

JRC SCIENCE FOR POLICY REPORT

Socio-economic transformation in coal transition regions: analysis and proposed approach

Pilot case in Upper Nitra, Slovakia

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Title:

**Socio-economic transformation in coal transition regions: analysis and proposed approach
*Pilot case in Upper Nitra, Slovakia***

Abstract

This is a pilot study of DG JRC, performed in support to European Commission's "Coal Regions in Transition Initiative", which aims at providing practical guidance during the demanding process of socio-economic change in coal regions in transition, in particular concerning the existing instruments to be used, the potential synergies amongst them, as well as the best practices that address the economic, environmental and social challenges of the transition. The JRC pilot study aims at providing the initial diagnostic evidence, together with a proposal of a possible strategic approach, to address the challenge of the closure of the last remaining coal company in Slovakia, situated in Upper Nitra, Prievidza district of the Trenčín region.

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Acknowledgements

The aim of the JRC pilot study was to provide the initial diagnostic evidence, together with a proposal of a possible strategic approach, to address the challenge of the closure of the last remaining coal company situated in Upper Nitra, Prievidza district of the Trenčín region (NUTS3).

This report is a common DG JRC contribution of units A2, A3, B3, B4 and C3. The diagnostic work was carried out by C3 and B3 units. The methodological contribution is the work of Smart Specialisation Platform and RIS3 in Lagging Regions project (B3) and the work on skills was carried out by B4. The consultation and guidance on preparation were provided by Luis Delgado Sancho, Fernando Hervás Soriano and Alessandro Rainoldi.

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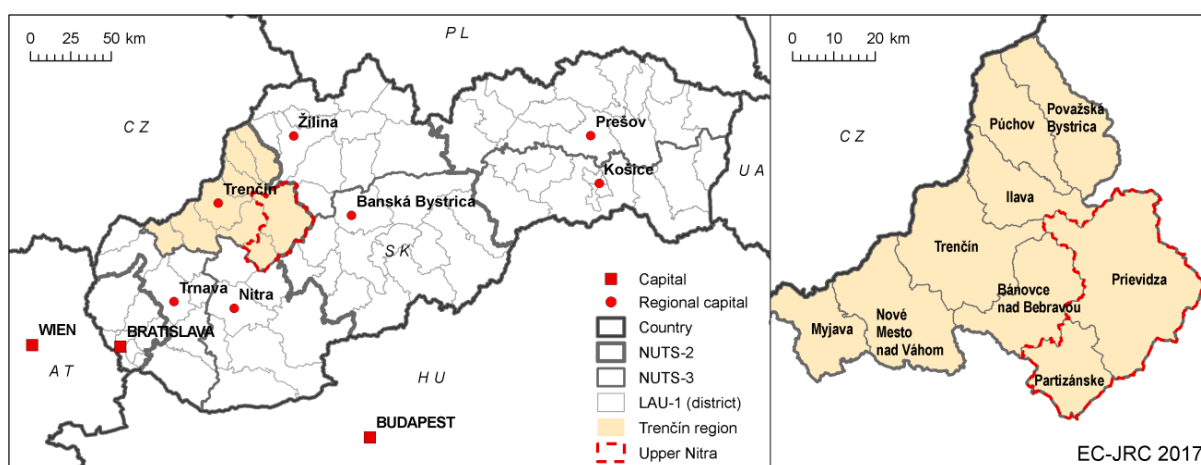
Executive summary

Coal transition constitutes a multi-dimensional challenge for Europe with economic, societal and environmental impacts that can affect up to 52 regions in eight Member States. The European Commission is launching the "Coal Regions in Transition Initiative" to provide practical guidance during the demanding process of socio-economic change, in particular concerning the existing instruments to be used, the potential synergies amongst them, as well as the best practices that are already observed that address the economic, environmental and social challenges of the transition.

The aim of the JRC pilot study is to provide the initial diagnostic evidence, together with a proposal of a possible strategic approach, to address the challenge of the closure of the last remaining coal company situated in Upper Nitra, Prievidza district of the Trenčín region (NUTS3).

Four well-established methodological approaches have been applied to identify and analyse various technical, economic and social impacts of the mine closure in Upper Nitra and the implications for the energy transition and the security of energy supply: value chain analysis, energy/power system modelling, the smart specialisation and its application on research and innovation strategies (RIS3) in lagging regions.

The geographical scope of this analysis is restricted to the districts of Partizánske and Prievidza located in the Slovak administrative region of Trenčín (Trenčiansky kraj or TSK). This territory is called the Upper Nitra. Its area is 1,261 km² (2.5% of total area of Slovakia) and has about 184,000 inhabitants (3.4% of the country total). The area lacks connection to larger cities by motorway or high-speed railway. Although Prievidza serves as a regional railway hub, the existing passenger lines have inferior speed and frequency compared to other parts of Western Slovakia.



Location of Trenčín region (left) and Upper Nitra and the districts of Trenčín region (right)

MAIN FINDINGS

1. Socio-economic indicators and impact of the mine closure in Upper Nitra

The Trenčín region is an economically developed region of Slovakia with a large density of the industrial sector (some 50% of the total jobs in the region).

In total, there are 414 industrial enterprises with 20+ employees. The Trenčín region has a long tradition in the field of rubber, plastic and machinery production, in the manufacture of transport and electrical equipment as well as textiles, footwear and leather. Recently, even advanced industries, such as electro-technical production, started to play a strategic role in the area. The most significant foreign investments are in the supply for the automotive industry.

On the other hand, **the population of Upper Nitra** has been almost continually **decreasing since the late 1990s**. In the last 20 years it lost over 4% due to a combination of negative migration balance and natural population decrease. Such trend, however, is not isolated and it is present in Trenčín region, Nitra region and the majority of Slovakia.

Ageing of the population has been the characteristic demographic process in Slovakia for many years, and in Upper Nitra it has been accelerating at a faster pace compared to that of the region or the country.

In contrast to population, **GDP** is expected to continue the growth trajectory from the past. **The unemployment rate in Slovakia has been continuously decreasing since 2012**. This trend is registered also in Trenčín region and Upper Nitra area. According to the Central Office of Labour, Social Affairs and Family of Slovak Republic the unemployment rate has been decreasing in recent years and it reached 4.5% in Partizánske and 6.1% in the Prievidza district (May 2017). This can be linked to the arrival of new multinational investors in the region.

Indeed, the highest number of newly registered **job-seekers** for employment was recorded in the Prievidza district. Most of the job-seekers have achieved secondary vocational education and full secondary vocational education. The number of unemployed with basic education represents a large part of the long-term unemployed. Despite the large number of registered job-seekers there are vacancies that remain unoccupied as most jobs are offered to qualified technicians, qualified craftsmen and operators of machinery and equipment. This problem has already been recognized by the office of the Self-Governing Region of Trenčín and it is necessary to look for solutions with a focus on young generation

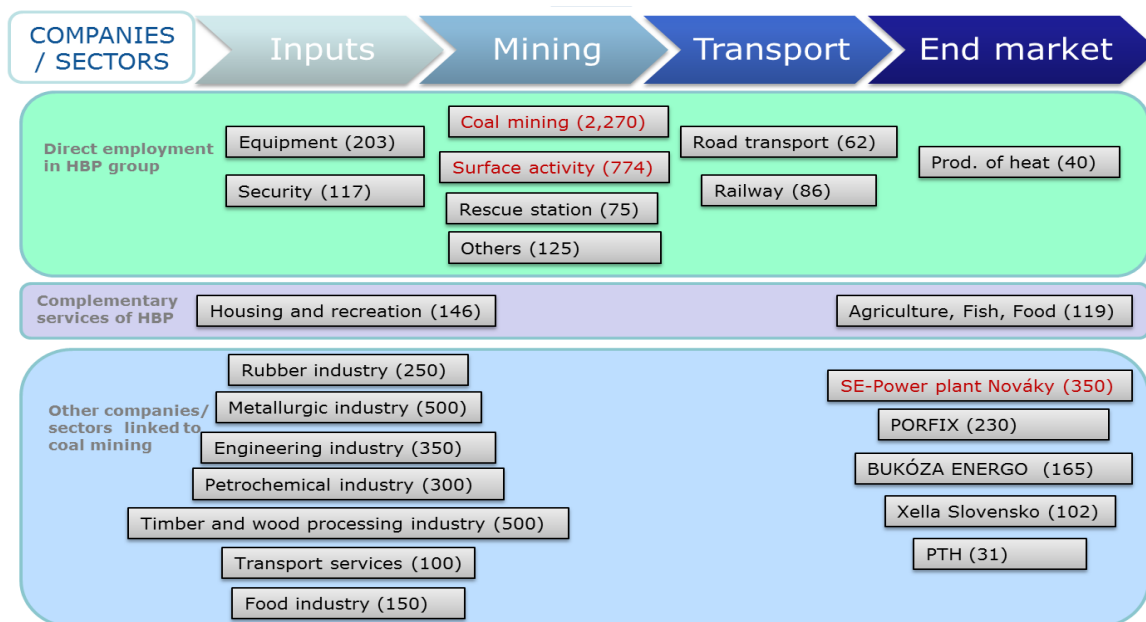
Interestingly, **one of the lacking profession in the Prievidza district is miner**. The most common obstacle is the physically demanding work that is perceived by job-seekers as health and life threatening with inadequate financial compensation and fear for the future, due to an expected decline in coal production in Hornonitrianske bane Prievidza (HBP).

In the period 2007-2014, the Trenčín region received a total of 94M EUR which were invested in 7 companies from 5 cities (Trenčiansky samosprávny kraj, 2015). These investments created 3,019 new jobs in the region.

1.1 Value chain analysis of the coal value chain in Upper Nitra

Today Hornonitrianske bane Prievidza a.s. (HBP a.s.) is the only coal mine company in the country. It has 100-years of tradition in brown coal and lignite mining in Slovakia. The company's main areas of activity are exploration mining treatment and sale of brown coal.

The HBP group activity stimulates the business in a big part of the economy in the country creating direct and indirect economic benefits in the Upper Nitra area of around 4,000 jobs at least. Other business activities (e.g. heat production and supply, electricity generation, rubber industry, engineering industry, transport services, food industry) are linked to the coal sector and account for more than additional 3,000 jobs in the area.



Coal value chain in Upper Nitra

The plan of closing the mine will affect mainly the sectors that are directly related to the mining activity which corresponds to at least 53% of the employment of the HBP group and of complementary business and in general those companies whose business depends mainly on the mining activity. However, the current **age structure of employees and their professional skills are one important factor for the number of affected jobs**. Taking into account that the number of employees in HBP has been continuously decreasing and the open positions for mining jobs are not easily occupied, the Office of Employment, Social Affairs and Family in Prievidza expects that only 10% of the miners and 20-30% of employees directly linked to the mining activities will be absorbed by the labour market when the mines close their operation.

In conclusion, the more diversified the business of the companies that are part of the value chain of the coal industry and the wider the geographical perimeter of their activity, the lower is the loss to be expected in terms of private and social benefits.

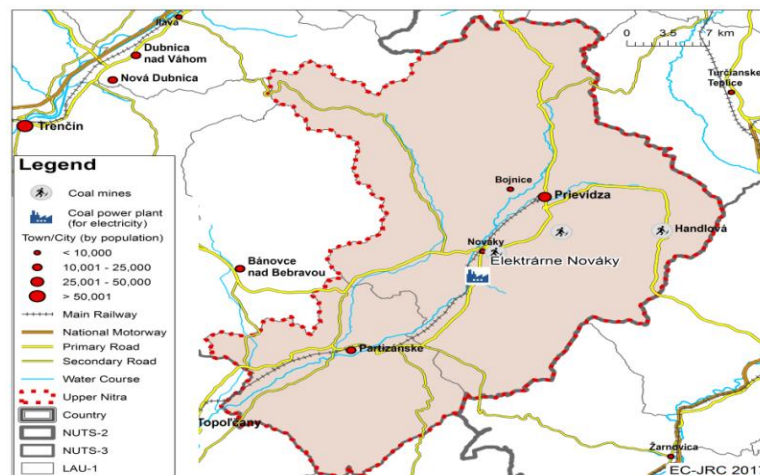
1.2 Electricity and heating sector in the Upper Nitra: the Nováky Power Plant

The most important coal mines in Slovakia are in the Upper Nitra, located in three underground collieries at Nováky, Čígel' and Handlová. The production of brown coal has been moderately decreasing since 1990 reaching 1.8 Mt in 2016. Slovakia also imports brown coal mainly from the Czech Republic, although such imports have been gradually decreasing. Slovakia does not have abundant reserves of hard coal, which is imported from Ukraine to satisfy the large amount of hard coal and its derivatives, consumed primarily in the steel industry - U.S. Steel Košice - and the thermal power plants in Vojany, both in Eastern Slovakia.

The final energy consumption of brown coal has been decreasing over time and it is mainly used by power producers and energy transformation processes. Only 5% it is used for final energy consumption. Contrary to the hard coal primarily used in the industrial sector, the dominant share of final energy consumption of brown coal has been shifting over time among the industry residential sector and services. In 2016 more than 98% of the produced coal was used for electricity generation (Combined Heat and Power).

The biggest customer of HBP a.s. is Slovenské elektrárne a. s. owner of the Nováky power plant (ENO) that purchases almost 94% of HBP production for the power plant Nováky. Another important long-term business partner is Bukóza Energo in Eastern Slovakia. A small amount of coal around is also delivered to the steel industry at US Steel Košice.

Nováky Power Plant (ENO) in Zemianske Kostol'any, with its total installed capacity of 266 MWe, it accounts for 5.22% of the total electricity in Slovakia and it is **the main source of electricity in the Trenčín region**. It accounts for 1.8% of the total national district heating and for 0.9% to the total heat supply including industry and other sectors. ENO also supplies hot water for **central heating** systems of the towns of **Prievidza, Nováky and Zemianske Kostol'any** and **heat to the surrounding industrial enterprises**. Around 350 employees are employed in ENO, nearly 93% of them come from Prievidza district.



Map of the Slovak coal mines and Nováky power plant

1.3 Impact of the mine closure on the Slovak energy system

The mining activity is highly subsidized by the Slovak government. Slovak consumers pay around 53M EUR/year via their electricity bills to support the mining industry. Moreover, substantial new investments to upgrade the Nováky plant will be needed to ensure it operates in compliance with the new emission standards that apply from 2021 onwards (around 90M EUR according to some estimates to avoid being shut down). Besides, the European Environmental Agency ranks the Nováky plant as the 18th most polluting facility in Europe.

