinpointing regional transformative potential in all RIS4Danu regions.

### *The complex topic of traffic: Too much? Too little? Too unsustainable!*

Fourth, traffic is an issue in all cases, but the challenges and assets associated with it come in many shapes. Some regions suffer from the burden of too much traffic in the form of transit (Podravje), commuters (Schwarzwald-Baar-Heuberg), or simply unsustainable mobility systems (e.g., Lower Austria). Other regions lack sufficient transport routes and accessibility for economic development (Banska Bystrica). On the other hand, Usti and Podravje both show that good connectedness and accessibility can be a double-edged sword, which might lead to an outflow of assets to more dynamic centres like Prague or Graz (see on pages 58 or 75). Generally, transformative activities in relation to more sustainable forms of mobility and transport are in high demand in many RIS4Danu regions. Here, social innovations, e.g., a reactivation of active mobility, are key as well.

### *Interconnected: the important role of external influences*

Fifth, external influences are key to understand regional sustainability transitions. Indeed, regions are complex, open systems; their evolution strongly influenced by their embeddedness in multi-governance policy structures, global production networks, international knowledge networks and so on. This is clearly proven by the RIS4Danu regions. Accordingly, the supra-national, European level is generally indispensable in all cases to understand change processes towards sustainability (see also more general considerations at the end of this section). Also, several regions place high hopes in their international networks. For instance, the Usti region seeks to intensify links to neighbouring Saxony in order to set transition processes in motion. Podravje is another interesting example, as it is well connected to Austria (Graz), Croatia (Zagreb) and Ljubljana. While not always strictly positive (see outflow of assets mentioned above), these links are essential to understand regional evolution there. Indeed, there are dark sides attached to external influences. Here, Hajdú-Bihar and Banska Bystrica are interesting examples. Interviewed experts in both cases have revealed that regional development is impaired by the centralism in policy design originating from Budapest and Bratislava, respectively.

### *Social challenges: taking inclusiveness and just transitions seriously*

Sixth, all RIS4Danu regions face different manifestations of severe social challenges in need of responses. As many of the places we investigated so far are rural and close to centres like Vienna, Stuttgart or Prague, it is hardly surprising that regions suffer from outmigration, especially of young and creative individuals. It goes without saying that this contributes decisively to worsening the ongoing demographic change (see, for instance, Figure 8) and an inhibiting lack of specialists (Figure 16). Furthermore, some places face important tasks in relation to the integration of minorities (Ústi, Banska Bystrica). Moreover, many regions are confronted with severe regional inequalities and disparities, sometimes within (Banska Bystrica), but more often in relation to other region within their national frame. All these social challenges bear an enormous risk of creating 'left-behind' places (MacKinnon et al., 2022), coming with worrying consequences, not least at the ballot box (Rodriguez-Pose, 2018). Indeed, in several places, a rise of populism can be observed (especially in Usti and Banksá Bystrica). On top, the imperative to move towards more sustainable ways of doing things can create even more social tensions. The main takeaway here is that 'just transitions' cannot remain an empty phrase. As such, transformative activities at the RIS4Danu sites should strive for high levels of inclusiveness and consider the specific social challenges in the different region when developing business plans.

### *The 'soft spot' of transformative activity: awareness, trust, and the need for social innovation*

Seventh and finally, apart from these "hard" issues and potentials, we found all regions to face challenges or to provide assets in what could be labelled "softer" domains. For instance, we

found that some regions seem to provide high levels of awareness about challenges and demonstrate interesting levels of challenge-orientation in their development strategies (Usti & Podravje). In contrast, other regions seem to lag behind in this regard (Schwarzwald-Baar-Heuberg). Further, regional networks are configured in very different ways. While some are well-functioning, very coherent and rather closed (Lower Austria, Schwarzwald-Baar-Heuberg), others are characterized by high degrees of fragmentation and/or a lack of trust (Banska Bystrica, Podravje). Such RIS deficiencies should be considered an important factor for change processes. Social innovation initiatives, e.g., to establish new relations or networks, can therefore be of utmost importance. Moreover, we found living conditions to vary substantially between the RIS4Danu regions (see, for instance, Figures 19 or 34). These issues and assets are tightly connected to goals oriented towards more social sustainability. In addition, it is important to acknowledge that they can become important determinants of the success or failure of transformative activity. At the same time, they themselves can be aimed at through challenge-oriented initiatives at RIS4Danu sites (e.g., through awareness-raising activities).

In addition to the identified regional assets, challenges and associated opportunities, there are other, more general and overarching insights on regional sustainability transitions we have gained so far through this project. While they are rather horizontal in nature and somewhat unrelated to specific transformative avenues at single RIS4Danu sites, we still acknowledge them as being worth noting at this point.

Generally, catching-up economically remains the key development motive of many regions, especially in lagging countries. This is the case regardless of the presence of more challenge-oriented initiatives. *“Everything is under the priority of economy”* a regional expert from Hajdú-Bihar explained in this respect. As such, transformative activities are often not considered an opportunity, but seen as contradictory to the way to (more) economic prosperity. Against this background, a shift of attention and awareness-raising activities seem highly relevant.