In our study, **we present insights to the energy sector** focusing on **alternatives to the coal combusting sources** from a techno-economic perspective, using an in-house energy system model.

In the first part of the analysis, we look at the **entire collection of energy sources and technologies** required by the Slovak economy under two scenarios:

- **Scenario Coal Nováky 2030:** extending the operations of both the plant and the coal mines until 2030;
- **Scenario Phase out 2023:** foreseeing the closure of both the mining activities and the plant in 2023¹.

Main results are i) Phasing out coal mining and operation of power plant brings **reduction of CO₂ emission** by 6.32% in 2025 and of 7.67% in 2030; ii) **Decrease of the total system energy costs of 388M EUR** in case of Phase out 2023 compared to power plant Nováky in operation until 2030.

The phase out scenario fits well the trajectory of a low carbon scenario presented by the JRC-EU-TIMES. This means that the phase out is what should be done following a least cost low carbon transition for the energy sector.

In the second part of the analysis, we provided **additional insights on the transition towards coal-free electricity in Slovakia.**

We tested the technical adequacy of the operation of the European system using an electricity dispatch model under three different case studies with the Reference Scenario 2030 ENTSO-E Vision3:

- Study case 1: without 223MW lignite (brown coal) in Slovakia;
- Study case 2: without 223MW lignite and with new 111MW geothermal capacity in Slovakia;
- Study case 3: without 223MW lignite and with new 223MW geothermal in Slovakia.

Additionally, we estimated the economic benefit resulting from **avoiding the environmental and health impact** of operation of the power plant. The market and non-market social welfare consequences **of the phase-out of the Nováky** power plant and the coal mines in the first year are positive and are estimated to be at least in the range of **+160-170M EUR** for the year after the phase out. Local works for demolition and treatment of surface and subsurface of mines are not treated, depending on the future destinations and uses of spaces, and which source of finance will cover capital and operative costs.

¹ The Slovak TSO assessed that the completion of the works on the Bystričany power node that is expected sometime between 2021–23. For this reason the assumption of the closure of the plant and the coal mines is set to 2023 in the phase-out scenarios.

Finally, we provide **a cost-benefit analysis to include investment costs for the installation of new geothermal capacity**. We define changes in net present value, including the economic benefit resulting from avoiding the environmental and health damage, compared to the reference scenario of an order of 2.9bn EUR for scenario 1, 2.7bn EUR for scenario 2 and 2.5bn EUR for Scenario 3. Positive values reveal an **estimate on what the society could gain from the phasing out of the power plant**.

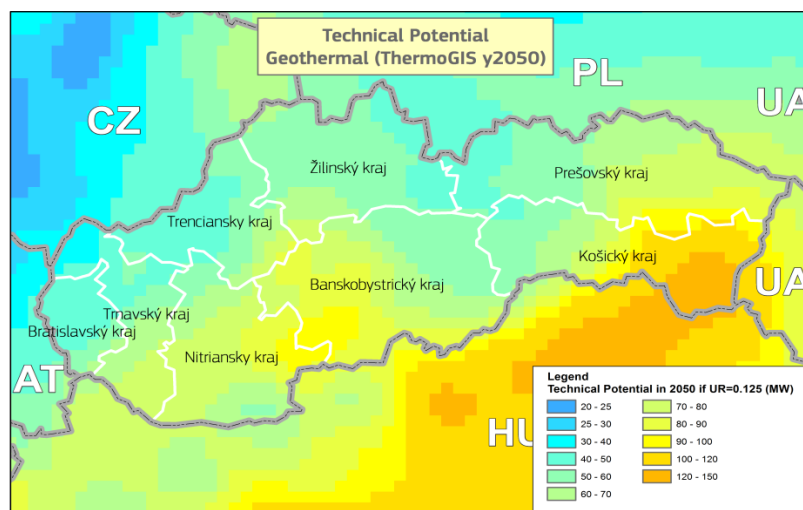
Our analysis shows that Scenario 1 (compared with reference) leads to higher imports and higher generation from some power plants (biomass and pumped hydro) as the absence of a 223MW brown coal power plant should be covered. Only electricity production from gas-fired power plant is lower in Scenario 1. This is due to provision of emergency power reserves done previously by the brown coal plant. This puts additional constraints on generation flexibility and capacity. In scenarios 2 and 3, due to new geothermal power plant, power balance in Slovakia improves as net imports are lower. In addition, electricity price may increase in Scenario 1, mainly due to the effect of importing electricity from other regions, while they decreases in the other two scenarios (2 and 3), mainly because of the production of cheap electricity from geothermal.

Focus: Geothermal potential in Slovak Republic

Slovakia is rich in low enthalpy source of geothermal energy accessible by conventional technology that could find synergy in the residential sector as district heating purposes.

Currently, 27 hydro geothermal areas have been identified as prospective for geothermal energy, accounting for 34% of the country territory.

The total potential of geothermal energy in Slovakia reaches 6,234MWt. However, only a small amount has been actually exploited. Most of the geothermal reservoirs have temperature at the well head lower than 100°C which is more favorable for direct heating purposes rather than for electricity production. Geothermal wells in Slovakia are dominantly used for recreational purposes (68.7%), to a lesser extent for agriculture (18.7%), heating of buildings (11.5%) and ground source heat pumps (1.1%). In its National Renewable Action Plan, Slovakia targets 14.6% renewable energy sources in heating and cooling in 2020, including geothermal.



Geothermal potential in Slovak Republic. Source: (ThermoGIS, 2018)

At present, there are some **successful cases of geothermal district heating** systems in Slovakia. In all of them the geothermal energy used for the base load heat and natural gas boilers are used as a peak and back up source. The oldest is in Galanta and has been in operation since 1996. The installed capacity of the geothermal plant is 8MWt and it supplies heat for 1,236 flats together with the public service sector and the hospital in Galanta city. The geothermal system continues its operation and it is recognized as a well design project producing heat in economically and environmentally friendly manner. Two more such systems started operation in 2011 and 2012 in Šaľa and Sered', respectively.

Although accessibility to innovative exploration and drilling technologies has still to be carefully assessed in our study, geothermal would bring **more qualified jobs and investments closer to the mining sector than other local renewables.**

2. Smart specialisation (S3) as an instrument for economic transformation in coal regions

Coal transition constitutes a significant challenge for Europe that has essentially three dimensions:

- **Economic**, where a regional economy has to modernize and transform from a coal industry that is no longer competitive to other sectors,
- **Societal**, where social change is needed for occupational restructuring in places, where heavy industry is often strongly embedded in the local identity,
- **Environmental** – meaning a strong impact of energy transformation on climate change.

As smart specialisation is a strategy for knowledge-based economic modernisation tested in 120 European regions and countries, there is a valid case to apply its methodology in coal transition regions in Europe. However, it is important to stress that the presented approach requires **strong involvement of all relevant stakeholders, including national, regional and local authorities.**

Adapted smart specialisation (S3) methodology for coal transition regions

I. Political and institutional framework

- Stage 1: Clear definition of the energy policy and planned energy mix
- Stage 2: Identification of partners at regional and national levels
- Stage 3: Identification of strategic mandates (existing strategic framework)

II. Diagnosis

- Stage 4: Detailed analysis of economic, innovative and scientific potential
- Stage 5: Identification of good practice and possible barriers

III. Stakeholders involvement

- Stage 6: Entrepreneurial Discovery Process (EDP)

IV. Skills and social transition

- Stage 7: Definition of needed changes in skills profile
- Stage 8: Social change management (mobilisation of civic society)

V. Smart Specialisation Strategy and Implementation Plan

- Stage 9: Preparation of S3 coal transition strategy
- Stage 10: Design of implementation system

Additional considerations should be taken into account when applying S3 methodology in coal transition regions:

- **Transitions imply not merely a change of policies but a transformation of the underlying economic, social and political systems.**
- **The transition is not just about innovation policy.**
- **Greater need for public intervention and increased complexity of multi-level governance.**
- **Public investments in infrastructure, particularly when they support the creation of local markets, can be important elements of a transition.**
- **There should be a wider involvement of civic society.**
- **Identification of individual transformation models is also key.**
- **Not everything can happen at once!**

3. The tourism sector: an example of potential for possible further developments

Further developing the tourism sector can be an important part of the attempt to sectorally diversify the Upper Nitra region and therefore contribute to cope with the transition from coal economy. Upper Nitra has several important attractions, the main ones being clustered in the town of Bojnice (therapeutic and wellness spa, the national zoological garden and a preserved medieval castle). The same area is also the major hotspot of touristic accommodation. Other attractions or potential attractions are scattered around Upper Nitra – historical monuments, minor museum, protected natural areas, industrial monuments, sports and recreation facilities.

One of the key obstacles to tourism growth in Upper Nitra –the inferior road accessibility compared to other regions– will likely gradually diminish thanks to the planned motorway network upgrades. Other investments are no less important, such as the education and training of the workforce in the HORECA (hotels, restaurants and catering) sector.

Investment in the maintenance of existing attractions (e.g. the Bojnice ZOO and spa) could be accompanied by differentiation of tourist attractions and products to address challenges as seasonality, volatile demand and decreasing cost-competitiveness due to economic development.

Potential attraction diversification could build on the current strengths of the region:

- Stepping up existing nature conservation to create more valuable, interconnected areas of wild nature;
- Preserving traditional agriculture in the less favourable hilly landscape might contribute to keep biodiversity and promote agrotourism;
- Part of the industrial heritage of Upper Nitra might become a target of conservation efforts and a tourist attraction (Handlova coal mines, Bata complex in Partizanske).

Innovation can also be an important part of efforts to support growth in the tourism sector. Innovation can result in the development of new tourist products and services, and/or the stronger differentiation of existing products.

Mine and heavy-industry conversion to attractions can be found elsewhere in Europe. The European Route of Industrial Heritage lists many of these cases, as well as other types of industrial heritage, such as:

- The ironworks of Lower area of Vítkovice in Ostrava, Czech Republic, that have been recently converted to a successful touristic attraction;
- Zollverein coal mine and industrial complex in Ruhr Valley Germany;
- "be mine" mining museum near Hasselt in Belgium;
- Former mine science and art centre in Walbrzych, Poland.

Another crucial theme regards skills and their role in the transition process.

Anticipation and participatory planning of a transition strategy are key factors to reduce conflicts and resistance to change. By careful planning the future of a coal production area based on its post-mining potential in the context of its broader socio-economic transformation, matching skills policies as well as human capital development interventions can be designed. Establishing a well-defined link between skills needs

anticipation and regional development policies is therefore essential to ensure the effectiveness of any active labour market policy targeted to the re-skilling of coal miners.

How the JRC can help?

JRC can contribute to this process on many levels - most importantly by providing an in-depth diagnosis of the affected regions in terms of energy policy and coal transition issues as well as more general socio-economic problems. Another input is the support in the design and possible application of the transition process by using smart specialisation approach, including experiences from lagging regions that need a specific, hands-on approach.

Zhrnutie

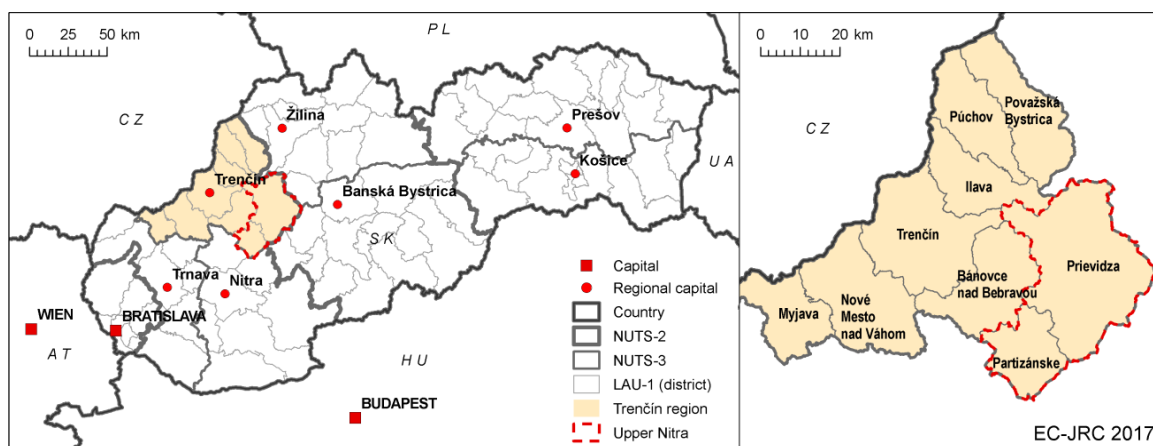
Prechod od uhlia na iné energetické zdroje predstavuje pre Európu mnohorozmernú výzvu s hospodárskymi, spoločenskými a environmentálnymi dôsledkami, ktoré môžu postihnúť až 52 regiónov v ôsmich členských štátoch. Európska komisia preto spustila iniciatívu "Uhoľné regióny v procese premeny" s cieľom poskytnúť dotknutým regiónom praktickú podporu počas náročného procesu sociálnoekonomickej premeny, najmä pokiaľ ide o existujúce nástroje, ktoré je možné využiť, potenciálne synergie medzi nimi, ako aj osvedčené postupy, ktoré sa už použili pri riešení hospodárskych, environmentálnych a spoločenských výziev spojených s prechodom.

Cieľom pilotnej štúdie Spoločného výskumného centra Európskej komisie (JRC) je poskytnúť prvotné vedecké dôkazy a návrh možného strategického prístupu vo vzťahu k plánovanému ukončeniu ťažby uhlia v oblasti Hornej Nitry na Slovensku.

Na identifikáciu a analýzu technických, hospodárskych a spoločenských dôsledkov zatvorenia baní na Hornej Nitre, alternatív prechodu na iné zdroje energie a ich vplyvu na energetickú bezpečnosť sa použili štyri osvedčené metodologické postupy: analýza hodnotového reťazca, modelovanie energetického systému, inteligentná špecializácia a jej využitie v rámci výskumných a inovačných stratégií (RIS3) v zaostávajúcich regiónoch.

Z geografického hľadiska sa štúdia zameriava na okresy Prievidza a Partizánske, ktoré sa nachádzajú v Trenčianskom samosprávnom kraji. Ide o oblasť, ktorá sa nazýva Horná Nitra, s rozlohou 1261 km² (2,5 % z celkovej rozlohy Slovenska) a približne 184 tis. obyvateľmi (3,4 % z celkového počtu obyvateľov v Slovenskej republike).

V oblasti Hornej Nitry chýba prepojenie s väčšími mestami prostredníctvom rýchlostných ciest alebo vysokorýchlostnej železnice. Napriek tomu, že Prievidza slúži ako železničný uzol, existujúce osobné linky majú nižšiu rýchlosť a frekvenciu v porovnaní s ostatnými časťami západného Slovenska.



Poloha Trenčianskeho kraja a Hornej Nitry (vľavo) a okresy Trenčianskeho kraja (vpravo)

HLAVNÉ ZISTENIA

1. Socioekonomické indikátory a dôsledky zatvorenia uhoľných baní na Hornej Nitre

Trenčiansky kraj patrí medzi hospodársky rozvinuté regióny Slovenska s veľkým podielom priemyselného sektora (približne 50% pracovných miest v regióne).

Celkovo sa tam nachádza 414 priemyselných podnikov s vyše 20 zamestnancami. Dlhú tradíciu má v Trenčianskom kraji najmä gumársky priemysel, spracovanie plastov, strojárstvo, výroba dopravných a elektrických zariadení, ako aj textilný, obuvnícky a kožiarsky priemysel. V súčasnosti zohrávajú strategickú úlohu v regióne aj nové priemyselné odvetvia, ako napr. elektrotechnický priemysel. Najvýznamnejšie zahraničné investície sa týkali najmä výroby komponentov pre automobilový priemysel.

Od konca 90-tych rokov **počet obyvateľov Hornej Nitry** takmer neustále **klesá**. V posledných 20-tich rokoch prinieslo negatívne migračné saldo v kombinácii s prirodzeným úbytkom populácie vyše 4-percentný pokles. Tento trend však nie je ojedinelým javom a platí takisto v Trenčianskom a Nitrianskom kraji, ako aj na väčšine Slovenska. **Starnutie populácie** je charakteristickým demografickým javom na Slovensku už dlhé roky, v oblasti Hornej Nitry sa však zrýchľoval ešte viac ako v celom regióne alebo na celom Slovensku.

Na rozdiel od počtu obyvateľov má **HDP** podľa očakávaní aj naďalej rásť. **Miera nezamestnanosti na Slovensku sa postupne znižuje od roku 2012**. Tento trend je badateľný aj v Trenčianskom kraji a na Hornej Nitre. Podľa Ústredia práce, sociálnych vecí a rodiny Slovenskej republiky miera nezamestnanosti v posledných rokoch klesla a v máji 2017 dosahovala úroveň 4,5% v okrese Partizánske a 6,1% v okrese Prievidza. To súvisí aj s príchodom nových zahraničných investorov do tohto regiónu.

Najvyšší počet nových záujemcov o zamestnanie sa zaregistroval v okrese Prievidza, pričom väčšina z nich dosiahla úplné alebo čiastočné odborné vzdelanie druhého stupňa. Nezamestnaní so základným vzdelaním predstavujú veľkú časť dlhodobozamestnaných. Napriek veľkému počtu registrovaných záujemcov o prácu však mnohé pozície ostávajú neobsadené, keďže väčšina pracovných miest sa ponúka kvalifikovaným technikom, remeselníkom a operátorom strojov a zariadení. Tento problém vníma aj Úrad Trenčianskeho samosprávneho kraja a je nevyhnutné hľadať riešenia so zameraním na mladú generáciu.

Zaujímavé je, že v prievidzskom okrese je už teraz nedostatok pracovnej sily v oblasti baníctva. Dá sa to vysvetliť tým, že ide o fyzicky náročnú prácu, ktorú záujemcovia o zamestnanie často vnímajú ako ohrozujúcu zdravie a život, s neadekvátnym finančným ohodnotením a neistou budúcnosťou z dôvodu očakávaného poklesu ťažby uhlia v HBP.

V rokoch 2007 až 2014 Trenčiansky kraj získal vyše 94 mil. €, ktoré sa investovali do 7 podnikov v 5 mestách² a pomohli vytvoriť 3019 nových pracovných miest v regióne.

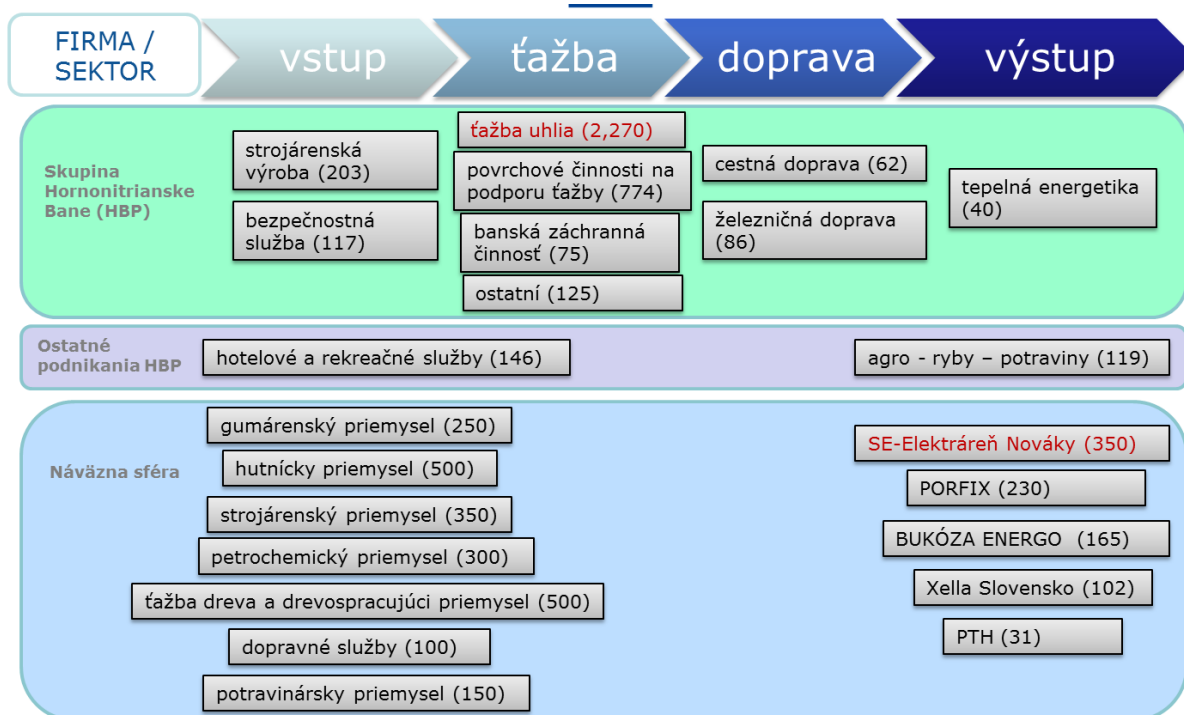
1.1 Hodnotový reťazec ťažby uhlia na Hornej Nitre

Skupina HBP je jedinou spoločnosťou na Slovensku, ktorá sa venuje ťažbe uhlia. Má 100-ročnú tradíciu ťažby hnedého uhlia a lignitu. Spoločnosť sa venuje predovšetkým prieskumu, ťažbe, spracovaniu a predaju hnedého uhlia.

Činnosť skupiny HBP má významný hospodársky vplyv a podieľa sa na tvorbe vyše 4000 pracovných miest na Hornej Nitre. Ďalšie podnikateľské činnosti (napr. výroba a dodávka tepla, výroba elektrickej energie, gumársky priemysel, strojársky priemysel,

² Trenčiansky samosprávny kraj, 2015

dopravné služby, potravinársky priemysel) sú naviazané na uhoľný sektor a celkovo vytvárajú ďalších 3000 pracovných miest v regióne.



Plán ukončenia ťažby ovplyvní najmä sektory priamo naviazané na ťažbu uhlia, ktoré predstavujú minimálne 53% pracovných miest v skupine HBP a v nadväzujúcej sfére, a vo všeobecnosti spoločnosti, ktorých aktivity priamo závisia od ťažby uhlia. Avšak dôležitým činiteľom je aj **aktuálna veková štruktúra a profesionálne zručnosti** dotknutých zamestnancov. Keďže počet zamestnancov HBP neustále klesá a obsadzovanie nových pracovných pozícií nie je jednoduché, Úrad práce, sociálnych vecí a rodiny v Prievidzi odhaduje, že trh práce dokáže po ukončení prevádzky absorbovať iba približne 10% baníkov a 20-30% ďalších zamestnancov.

Dá sa predpokladať, že negatívne dôsledky prechodu v spoločnostiach, ktoré patria do hodnotového reťazca ťažby uhlia, budú tým menšie, čím väčšia je diverzifikácia a geografický záber ich činnosti.

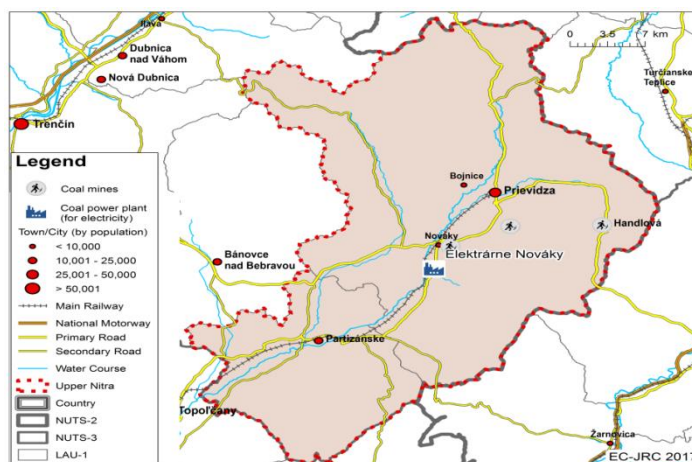
1.2 Výroba elektrickej energie a tepla na Hornej Nitre: Elektrárne Nováky

Najvýznamnejšie uhoľné bane na Slovensku sa nachádzajú v troch lokalitách na Hornej Nitre – Nováky, Cígeľ a Handlová. Ťažba hnedého uhlia od roku 1990 mierne klesá; v roku 2016 predstavovala 1,8 mil. ton. Slovensko tiež dováža hnedé uhlie predovšetkým z Českej republiky, hoci tento dovoz sa postupne znižuje. Slovensko nemá zásoby čierneho uhlia a dopyt po ňom a jeho derivátoch (najmä kokse) uspokojuje dovozom z Ukrajiny. Čierne uhlie sa využíva najmä v oceliarskom priemysle – U.S Steel Košice – a v tepelnej elektrárni vo Vojanoch na východnom Slovensku.

Celková spotreba hnedého uhlia sa postupne znižuje, pričom veľkú väčšinu využívajú výrobcovia elektrickej energie a tepla. Iba 5% využívajú priamo koneční spotrebitelia. Na rozdiel od čierneho uhlia, ktoré sa primárne využíva v priemyselnom sektore, hnedé uhlie sa postupne začalo viac využívať v rezidenčnom sektore a službách. V roku 2016 sa viac ako 98% vyťaženeho uhlia použilo na výrobu elektrickej energie a tepla.

Najväčší zákazník spoločnosti HBP sú Slovenské elektrárne a.s., vlastníci elektrárne Nováky (ENO), ktorá nakupuje takmer 94% produkcie HBP. Ďalším dôležitým dlhodobým obchodným partnerom HBP je Bukóza Energo na východnom Slovensku. Malé množstvo uhlia sa dodáva aj oceliarskemu koncernu US Steel Košice.

Elektrárne Nováky (ENO) v Zemianskych Kostolánoch je hlavným zdrojom elektrickej energie v Trenčianskom kraji s celkovým inštalovaným výkonom 266MWe. Jej podiel na celkovej výrobe elektrickej energie na Slovensku je 5,22%. Zároveň sa podieľa 1,8% na celkovej výrobe tepla na diaľkové vykurovanie a 0,9% na celkových dodávkach tepla vrátane priemyslu a iných sektorov. ENO dodáva teplú vodu do systémov **ústredného kúrenia** v mestách Prievidza, Nováky a Zemianske Kostolány, ako aj **teplo do okolitých priemyselných podnikov**. V ENO v súčasnosti pracuje približne 350 zamestnancov, pričom takmer 93% z nich pochádza z okresu Prievidza.



Mapa uhoľných baní a elektrárne Nováky

1.3 Vplyv ukončenia ťažby uhlia na slovenský energetický systém

Vláda Slovenskej republiky v súčasnosti vysoko dotuje domácu ťažbu uhlia. Slovenskí spotrebitelia podporujú ťažobný priemysel prostredníctvom tarify zahrnutej v účtoch za elektrinu čistou sumou približne 53 mil. € ročne. Navyše, v roku 2021 vstúpia do platnosti nové emisné štandardy a na ich splnenie by boli potrebné vysoké investície do modernizácie elektrárne v Novákoch (podľa niektorých odhadov by na zabezpečenie pokračovania prevádzky bolo potrebných približne 90 mil. €). Je potrebné vziať do úvahy aj skutočnosť, že v rebríčku najväčších znečisťovateľov, ktorý zostavuje Európska environmentálna agentúra, patrí elektrárni Nováky 18. miesto v Európe.

V našej štúdii prezentujeme zistenia týkajúce sa energetického sektora so zameraním na možné alternatívy k spaľovaniu uhlia z technicko-ekonomického hľadiska a s využitím interne vyvinutého modelu energetického systému.

Prvá časť analýzy je venovaná energetickým zdrojom a technológiám s ohľadom na potreby slovenskej ekonomiky v dvoch scenároch:

- **Scenár Uhlie Nováky 2030:** predĺženie prevádzky elektrárne a uhoľných baní do roku 2030;
- **Scenár Ukončenie 2023:** predpokladané ukončenie ťažby uhlia a prevádzky elektrárne v roku 2023³.

Hlavné výsledky:

i) Ukončenie ťažby a prevádzky elektrárne v roku prinesie **redukciu emisií CO₂** o 6,32% v roku 2025 a o 7,67% v roku 2030;

ii) **Zníženie celkových nákladov energetického systému o 388 mil. € do roku 2030** v prípade ukončenia prevádzky ENO v roku 2023 v porovnaní s pokračovaním prevádzky do roku 2030.

Druhý scenár je v súlade s trajektóriou scenára s nízkymi emisiami CO₂ podľa modelu JRC-EU-TIMES. To znamená, že ide o najúspornejší scenár prechodu na nízkouhlíkové hospodárstvo v energetickom sektore.

Druhá časť analýzy poskytuje **dodatočné informácie týkajúce sa prechodu na výrobu elektrickej energie bez použitia uhlia** na Slovensku.