It is also important to note in this regard that the EU (especially through its various funds) takes a fundamental role in compensating a lack of directionality in policies at the national or regional level. Indeed, several experts highlighted this door-opening function of supra-national policy instruments, without which transformative action would be far less feasible.

Yet, also the more prospering regions face significant legitimacy barriers. The rather coherent and often closed systems that we found can be a paralyzing source of inertia. Hence, the problems originate from the idea that “too much sustainability” might put competitive advantages developed in the past in danger.

Against the backdrop of these diverse barriers, the RIS4Danu project can be considered important in every “type” of region, yet for somewhat different reasons.

## 5 Conclusions & perspectives

The RIS4Danu project has only recently crossed the half-way mark. Holding on to its fundamental goal, namely to turn disused industrial sites in several regions in the Danube macro area into transformative hubs for green structural change in a place-sensitive way, the project has made significant progress in the first year.

The project, both its past and future has been and will be guided by important conceptual underpinnings developed by the team of the University of Vienna (WP3). These conceptual underpinnings rest on a combination of academic literature streams on green regional structural change (Tripl et al., 2020) and Smart Specialization (Foray et al., 2009). The RIS4Danu concept – summarized in this report (section 3.1) – seeks to move towards a new challenge-led approach of Smart Specialization for Sustainability (S4). Fundamentally, this new approach follows four core principles, namely to (i) apply a place-sensitive and evidence-



based logic, (ii) adhere to a challenge-orientation approach, (iii) set a clear directionality, prioritizing transformational activities and (iv) embrace inclusiveness (Trippel et al., 2022).

Informed by these conceptual considerations, the RIS4Danu project develops a profound knowledge base of regional structural conditions in the form of regional analyses. Conducted by the team of the university of Vienna, these analyses help to advance steps towards sustainability at the regional industrial sites. Relying on a mixed methods approach, this work combines qualitative and quantitative approaches to data generation and analyses and offers a broad variety of different data points (see section 3.2 & 3.3). Thereby, insights into four key domains have been gathered that constitute the basis for the workshops at the industrial sites and highlight transformative avenues for their revitalization:

- General regional conditions
- Assets and potentials
- Challenges and problems
- Transformative opportunities one can derive from them

Following this procedure, six regional analyses have been conducted so far. This interim regional report has offered the opportunity to present and discuss these six cases and draw some first conclusions with relevance for other work packages in the project.

Accordingly, this report has first synthesized key findings in each of the four key domains from analyses on the following RIS4Danu regions analysed so far (ordered chronologically based on the first workshop date at the regional sites). The results can be found in sections 4.1 to 4.6 above.

- i. Lower Austria (Austria)
- ii. Schwarzwald-Baar-Heuberg (Germany)
- iii. Hajdú-Bihar (Hungary)
- iv. Ústí nad Labem (Czech Republic)
- v. Banská Bystrica (Slovakia) and
- vi. Podravje-Maribor (Slovenia).

Furthermore, this deliverable is a good occasion to provide preliminary overarching, cross-regional insights. Hence, the report has provided initial comparative perspectives on the six case studies in a second step, offering insights on the ambivalence of regional industrial structures, the varying potential of R&D impulses, the importance of regional social problems and the role of extra-regional connectedness, among others (section 4.7).

Importantly though, more is yet to come. In the second project half (from June 2023 to May 2024), at least three more regions will be investigated, providing novel insights in new contexts, a more fine-grained understanding of assets, challenges and opportunities in relation to regional sustainability transitions and more analyses to inform workshops at disused, but interesting industrial sites in Romania, Croatia and Serbia (and maybe elsewhere).

Finally, once all regional investigations are concluded, the team of the University of Vienna – in line with the project proposal – will work on more thorough cross-regional findings and will place more emphasis on the public dissemination of knowledge gained through RIS4Danu. In doing so, academic working papers, conference presentations as well as research translation pieces to address wider audiences are to be expected in the months to come.

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### Databases used

- Cohesion Open Data Platform (European Commission)
- CORDIS - EU research projects under Horizon 2020 (2014-2020)
- Datasets of the Austrian Statistical Office
- Datasets of the Czech Statistical Office
- Datasets of the Federal Statistical Office of Germany
- Datasets of the Hungarian Central Statistical Office
- Datasets of the Statistical Office of Baden-Württemberg
- Datasets of the Statistical Office of the Republic of Slovenia
- Datasets of the Statistical Office of the Slovak Republic
- Environment Agency of the Republic of Slovenia
- Enviroportal (Information Portal of the Ministry of Environment of the Slovak Republic): Atlas krajiny Slovenskej republiky
- ESPON Database: LOCATE (Territories and Low-Carbon Economy) project
- ESPON: QoL (Quality of Life Measurements and Methodology) project
- European Commission (2021) Regional Innovation Scoreboard 2021
- Eurostat: Regional statistics by NUTS classification
- European Social Survey (9th wave, data from 2017/18)
- JRC: The Energy and Industry Geography Lab
- JRC: SDG Mapper
- Interreg projects' database of the European Commission (keep.eu)
- National Forest Centre of Slovakia – Information Database
- National Regional Development and Spatial Planning Information System of Hungary
- Slovak Road Administration
- OECD REGPAT Database (Spring 2022 version)