Otestovali sme technickú primeranosť prevádzky európskeho systému s využitím modelu distribúcie elektrickej energie v troch rozličných prípadových štúdiách v porovnaní s referenčným scenárom 2030 ENTSO-E Vision3:

- Prípadová štúdia 1: bez 223MW z hnedého uhlia;
- Prípadová štúdia 2: bez 223MW z hnedého uhlia a s nahradením 111MW geotermálnymi kapacitami na Slovensku;
- Prípadová štúdia 3: bez 223MW z hnedého uhlia a s nahradením 223MW geotermálnymi kapacitami na Slovensku.

Zároveň sme odhadli ekonomický prínos vyplývajúci z odstránenia negatívneho vplyvu prevádzky ENO na životné prostredie a zdravie. **Celkový trhový aj netrhový spoločenský prínos zatvorenia elektrárne Nováky a uhoľných baní** sa odhaduje na minimálne **160 až 170 mil. €** v prvom roku po ukončení prevádzky. Vo výpočte nie sú zohľadnené náklady na demoláciu, povrchovú a podpovrchovú úpravu bývalých baní, keďže budú závisieť od ich ďalšieho využitia a od finančných zdrojov na pokrytie kapitálových a operatívnych výdavkov.

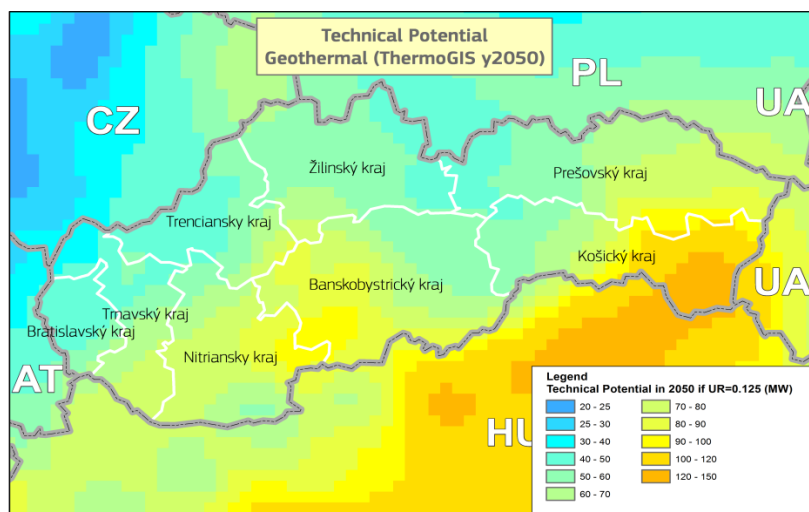
V neposlednom rade štúdia obsahuje **analýzu nákladov a výnosov pre účely započítania investičných nákladov na inštaláciu novej geotermálnej kapacity**. Zmeny sa rátajú v aktuálnej čistej hodnote vrátane hospodárskeho prínosu zníženia negatívneho vplyvu na životné prostredie a zdravie v porovnaní s referenčným scenárom a predstavujú 2,9 mld. € pre scenár 1; 2,7 mld. € pre scenár 2; a 2,5 mld. € pre scenár 3. Pozitívne hodnoty ukazujú predpokladaný **prínos pre spoločnosť v prípade ukončenia prevádzky elektrárne**.

Naša analýza ukazuje, že ak sa má nahradiť výroba 223 MW elektrickej energie z hnedého uhlia, scenár 1 (v porovnaní s referenčným scenárom) by viedol k zvýšeniu

³ Slovenský prevádzkovateľ prenosovej sústavy (SEPS) odhaduje dokončenie prác na elektrickom uzle Bystričany v rokoch 2021-23. Z tohto dôvodu sa v scenároch postupného vyradenia stanovil rok 2023 ako predpokladaný rok zatvorenia elektrárne a uhoľných baní.

dovozu a vyššej produkcii v niektorých elektrárňach (biomasa a vodné elektrárne). Iba výroba elektrickej energie z plynu je v scenári 1 nižšia, a to z dôvodu poskytnutia núdzových zásob elektrickej energie, ktoré predtým pochádzali z elektrárne Nováky. To prináša ďalšie obmedzenia pokiaľ ide o flexibilitu a kapacitu výroby. V scenároch 2 a 3 by sa vďaka novej geotermálnej elektrárni zvýšila energetická rovnováha a dovoz by sa znížil. Navyše, scenár 1 môže viesť k zvýšeniu ceny elektrickej energie, a to najmä z dôvodu dovozu elektrickej energie z iných regiónov, zatiaľ čo v ostatných dvoch scenároch cena klesá vďaka výrobe lacnej elektriny z geotermálnych zdrojov.

Geotermálny potenciál Slovenskej republiky



Zdroj: (ThermoGIS, 2018)

Slovensko je bohaté na geotermálnu energiu s nízkou entalpiou, prístupnú konvenčnou technológiou, ktorá by sa mohla využívať v synergii s diaľkovým vykurovaním v rezidenčnom sektore.

V súčasnosti sa identifikovalo 27 geotermálnych oblastí, ktoré sú perspektívne z hľadiska možného využitia geotermálnej energie, čo predstavuje 34% územia Slovenska.

Celkový potenciál geotermálnej energie na Slovensku dosahuje 6,234MWt, len malá časť sa však skutočne využíva. Väčšina geotermálnych zdrojov má teplotu na ústí vrtu nižšiu ako 100°C, čo je vhodnejšie skôr na účely priameho vykurovania než na výrobu elektrickej energie. Geotermálne vrty na Slovensku sa využívajú prevažne na rekreačné účely (68,7%), v menšom rozsahu pre poľnohospodársku výrobu (18,7%), vykurovanie budov (11,5%) a tepelné čerpadlá (1,1%). Podľa Národného plánu pre obnoviteľné zdroje energií chce Slovensko v roku 2020 dosiahnuť podiel 14,6% energií na vykurovanie a chladenie z obnoviteľných zdrojov vrátane geotermálnej energie.

Na Slovensku už existuje viacero **úspešných príkladov využitia geotermálnej energie na diaľkové vykurovanie**. Vo všetkých prípadoch sa využíva geotermálna energia ako základ a zemný plyn ako doplnujúci a záložný zdroj. Najstarší systém sa nachádza v Galante a je v prevádzke od roku 1996. Inštalovaná kapacita geotermálnej elektrárne je 8MW a dodáva teplo pre 1236 bytov, verejný sektor a nemocnicu v Galante. Ide o fungujúci a efektívny projekt výroby tepla, ktorý je úsporný a zároveň šetrný voči životnému prostrediu. Ďalšie dva podobné systémy boli spustené v rokoch 2011 a 2012 v Šali a Seredi.

Aj keď dostupnosť inovatívnych technológií v oblasti prieskumu a vŕtania je potrebné ešte podrobne analyzovať, využitie geotermálneho potenciálu na Hornej Nitre môže priniesť kvalifikované pracovné miesta a investície v sektore, ktoré má k baníctvu bližšie ako iné obnoviteľné zdroje v regióne.

2. Inteligentná špecializácia (S3) ako nástroj pre hospodársku transformáciu uhoľných regiónov

Prechod na uhlie predstavuje pre Európu významnú výzvu, ktorá má v zásade tri rozmery:

- **Hospodársky** - kde je potrebné modernizovať a transformovať regionálnu ekonomiku z uhoľného priemyslu, ktorý už nie je konkurencieschopný vo vzťahu k iným odvetviam,
- **Sociálny** - kde sú potrebné sociálne zmeny na reštrukturalizáciu pracovných miest v oblastiach, kde je ťažký priemysel často silno zakotvený v miestnej identite,
- **Environmentálny** - ktorý sa zameriava na výrazný vplyv energetickej transformácie na klimatické zmeny.

Kedže inteligentná špecializácia je stratégiou pre modernizáciu ekonomiky založenú na vedomostiach a osvedčila sa v 120 európskych regiónoch a krajinách, dá sa usudzovať, že túto metodológiu je možné využiť aj v európskych uhoľných regiónoch v procese premeny. Treba však zdôrazniť, že navrhovaný prístup vyžaduje **silné zapojenie všetkých relevantných zainteresovaných strán vrátane národných, regionálnych a miestnych orgánov.**

Inteligentná špecializácia (S3) pre uhoľné regióny v procese premeny v 10 krokoch

2. Jasné vymedzenie energetickej politiky a plánovaného energetického mixu
3. Identifikácia partnerov na regionálnej a národnej úrovni
4. Určenie strategických mandátov (existujúci strategický rámec)
5. Podrobná analýza hospodárskeho, inovačného a vedeckého potenciálu
6. Identifikácia osvedčených postupov a možných bariér
7. Proces objavovania činností podnikania
8. Definovanie potrebných zmien v oblasti zručností
9. Riadenie sociálnej zmeny (mobilizácia občianskej spoločnosti)
10. Príprava stratégie pre inteligentnú špecializáciu (S3) pre uhoľné regióny v procese premeny
11. Návrh implementačného systému

Pri uplatňovaní metodológie inteligentnej špecializácie (S3) v uhoľných regiónoch v procese premeny je potrebné vziať do úvahy aj ďalšie aspekty:

- **Transformácia neznamená len zmenu politík, ale aj základných hospodárskych, spoločenských a politických systémov.**
- **Transformácia nie je len o inovačnej politike.**
- **Zvýšená potreba verejnej intervencie a väčšia zložitosť viacúrovňového riadenia.**
- **Verejné investície do infraštruktúry, najmä ak podporujú vytváranie lokálnych trhov, môžu byť dôležitými prvkami transformácie.**
- **Mala by byť zabezpečená širšia účasť občianskej spoločnosti.**

- **Identifikácia jednotlivých transformačných modelov je tiež kľúčová.**
- **Nie všetko sa dá uskutočniť naraz.**

3. Sektor cestovného ruchu: príklad možného ďalšieho vývoja

Rozvoj cestovného ruchu je jedným zo spôsobov ako prispieť k diverzifikácii Hornej Nitry a vyrovnáť sa s prechodom z uhoľného hospodárstva. Horná Nitra má niekoľko významných atrakcií, pričom tie hlavné sa nachádzajú v meste Bojnice (liečebné a rekreačné kúpele, národná zoologická záhrada a zachovalý stredoveký hrad). Táto oblasť je tiež hlavným centrom turistického ubytovania. Ďalšie atrakcie alebo potenciálne atrakcie sú roztrúsené na celom území Hornej Nitry – historické pamiatky, menšie múzeum, chránené prírodné oblasti, priemyselné pamiatky, športové a rekreačné zariadenia.

Jednou z kľúčových prekážok rastu cestovného ruchu v Hornej Nitre je horšia dopravná dostupnosť v porovnaní s ostatnými regiónmi, ale vďaka plánovaným investíciám do cestnej siete sa dá predpokladať jej postupné odstránenie. Rovnako dôležité sú aj ďalšie investície, napríklad v oblasti vzdelávania a odbornej prípravy zamestnancov v odvetví hotelierstva, reštauračných a stravovacích služieb.

Investície do údržby existujúcich atrakcií (napr. ZOO a kúpele Bojnice) by mala sprevádzať diverzifikácia turistických atrakcií a produktov, čo by pomohlo čeliť výzvam ako sezónnosť, nestály dopyt a znižujúca sa cenová konkurencieschopnosť v dôsledku hospodárskeho rozvoja.

Možná diverzifikácia by mala stavať na súčasných silných stránkach regiónu:

- zintenzívnenie existujúcej ochrany prírody s cieľom vytvoriť hodnotné, prepojené prírodné oblasti;
- zachovanie tradičného poľnohospodárstva v menej priaznivých podmienkach v kopcovitej krajine by mohlo prispieť k zachovaniu biodiverzity a podpore agroturistiky;
- časť priemyselného dedičstva Hornej Nitry by mohla prejsť pamiatkovou obnovou a zaradiť sa medzi turistické atrakcie (Uhoľné bane Handlová, Komplex Baťa v Partizánskom).

Inovácie môžu byť takisto významne podporiť rast v odvetví cestovného ruchu a priniesť nové turistické produkty a služby a/alebo ich jasnejšie rozlíšenie.

Príklady konverzie minerálneho a ťažkého priemyslu na atrakcie je možné nájsť v mnohých európskych krajinách. Zoznam "Európskych ciest priemyselného dedičstva" obsahuje veľa takýchto príkladov, ako napr.:

- Bývalé železiarne Dolné Vítkovice v Ostrave, ktoré sa nedávno premenili na úspešnú turistickú atrakciu;
- Uhoľná baňa Zollverein a priemyselný komplex v údolí rieky Ruhr v Nemecku;
- Banícke múzeum "be mine" blízko miesta Hasselt v Belgicku;
- Bývalé centrum baníckej vedy a umenia vo Walbrzychu v Poľsku.

Ďalšou kľúčovou témou sú zručnosti a ich úloha v procese transformácie.

Aby sa znížila pravdepodobnosť konfliktom a odolnosť voči zmenám je potrebné venovať náležitú pozornosť plánovaniu a zahrnúť do prípravy transformačnej stratégie všetky zainteresované strany. Vďaka dôkladnej príprave plánu premeny uhoľného regiónu založeného na využití existujúceho potenciálu v kontexte širšej sociálno-ekonomickej transformácie je možné zladit' politiky a podporné nástroje v oblasti nadobúdania nových zručností a rozvoja ľudského kapitálu. Akákoľvek aktívna politika trhu práce zameraná na

rekvalifikáciu uhoľných baníkov môže byť účinná iba v prípade, že bude zohľadňovať predpokladané potreby a požadované zručnosti na trhu práce v budúcnosti, ako aj zámary v oblasti regionálneho rozvoja.

Ako môže pomôcť Spoločné výskumné centrum (JRC)?

Spoločné výskumné centrum (JRC) môže prispieť k tomuto procesu na mnohých úrovniach –najmä poskytnutím podrobnej diagnózy dotknutých regiónov z hľadiska energetickej politiky a energetického prechodu, ako aj všeobecných sociálno-ekonomických problémov. Ďalším prínosom by mohla byť podpora pri navrhovaní a uplatňovaní transformačného procesu s využitím prístupu inteligentnej špecializácie a skúseností zo zaostávajúcich regiónov, ktoré potrebujú špecifický a aktívny prístup.

Coal regions in transition

In the "Clean Energy for All Europeans" Communication issued on 30th November 2016 (European Commission, 2016), the European Commission (EC) stated that: *"will examine how to better support the transition in coal and carbon-intensive regions. To this end, it will work in partnership with the actors of these regions, provide guidance, in particular for the access to and use of available funds and programmes, and encourage exchange of good practices, including discussions on industrial roadmaps and re-skilling needs, through targeted platforms."*

The "coal regions in transition" initiative is one of the deliverables of the Energy Union Enabling Framework 2017-2018 - to which JRC expressed its interest to be associated. The main aim of the initiative is to provide practical guidance, in particular on the existing instruments, the potential synergies amongst them, as well as on the best practices that are already observed that address the economic, environmental and social challenges of this transition.

The decline in coal mining activity in Europe is already an ongoing and inevitable process. There are up to 52 regions in Europe that are facing these challenges to various extent. This initiative will focus on a limited number of Member States including Slovakia, Poland, Greece, Germany, Czech Republic, Bulgaria, Spain and Romania, depending on the demand.

This initiative is also mentioned in the new Commission Communication on Smart Specialisation (issued on 18th July) (European Commission, 2017), with reference to the pilot project "Tailored support for the specific challenges of regions facing industrial transition".

This report is focused on the pilot case identified in the region of Trenčín, Slovakia. The Slovak government plans to phase out coal mining activities completely with the closure of the last remaining coal company situated in Trenčín region (NUTS3) (Hornonitrianske bane Prievidza - HBP) and asked the EC for assistance in this process.

The framework of the analysis – diagnostic methodologies

Table 1 summarizes the elements of the diagnostic framework applied to the study on the technological, economic and social challenges of the Slovakian region of Trenčín and the coal-intensive area of Upper Nitra in the transition process of phasing-out of coal production activities. Moreover, the diagram identifies the preliminary stakeholders that play a fundamental role in the support of both the analytical study (i.e. collection of relevant data; validation of results) and the elaboration of the policies in support of the transition (identification of the national and regional priorities in the field of socio-economic development; areas of specialisation and innovation).

Table 1. Analytical framework: input data – methodology – output – stakeholders

Input data	Methodology	Output	Stakeholders
Professional skills in mining companies	Value chain analysis	Impact on employment/reskilling possibilities	Mining company (HBP, a.s.) ⁴
Demand of additional services in the region			Local and regional authorities ⁵
Collection of historical economic and financial data of the companies active in the region		Impact on economy/potential diversification of business	Local and regional authorities
List of coal customers and quantity of coal supplied		Possibilities of diversification of the coal supply	Mining company (HBP, a.s.)
Update on future national energy policies	Energy system modelling	Impacts on coal trade, energy mix, CO ₂ emissions, investments in energy technologies	Ministry of Economy
Energy demands of end use sectors by fuel; existing capacities associated to the main energy sources and technologies			Ministry of Economy and local authorities
Future power system operator projections	Power system modelling	Impacts on electricity prices, utilisation of power plants and cross-border power exchanges	Transmission system operator (Slovenská elektrizačná prenosová sústava, a.s.)

Source: JRC

Coal industry value chain

Phasing out coal mines affects not only the mines themselves but also many connected industries. The basic coal industry value chain can be defined as follows (Figure 1):

- acquisition of factors of production (INPUT);
- extraction and processing of coal (MINING);
- transportation (TRANSPORT);
- consumption of the coal resource (END MARKET)⁶.

The analysis of the coal industry value chain allows us to adopt a holistic approach to the assessment of the socio-economic impacts from a mine closure in the identified region. For each segment of the coal industry value chain we identify the economic sectors and sub-sectors and the companies that are part of them. This mapping activity can be tedious because it requires detailed data on the companies by business activities, number

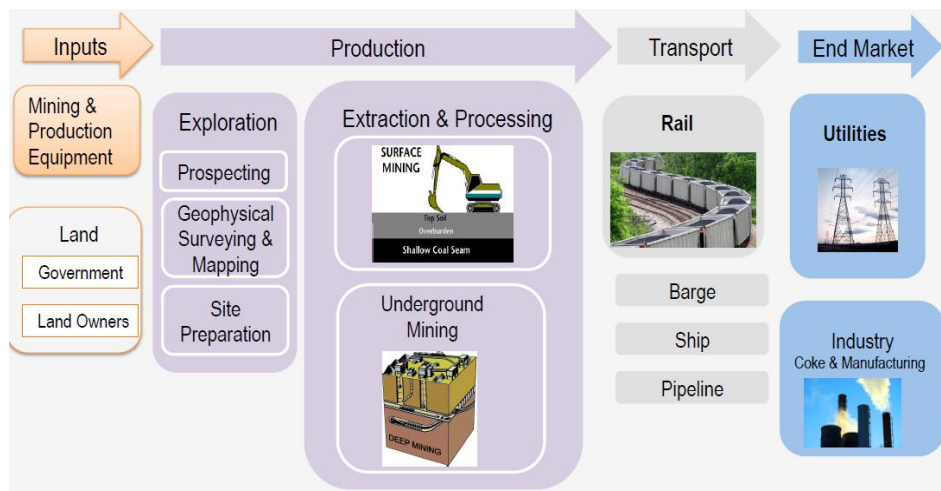
⁴ a.s. stands for Akciová spoločnosť (Literal translation: "joint-stock company")

⁵ E.g. The Self-Governing Region of Trenčín; Office of Labour, Social Affairs and Family Prievidza and Patizánske; Office of the Prievidza city.

⁶ A more detailed description of the activities within each Value Chain segment is given in chapter 2.2.

of employees and working profiles, financial performance, economic result of the activity, various categories of costs, taxes paid to the local and national government, shareholders rents. The final goal of this analysis is to quantify possible losses in terms of jobs, revenues, local taxes and invested capital in the region due to the phasing out of mining activities.

Figure 1. Coal value chain



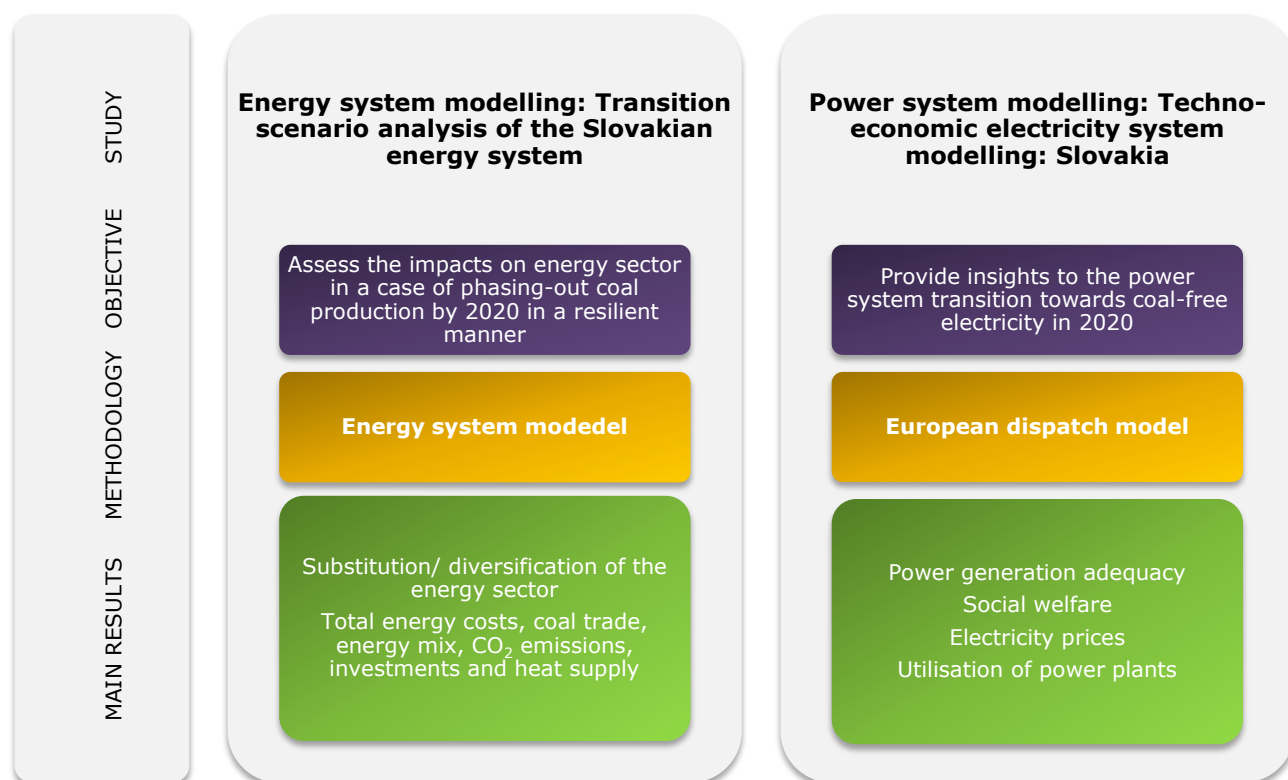
Source: (Gary Gereffi, Ghada Ahmed, Ajmal Abdulesamad, 2012)

The understanding of the coal value chain framework allows mapping the industrial activities of interest and the relative contribution to up and down-stream industries. Figure 1 is a good example for the case of the coal value chain framework.

Energy system modelling and analysis

The second part of the study addresses the impact of the mine closure on the energy system and of the electricity system of Slovakia.

Figure 2. Overview of the energy modelling approach



Methodologies to support to the process of socio-economic change in the pilot region

The above diagnostic approaches, the value chain analysis and the system modelling analysis, are meant to inform and support the last part of this study that is devoted to the elaboration of a proposal, based on analysis of specific needs and opportunities in Slovak NUTS3 region of Trenčín, that seeks to apply smart specialisation methodology in a specific context of coal transition territories (chapter 0).

Smart specialisation for coal transition

S3 approach has been tested in all the EU Member States – 120 national and regional Research and Innovation Smart Specialisation Strategies (RIS3) have been prepared as an *ex ante conditionality* for European Regional Development Fund (ERDF). As a result, more than EUR 40 billion have been allocated to implement the planned actions for carefully selected priority domains. 350,000 jobs are to be created at the end on the programming period 2014-2020.

Slovakia has a national RIS3, which, at present, does not include priorities directly connected with energy issues. The proposed approach does not foresee changes in the RIS3 that was earlier approved by the Commission (with an additional Implementation Plan), but to apply S3 methodology to solve complex challenges faced by Slovak NUTS3 region of Trenčín.

Smart specialisation process, especially including additional focus on societal change and skills can take 1-2 years. If the process is to be methodologically correct, there is a need to involve appropriate financial and organizational resources, both on JRC and pilot region's side. The approach described below is treated as a pilot, experimental action,

and can be updated during the implementation. In order to proceed to any next stage, the involvement of Slovak partners (as described below) will be necessary. After the testing phase and necessary updates, the methodology can be applied in other coal regions in Europe.

Table 2. Proposed S3 methodology for the pilot region

Stage	Description	Expected results	JRC support (S3 and energy experts)	Input from Slovak partners
I. Political and institutional framework				
1. Clear definition of the energy policy and planned energy mix	In order to plan the economic transition along the coal value chain, clear understanding of planned end result is needed – should the existing industries connected with coal be transformed/modernised or phased out? Energy transition scenarios can help decision-making in this case.	Defined energy policy and planned energy mix for the country	Development of energy transition scenarios, consultation of national energy mix	Decisions concerning energy policy taken by the national government
2. Identification of partners	In order to guarantee local ownership, appropriate partners at regional and/or national level have to be identified. They should be representatives of public authorities with power to design, launch, implement and monitor innovation policies and mobilise stakeholders.	Identified contact persons and decision-makers that can manage the smart specialisation process	Consult the choice of best partners	Appoint and empower appropriate entities – decision-makers and operational team
3. Identification of strategic mandates	Existing smart specialisation and other valid strategies should be analysed in order to identify priorities and sectors that are already supported, the actions already taken and possible synergies.	Clear picture of existing priorities, possible synergies and need to update strategic documents (if any)	Methodological support and consultation	Work of operational team on policy analysis
II. Diagnosis				
4. Detailed analysis of economic, innovative and scientific potential	S3 diagnosis is an analysis of economic, innovative and scientific potential. Analysis of economic potential should include regional specialisation and economic concentration patterns based on employment, value added and number of companies in different sectors. Other important aspects are	Evidence-based definition of possible transformation paths for the pilot regions	Expert support for the analysis of specialisation	Provision of statistical data and involvement of local experts, so capacity is built for future updates of the strategy

	national and international competitiveness of different sectors, preferably at NACE4 level. Innovative potential assessment is based on Research, Development and Innovation (R&D&I) performance of different sectors (Community Innovation Survey (CIS)-type data). Scientific potential analyses the ability of Research and Development (R&D) sector to contribute to knowledge-based industrial transformation. Sources of data include bibliometrics and patents.			
5. Identification of good practice and possible barriers	Examples of successful and unsuccessful transformation examples that can be an inspiration for the development of vision for the pilot region but also indicate possible barriers	Identification of possible partners/ experts for interregional cooperation	Organisation of a good practice sharing workshop	Providing venue and logistics for the workshop and mobilising appropriate stakeholders to take part
III. Stakeholders involvement				
6. Entrepreneurial discovery process (EDP)	Qualitative analysis and organized dialogue with business sector, representatives of research community and public authorities.	Verification of the preliminary transformation paths; definition of main trends and challenges, elaboration of vision of development and identification of necessary policy actions and instruments to be implemented	Expert support for the design and moderation of stakeholder workshops	Participation of the relevant stakeholders (including the political decision-makers) in EDP meetings, organisation of meeting venues and logistics, promotion of events
IV. Skills and social transition				
7. Definition of needed changes in skills profile	Analysis of business needs focused on definition of skills profile needed for the economic transformation. The analysis should include the identification of embedded competences of the workforce connected with the coal industry as well as the definition of the options for their best application in new industries, retraining and requalification and new competences and skills	In-depth understanding of skills needed to implement the defined vision of transformation of the region	Expert support for the design and execution of the study	Implementation of the results in existing strategies and Operational Programmes concerning education (new national education strategy, Operational Programme Education 2014-2020) and other available

	needed.			implementation instruments
8. Social change management	Involvement of wider civic society in the discussion on possible paths of modernisation, done according to the "participation ladder" – information (wider awareness campaign), consultation (participation of civic leaders and Non-Governmental Organisations (NGOs) in the debate), co-deciding and co-management.	Public acceptance of the chosen transformation path	Expert support and help to identify moderators for the process	Openness to involve citizens in decision-making process, consequence in implementation of the decisions (in order not to damage the public trust) and organization of meeting venues and logistics, promotion of events
V. Smart Specialisation Strategy and Implementation Plan				
9. Preparation of S3 coal transition strategy	Document with long-term transformation vision for the pilot regions, concrete actions to be taken and financial plan		Methodological support and consultation	Cooperation of decision-makers, operational team, local experts and stakeholders in preparation of the document plus its formal approval.
10. Implementation system	Definition of organizational structure able to deliver the implementation and monitoring of S3 coal transition strategy plus sound financing system to enable the implementation	Clear division of responsibilities for the implementation of S3 coal transition strategy, nomination of coordinating body and providing necessary financial resources to implement the planned actions	Involvement of JRC team with practical implementation experience in advisory and mentoring capacity	Nominating appropriate institutions and people able to ensure the implementation of S3 coal transition strategy at regional level and providing necessary financial and organizational resources

Source: JRC

In case more intense expert support is needed, it is suggested to use Lagging Regions methodology – see below.

Lagging regions methodology

The Lagging Regions methodology was first developed for the refinement and implementation of the Research and Innovation Smart Specialisation Strategy (RIS3) in the region of Eastern Macedonia and Thrace. This action also had the explicit aim to draw lessons for other low growth and less developed regions in Europe which were later used in Romania and selected low-growth and less developed regions in seven other EU member states.

An essential aspect of the methodology is to build a common understanding of RIS3 and the challenges to its implementation by stakeholders, the EC and the regional authority with the help of a series of stakeholder events, critical for the mutual learning process and trust building among stakeholders. The various tools developed and applied in the

region of Eastern Macedonia and Thrace preparatory action can, taken together, be seen to constitute a toolbox of approaches for RIS3 implementation (Boden, M., Dos Santos, P., Haegeman, K., Marinelli, E. & Valero, S., 2016).

This toolbox offers flexibility to further adapt methodologies to local needs and context. It can generate a wide set of tools and lessons on the implementation of regional smart specialisation strategies. These can be of benefit both to less developed regions that have struggled to restructure their economy in spite of considerable investments, and to all regions facing difficulties in implementing S3 as a new governance approach.

Table 3. Tool box for implementation and refinement of RIS3

Objective	Tool	Description
Idea generation, trust building and support quadruple helix cooperation	EDP focus group methodology	Step-by-step approach to identify or refine S3 priorities involving the quadruple helix
Open up to wider (online) communities	Online stakeholder engagement	Online tool for spreading information to wider groups of stakeholders. Can be used for idea prioritisation, partnership formation, online idea development, etc.
Address brain drain and build skills	Mobility Working Group	Bottom-up approach to develop a joint strategy and roadmap for increasing cross- sectoral and international mobility. It can also be widened to cover other types of skill development. Critical elements include both joint development and joint implementation by all actors involved.
Increase coordination between national and regional level	Methodology Project Development Lab 1 (PDL1)	Coordinated approach to analyse fundability, duplication and administrative and legal and state aid issues of business ideas involving relevant national and regional level administrations
Widen funding sources to draw on for idea implementation	Methodology Project Development Lab 2 (PDL2)	Specific advice from national contact points on the use of alternative funding sources for specific ideas
	Online Research, Development and Innovation (R&D&I) Funding Guide	Online overview of available funding sources
	Case descriptions	Examples of further developed ideas illustrating the potential use of different funding sources to support implementation
Implement or optimise a S3 governance structure	Governance working group	Bottom-up approach to develop or refine a joint strategy and roadmap for a S3 governance structure. Critical elements include both joint development and joint implementation by all actors involved.
Support ongoing stakeholder engagement	Stakeholder round table discussions	Well-orchestrated stakeholder discussions centred on specific discussion topics. Such discussions were applied in the kick-off event and in the Xanthi final event.
Identification of barriers and systemic failures and possible solutions	Tailored peer review events	Adaptation from the traditional approach to peer learning. Peer regions critically review one specific region, based on an identification of key bottlenecks in RIS3 implementation
Mutual learning		
Support to international cooperation	Board of critical friends	International group of experts from different backgrounds (peers, business, academia) reflect on methodology, thematic priorities and related implementation issues
	Collaboration spotting tool (developed through CERN-JRC collaboration)	Quantitative visualisation tool for identifying potential international R&D partners in specific cooperation areas
Develop the potential of Key Enabling Technologies (KETs) in S3	KET value chain analysis	Analysis of the potential contribution of KETs along the whole value chain of a thematic area, including supported functions, expected benefits and other knowledge supply synergies. Example developed for Information and communications technology (ICT) along the value chain of non-metallic minerals
	KET contribution and knowledge mapping at idea level	Analysis at detailed level of granularity of KET potential and required related knowledge and partners. Example developed for ICT for a series of business ideas.

Characterisation of the coal area of Upper Nitra, Trenčín region, Slovakia

1.1 Socio-economic analysis

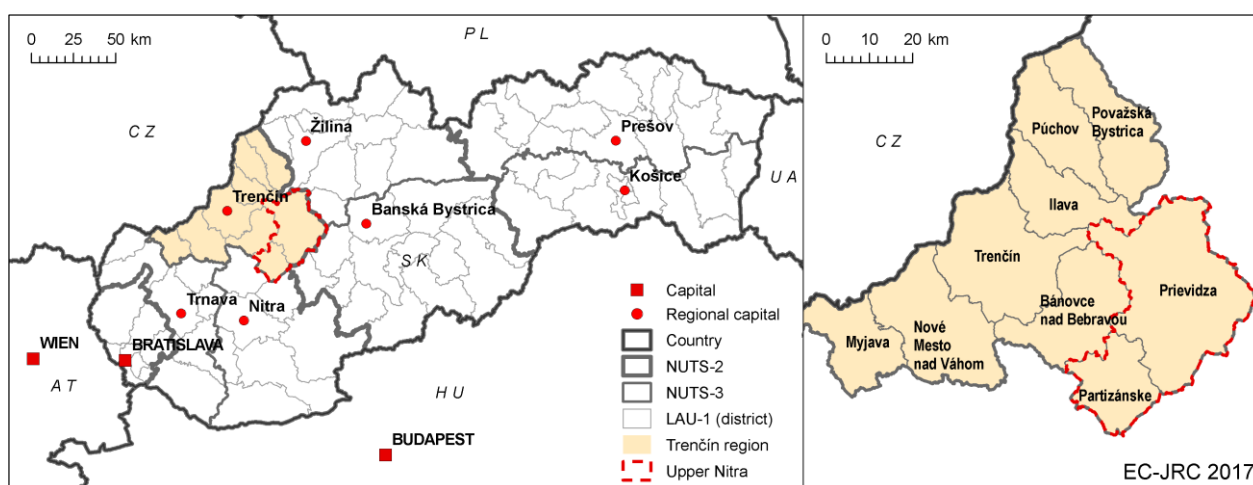
1.1.1 Geographical information

The geographical scope of this analysis is restricted to the districts of Partizánske and Prievidza located in Slovak administrative region of Trenčín (Trenčiansky kraj or TSK) (Trenčiansky samosprávny kraj, 2017). This territory is called the Upper Nitra and it is a transitional area between Central and Western Slovakia (Figure 3). Upper Nitra (Horná Nitra) is a physical-geographical and historical region in Slovakia with a rather vague definition (it currently does not exist as an administrative or statistical region). In physical terms, it is defined as the upper part of river Nitra's catchment. Hence it can be partly delineated by watersheds formed by mountain ranges surrounding the area (Strážovské vrchy, Žiar, Kremnické vrchy, Vtáčnik) rising to around 1,000 meters above sea level. This definition corresponds mainly to the districts (LAU 1 units) of Prievidza and Partizánske. The boundary of Upper Nitra is less clearly defined in the lowland, thus in a broader sense, it may extend to the east to include the districts of Topoľčany (gravitating towards Nitra) and Bánovce nad Bebravou (gravitating towards Trenčín). In the context of the coal economy, the latter districts are only indirectly concerned, the following figures will thus relate to the narrow definition (if not specified otherwise).

The administrative region of Trenčín has in total 9 districts. Its area is 4,502 km² (9.2% of total area of Slovakia) and has 592,394 inhabitants (9.1% of the country total) (Trenčiansky samosprávny kraj, 2015). The geographical scope of the JRC study is restricted to the districts of Partizánske and Prievidza located in the Slovak administrative region of Trenčín (Figure 4). This territory is called **the Upper Nitra**. The area of Upper Nitra is 1,261 km² (2.5% of total area of Slovakia) and has about 184,000 inhabitants (3.4% of the country total). The area lacks connection to larger cities by motorway or high-speed railway. Although Prievidza serves as a regional railway hub, the existing passenger lines have inferior speed and frequency compared to other parts of Western Slovakia.

Even though this analysis focuses mainly on the Upper Nitra, it is important to recognize that activities of the coal industry can be interconnected within the surrounding regions.

Figure 3. Location of Trenčín region and Upper Nitra (left) and the districts of Trenčín region (right)



Source: JRC

Table 4. Key facts about Trenčín region (2015)

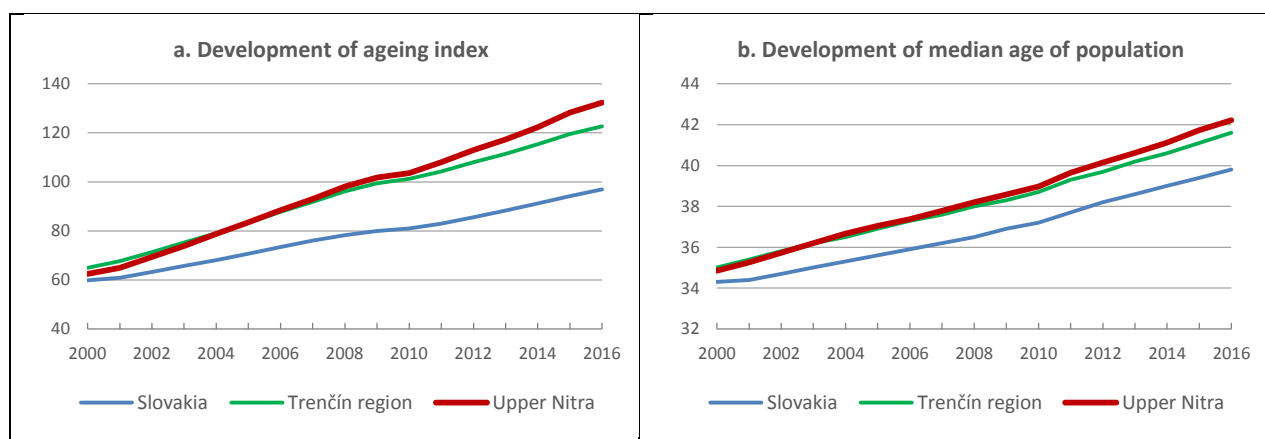
Territory	Area (km²)	Municipalities	Cities/Towns	Population	Population living in urban area	Density of population (inhabitant /km²)
Slovakia	49,035	2,890	138	5,415,949	2,928,981	110.5
Trenčín region	4,502	276	18	592,394	331,372	131.6
Bánovce nad Bebravou	462	43	1	36,963	19,133	80.0
Ilava	359	21	3	60,428	41,789	168.6
Myjava	327	17	2	27,229	17,155	83.2
Nové Mesto nad Váhom	580	34	2	62,468	29,415	107.7
Partizánske	301	23	1	46,735	23,709	155.3
Považská Bystrica	463	28	1	63,263	40,817	136.6
Prievidza	960	52	4	137,050	74,932	142.8
Púchov	375	21	1	44,596	18,121	118.8
Trenčín	675	37	3	113,662	66,301	168.4
Partizánske and Prievidza (% of total with respect to Slovakia)	2.57			3.4		

Source: (Trenčiansky samosprávny kraj, 2015)

1.1.2 Population

The population of Upper Nitra has been almost continually decreasing since the late 1990s. In the last 20 years it lost over 4% due to a combination of negative migration balance and natural population decrease. Such trend, however, is not isolated and is present in Trenčín region, Nitra region and the majority of Slovakia. Ageing of the population has been the characteristic demographic process in Slovakia for many years, and in Upper Nitra it has been accelerating at a faster pace compared to that of the region or the country. According to Slovak Statistical Office (Figure 4a and Figure 4b), the ageing index in Upper Nitra was over 130% and the median age was 42 years in 2016. Both indices exceeded the values recorded for Trenčín region as well as for the whole country).

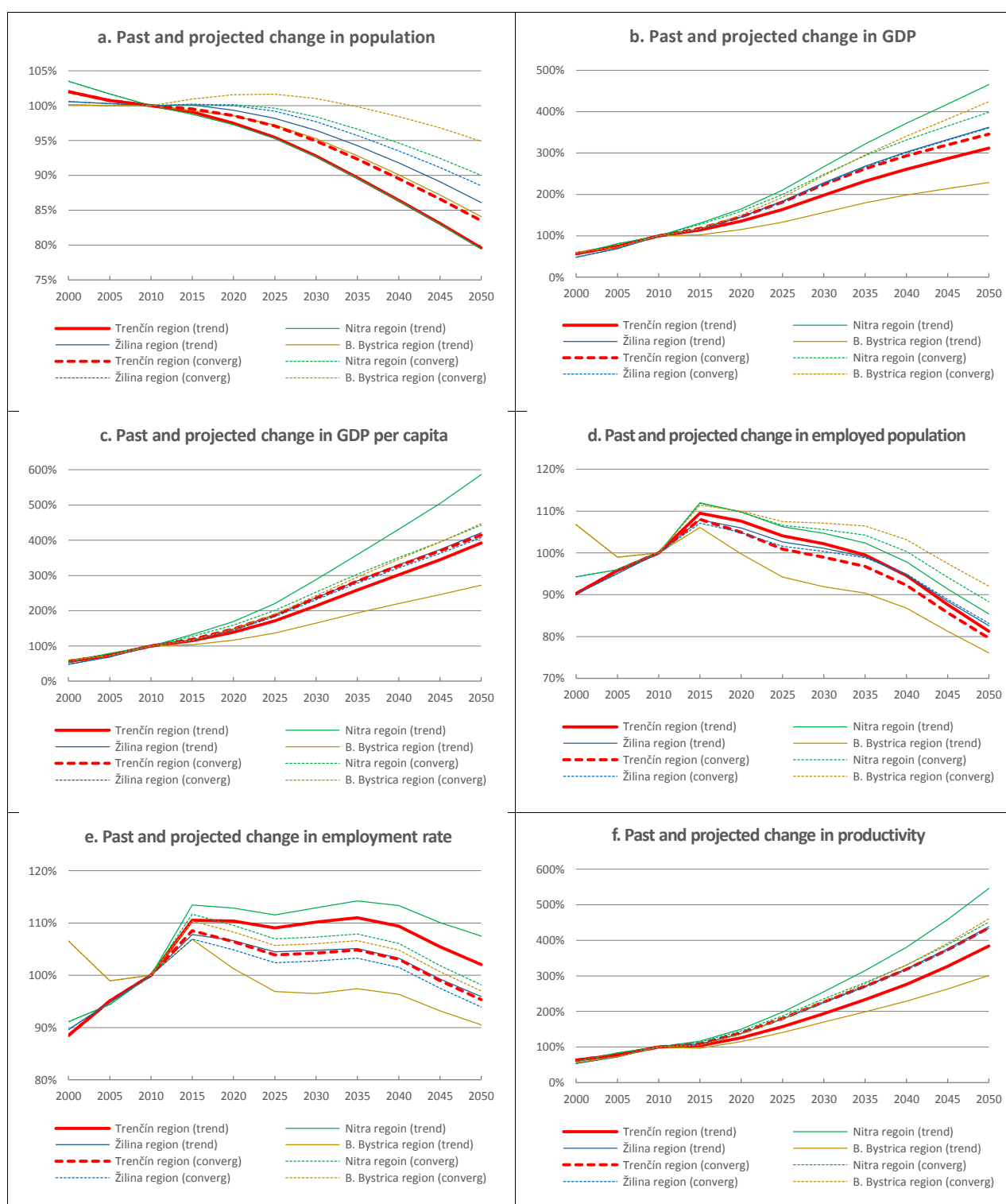
Figure 4. Ageing trends (2000-2016)



Source: (Statistical Office of the Slovak Republic, 2017)

Demographic and economic projections have been regionalised to NUTS3 level from Eurostat and DG ECFIN country-level data [73]. The regionalisation assumed two scenarios: trend scenario (business as usual) and convergence scenario (lagging regions are catching up). As for population, the decrease should continue until 2050 for the whole Trenčín region under both assumed scenarios – it should drop by around 20% compared to 2010 (Figure 5a). In contrast to population, GDP (in purchasing power parity) is expected to continue the growth trajectory from the past under both scenarios (Figure 5b). Given the decreasing population, GDP per capita is expected to grow even faster (Figure 5c). The absolute number of employed people is projected to drop (Figure 5d), as a result of ageing and decreasing population, but the employment rate is envisaged to become more or less stable until 2040 (Figure 5e). The productivity of labour is expected to increase substantially (Figure 5f), following the growing GDP produced by the shrinking workforce.

Figure 5. Past and projected changes in population and resulting impact on GDP, employment and productivity (NUTS3 level, values relative to the year 2010)



Source: JRC, (Batista e Silva, F., Dijkstra, L., Vizcaino Martinez, P., Lavalle, C., 2016)

1.1.3 Accessibility, land use and settlements

Upper Nitra lies at the intersection of influence zones of at least three regional capitals and, as a result, its administrative affiliation was changing in the past. Historically, it was part of the Nitra region, as the Nitra valley connecting the areas was the crucial transportation corridor in the past. During the socialist era, Upper Nitra was part of a

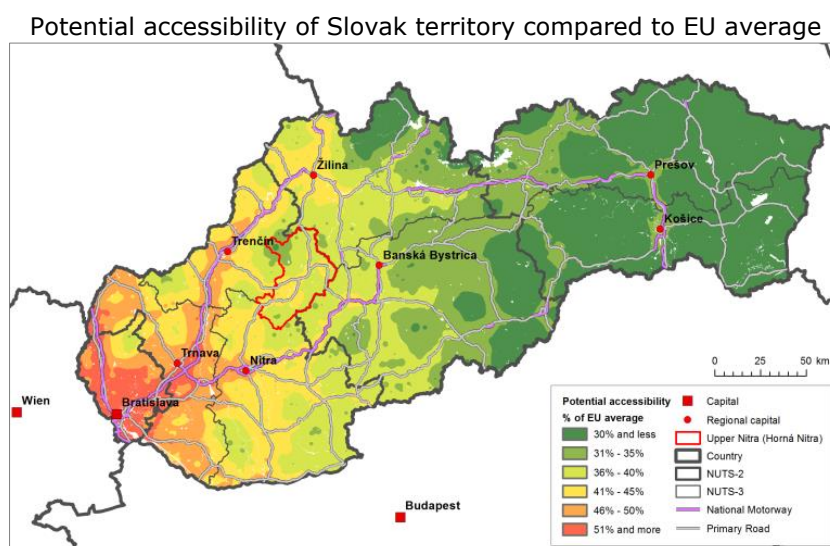
wider administrative region of Central Slovakia, with the capital of Banská Bystrica. Nowadays it is part of the wider region of Western Slovakia (NUTS2 Západné Slovensko), within the Trenčín self-governing region (NUTS3 Trenčiansky kraj).

Upper Nitra is located somewhat peripherally within Trenčín region, off the main regional axis of the Váh river valley, where the national motorway and the main railway corridor are located. Upper Nitra lacks connection to larger cities by motorway or high-speed railway. Although Prievidza serves as a regional railway hub, the existing passenger lines have inferior speed and frequency compared to other parts of Western Slovakia.

According to the potential accessibility modelling done by the EC-JRC LUISA Territorial Modelling Platform, Upper Nitra is lagging behind the central parts of Trenčín region and Nitra region and ranges within 35%-45% of the EU average (Figure 6). The potential accessibility is a measure that considers the opportunities for economic and other interactions, which are affected by both proximity and quality of road network and population density (Jacobs-Crisioni, C. et al.).

The modelling task did not consider the planned motorway R2 connecting Prievidza to Trenčín (via Bánovce nad Bebravou) and Banská Bystrica (via Handlová, Žiar nad Hronom and Zvolen), with some segments in the final stages of preparation. Upon completion, it should further ensure that the potential accessibility of Upper Nitra will increase despite the shrinking population.

Figure 6. Accessibility of Slovakia and the pilot region



Source: JRC, (Jacobs-Crisioni, C. et al.)

In terms of land use, mostly afforested mountains encircle the Hornonitrianska kotlina basin, which is occupied by agricultural, urban and industrial land uses. Centrally positioned in the basin is the town of Prievidza – the 11th largest town in Slovakia and the urban and industrial centre of Upper Nitra (food processing and mechanical engineering industries, among others). The headquarters of Upper Nitra mining company is located here, too. Prievidza is also a regional hub of transportation, commerce, services, education and healthcare. Together with the neighbouring town of Bojnice they form a continuously urbanized area of around 55,000 inhabitants. Bojnice is the regional centre for tourism with its spa, zoological garden, preserved castle and events. North of Prievidza, in Pravenec, manufacturing of car parts, windows and furniture takes place.

The town of Handlová (population 17,000) is located east of the Nitra river valley at higher altitude. Its economy has been unfolding mainly around the deposits of brown coal, extracted using depth-mining methods. Handlová also hosts a heating plant and a manufacturer of machinery parts. Another brown coal mine and a chemical plant are located in the town of Nováky. In its immediate vicinity (in Zemianske Kostolány) there is

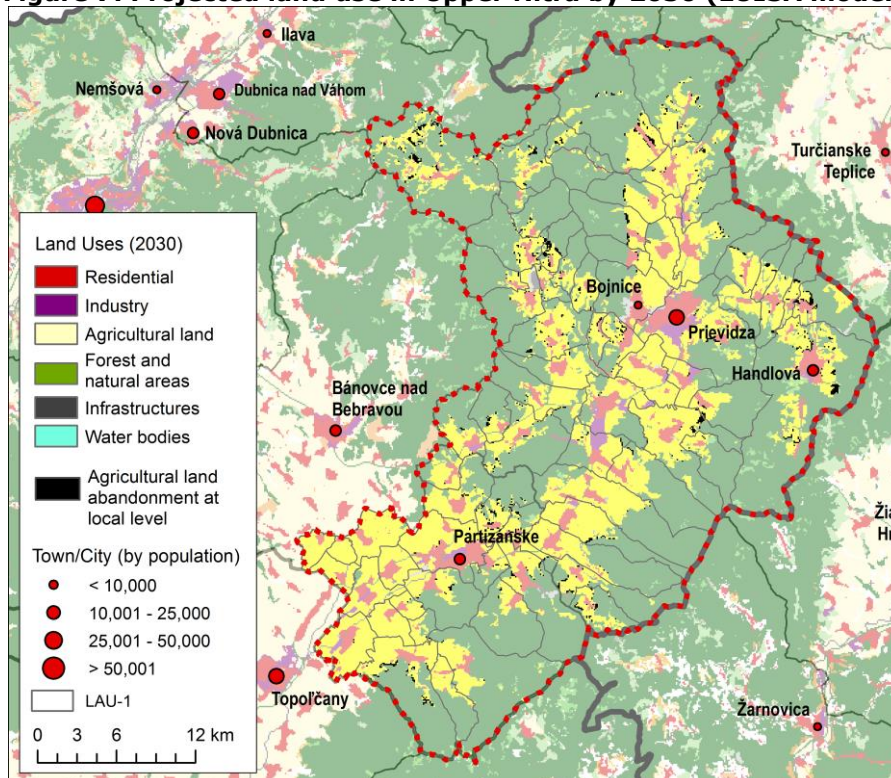
a thermal power plant (combusting the locally sourced coal and wood chips) as well as construction materials factory. A rubber processing factory is located in the nearby municipality of Dolné Vestenice.

Further downstream of Nitra river lies the town of Partizánske (population 23,000), known for its footwear industry, which gave rise to the town itself in the 1930s. Nowadays it harbours more diversified manufacturing, including a major producer of windows. The remaining municipalities are compact rural settlements (villages), with median population around 900 inhabitants. Typical agricultural activities are large-parcel arable agriculture and intensive livestock production done in cooperatives or in single farms. A notable exception is a mountainous area around Valaská Belá (northeast part of the region), with the settlement of scattered hamlets and more traditional, extensive agriculture.

The LUISA model (Lavallo C. et al.) estimates the possible and likely land use changes at a fine spatial resolution. The main land use changes concerning the region are growth of urban land and of land used for industry and commerce, as well as abandonment of agriculture. Demand for residential urban land expansion is driven by population change (but also changes in household sizes and other factors). As a result of the projected population decrease, only modest increase in the urban land is expected (6% until 2030). On the other hand, land for industry and commerce is projected to grow by 15%, owing to the economic growth.

Abandonment of farmland refers to land previously used for crop or pasture, which lost its farming functions (i.e. a cessation of agricultural activities) and has not been converted to forest or artificial areas. It is triggered by primary drivers – low productivity areas, remote and mountain regions, unfavourable soil and/or climate conditions for agriculture. Secondary drivers, such as rural depopulation, regional socio-economic factors, public policies and farming structure may further contribute to the risk of abandonment. There are multiple negative effects of such a land use change, e.g. landscape homogenisation and decline of regional incomes and employment. Taking into account projections of multiple abandonment drivers, Upper Nitra is estimated to lose 3.6% of its utilised agricultural area by 2030, while for the Trenčín region this value is envisaged to be more than double (7.7%) and for the whole Slovakia about 4.5% (Figure 7). All three values exceed the estimated EU-28 average of abandonment rate 2.5% (in the conservative scenario).

Figure 7. Projected land use in Upper Nitra by 2030 (LUISA model)



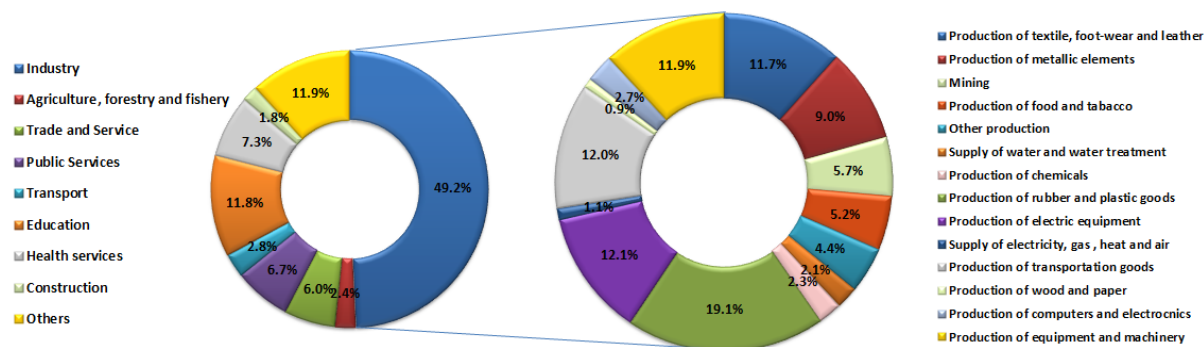
Source: JRC

1.1.4 Employment and skills profile

In 2014, the industrial sector holds 49.23% of the jobs in the Trenčín region (Figure 8). Significant shares were held by the sectors of education, trade and services and others: 11.8%, 6.0% and 11.9% respectively. The Upper Nitra employed in total 28,830 persons, of which 22,454 in Prievidza and 6,376 in Partizánske district (Trenčiansky samosprávny kraj, 2015).

Within the industrial sector, the regional enterprises employed 66,181 persons per month on average in the Trenčín Region, 3,845 in Prievidza district and 12,410 in Partizánske district in 2013 with an average salary of 875 EUR, 846 EUR and 674 EUR, respectively (Trenčiansky samosprávny kraj, 2015). Zooming to economic activities, the largest number of employees were in the manufacture of rubber and plastic products, 12,630 (19.1%); in the manufacture of electrical equipment 7,987 (12.1%); in manufacture of transport equipment 7,924 (12%); in production of equipment and machinery 7,848 (11.9%) and in the manufacture of textiles, footwear and leather and 7,736 persons (11.7%) (Trenčiansky samosprávny kraj, 2015).

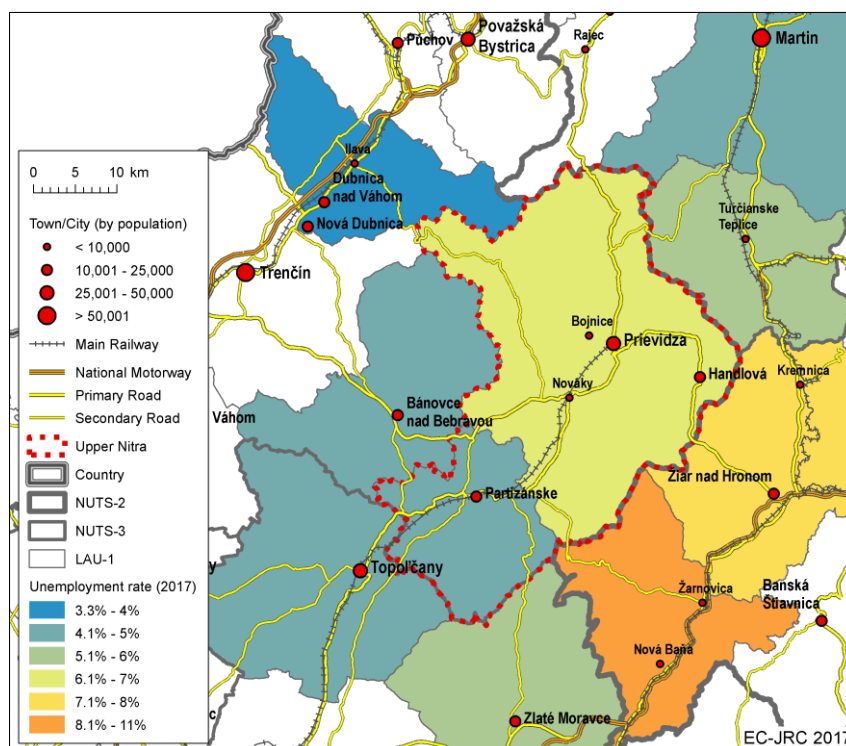
Figure 8. Share of jobs in Trenčín region by sector in 2013



Source: JRC elaboration on (Trenčiansky samosprávny kraj, 2015)

Figure 9 shows the unemployment rate in Partizánske, Prievidza and surrounding districts in 2017. The unemployment rate in Slovakia has been continuously decreasing since 2012 (Table 5). This trend is registered also in Trenčín region and Upper Nitra area. Although the unemployment rate in Prievidza is relatively high it has been decreasing in recent years. This can be linked to the arrival of new multinational investors in the region, such as BROSE spol. s r.o., Prievidza in 2015. This company specializes in the development, production and distribution of spare parts and accessories for motor vehicles, production of door systems, positioning seat systems and windows opening systems. In 2016, the company offered 150 new jobs and it plans to increase the number of new jobs to 600 over the next 5 years (Odbor služieb zamestnanosti, 2016). The steepest reduction in the unemployment rate in past years has been recorded in Partizánske district, mainly due to expansion of footwear manufactory and glass production company.

Figure 9. Unemployment rate in Partizánske, Prievidza and surrounding districts in 2017



Source: JRC elaboration on (Odbor služieb zamestnanosti, 2016)

Table 5. Trend of unemployment in Slovak republic, Trenčín region and Prievidza district

Territory	Year (December)							May
	2010	2011	2012	2013	2014	2015	2016	2017
	%							
Slovak Republic	12.46	13.59	14.44	13.5	12.29	10.63	8.76	7.35
Trenčín region	9.51	9.95	10.89	10.74	9.56	7.71	5.85	4.28
Prievidza district	12.05	12.88	12.97	13.9	12.47	10.37	8.13	6.11
Partizánske district	12.27	12.85	14.09	13.34	11.39	9.40	6.54	4.49

Source: (Hornonitrianske bane Prievidza)

According to the Central Office of Labour, Social Affairs and Family of Slovak Republic the unemployment rate was 4.49% in Partizánske and 6.11% in the Prievidza district in May 2017 (Generálne riaditeľstvo pre zamestnanosť, 2017). Indeed, the highest number of newly registered job-seekers for employment was recorded in the Prievidza district. Table 6 presents the detail of registered job-seekers at the Office of Labour, Social Affairs and Family in Partizánske and Prievidza districts. In Prievidza the number of registered job-seekers in dropped by half, from circa 10,000 in 2010 to 5,000 in 2017. Some of them have been unemployed before they registered as job-seekers. This group includes graduates, women after maternity leave and voluntarily unemployed. In both districts, job-seekers that worked as auxiliary not qualified workers before registering have the highest share, followed by job-seekers from services and trades.

Most of the job-seekers have achieved secondary vocational education and full secondary vocational education. The number of unemployed with basic education represents a large part of the long-term unemployed. The group of job-seekers that achieved university or higher education accounts for 5.71% in Partizánske and 4.62% in Prievidza.

Table 6. Detail numbers of unemployment in Upper Nitra in May 2017

	Partizánske	Prievidza
Number of economically active population	23,078	69,780
Total number of registered job-seekers	1,349	4,931
Categorized by last profession		
Trade Union	0	2
Management	10	72
Specialists	31	129
Technicians	56	209
Administration	46	253
Service and trades	123	485
Agriculture, forestry and fishery	11	20
Qualified craftsman	122	286
Machine operators	117	341
Auxiliary not qualified workers	127	532
Not identified	0	6
Unemployed before register	716	2,596
Disadvantaged job-seekers	1,099	3,996
Of which graduated	77	228
Of which University degree	26	58
Of which Higher education	51	170
Of which 50 years old and more	444	1,530
Of which long-term unemployed	531	1,997
Of which lower then vocational education	245	880
Of which longer than 12 months regular employment	767	2,768
Of which dependent citizens	37	3
Of which disabled citizens	50	342

Source: (Generálne riaditeľstvo pre zamestnanosť, 2017)

The group of disadvantaged job-seekers refers to the long-term unemployed (over 12 months), job-seekers who did not have regular paid employment for 12 calendar months, young below 29 years, older than 50 years, recently graduated, job-seekers with low education and disabled and dependent citizens. 96% of disadvantaged job seekers did not have regular work for 12 calendar months or is long-term unemployed. This is a complex issue as these people are losing their regular working habits and they are not willing to integrate to the job market. The share of unemployed over 50 years is also high, almost 40%. The biggest barrier in their integration is the concern of employers about their health issues, reduced intellectual capabilities, and lower productivity. Another targeted group are young people under 29 years. They are identified as a disadvantaged group of the population because they have little or no work experience. Even with increased demand from the labor market, companies prefer to employ a job-seeker with more experience and who has already developed his/her working habits. The young people face higher risk of being unemployed, also in the long-term. The long-term

unemployment of young people eventually converts to work passivity. Moreover, due to unemployment, a young person loses his/her knowledge and skills achieved during the studies period of time.

Despite the large number of registered job-seekers there are vacancies that remain unoccupied. Table 7 shows the number of vacancies in Partizánske and Prievidza registered at the Office of Labour, Social Affairs and Family. It should be noticed that companies are not required to report their vacancies. The registered offers are based on voluntary basis. Most job vacancies are offered to qualified technicians, qualified craftsmen and operators of machinery and equipment. This fact reflects the potential of the area for the development of industrial production and crafts. On the other hand, the lowest need is for skilled workers in agriculture, forestry and fisheries and in management. The imbalance between the job vacancies and job seekers remains a problem. The causes may be several, including, but not limited to, inadequate qualifications. This problem has been recognized by the office of the Self-Governing Region of Trenčín. Regional authorities focus especially on young generation promoting measures under which students follow more appropriate vocational courses (Office of Self-Governing Region of Trenčín).

Table 7. Registered open position in the Office of Labour, Social Affairs and Family of Partizánske and Prievidza district

	Partizánske	Prievidza
Total number of registered vacancies	508	1,172
Of which suitable for graduated	419	757
Of which suitable for disabled citizens	20	72
Suitable for profession of		
Management	0	12
Specialists	11	68
Technicians	5	43
Administration	8	32
Service and trades	48	190
Agriculture, forestry and fishery	8	1
Qualified craftsman	303	409
Machine operators	109	310
Auxiliary not qualified workers	16	107

Source: (Generálne riaditeľstvo pre zamestnanosť, 2017)

Interestingly, one of the lacking profession in the Prievidza district is miner (Odbor služieb zamestnanosti, 2016). The Office of Labour, Social Affairs and Family in Prievidza has so far recognized the situation in the mining company, HBP, as stabilized and in the near future also prospective. However, filling vacancies for a miner position is becoming challenging, because of a low success rate of compatible candidates. The most common obstacle is the physically demanding work that is perceived by job-seekers as health and life threatening with inadequate financial compensation. Working as a miner requires a good health condition. Also, there may be a certain fear that, due to an expected decline in coal production in Hornonitrianske bane Prievidza (HBP), the job is unstable.

1.1.5 The business sector

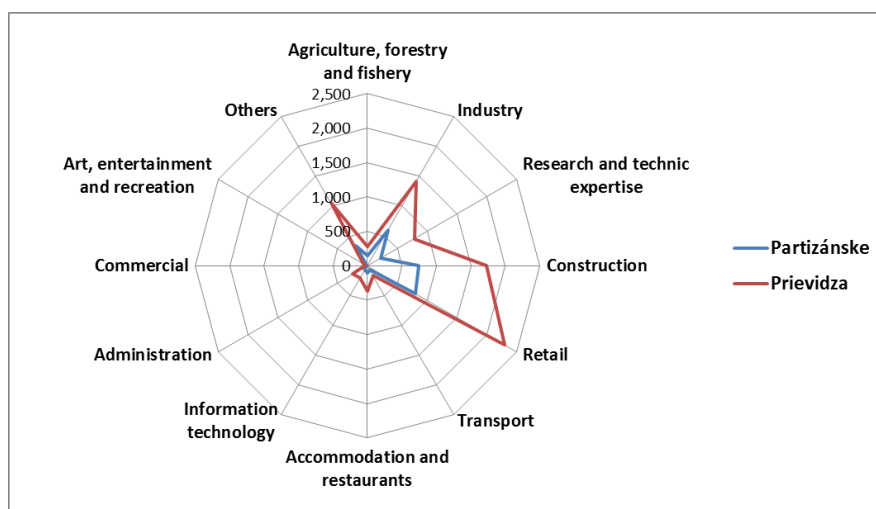
60,507 business entities were registered in the Trenčín region in 2014; out of which there were 1,209 in Partizánske and 4,028 in Prievidza non-profit organizations (Table 8). The highest number of entrepreneurs was recorded in Prievidza district, 8,643, accounting for 22% of the total number of entrepreneurs in Trenčín region. Most of them were in the wholesale and retail trade (24.9% in Trenčín), followed by the construction sector (21.5%) and the industry (18.6%) (Figure 10).

Table 8. Number of business entities

Business entities	Trenčín region	District	
		Partizánske	Prievidza
Legal entity	21,097	1,209	4,028
Of which: Companies	15,465	896	2,814
Non-profit institution	5,632	313	1,214
Entrepreneurs	39,410	3,183	8,643
Of which: Self-employers	36,921	2,964	8,105
Self-employed professionals	2,208	174	486
Self-employed farmers	281	45	52

Source: (Trenčiansky samosprávny kraj, 2015)

Figure 10. Number of entrepreneurs per business activity



Source: JRC elaboration on (Trenčiansky samosprávny kraj, 2015)

The Trenčín region is an economically developed region of Slovakia with a large density of the industrial sector. In total, there are 414 industrial enterprises with 20+ employees. The Trenčín region has a long tradition in the field of engineering, rubber production, and footwear and textile manufacturing. Recently, even advanced industries, such as electro-technical production, started to have a strategical role in the region. This is reflected in the financial situation of the industrial sector. In 2013, the largest share of sales was made by rubber and plastic products (28.6%), followed by the manufacture of electrical equipment (14.9%), the manufacture of machinery and equipment (13%) and the manufacture of transport equipment (12.1%) (Trenčiansky samosprávny kraj, 2015). Table 9 presents companies with the highest number of employees in the Upper Nitra

area. The mining company Hornonitrianske bane Prievidza, a.s.⁷ is the most important company in the district. Also company Fortishem, specialized in chemical industry, has long tradition in the region and employed more 1,100 employees in 2013. The most significant foreign investments were in the supply for the car industry. Cluster of three associated companies producing rubber and plastic components for car industry is situated in Dolné Vestenice. Another important companies, in terms of employment, in the Upper Nitra area are the manufacturer of footwear, Rialto, chain of pharmacies, Unifarma, food producer, Nestlé, and chain of general stores COOP Jednota located in each town of the area.

Table 9. Companies with the highest number of employees in Upper Nitra in 2013

Company	Number of employees	Activity
BROSE, Prievidza	150	Production of components and systems for car industry
ContiTech Vibration Control Slovakia s.r.o. ⁸ , Dolné Vestenice	597	Production of rubber and plastic components for car industry
COOP Jednota Prievidza, spotrebné družstvo, Prievidza	650	General store
FORTISCHEM a. s., Nováky	1,134	Chemical industry
GeWiS Slovakia s.r.o., Prievidza	1,069	Production of components and systems for car industry
Hornonitrianske bane Prievidza, a.s.	3,452	Mining
Nestlé Slovensko s.r.o., Prievidza	758	Production of food
Rialto, Partizánske	1,000	Production of footwear
SaarGummi Slovakia s.r.o., Dolné Vestenice	871	Production of rubber components for car industry
SLOVAKTUAL s.r.o., Pravenec	545	Production and installation of plastic windows
UNIPHARMA - 1. slovenská lekárnická akciová spoločnosť, Bojnice	730	Pharmacy
VEGUM a.s., Dolné Vestenice	696	Production of rubber

Source: (Odbor služieb zamestnanosti, 2016)

From the table above, it is possible to see, that in the period 2007-2014 Trenčín region received a total of EUR 94.534 million which were invested in 7 companies from 5 cities (Trenčiansky samosprávny kraj, 2015). These investments created 3,019 new jobs in the region.

⁷ a.s. stands for Akciová spoločnosť (Literal translation: "joint-stock company")

⁸ s.r.o stands for Spoločnosť s ručením obmedzeným. Literal translation: "company with limited liability".

Table 10. State subsidy to industry sector in the Trenčín region

Company	City	Subsidy (thousands EUR)	Year	Number of created jobs
AU Optronics Slovakia	Trenčín	38,268	2009	1,300
Continental Matador Rubber	Púchov	19,933 14,580	2013 2011	595 324
TRW Automotive Slovakia	Nové Mesto n. Váhom	8,498	2007	155
Delta Electronics (Slovakia)	Ilava	5,121	2012	200
Rübig SK	Prievidza	4,046	2007	155
SLOVAKTUAL	Prievidza	2,653	2014	120
LEONI Slovakia	Trenčín	1,435	2014	170
Together (7 companies)		94,534	-	3,019

Source: (Odbor služieb zamestnanosti, 2016)

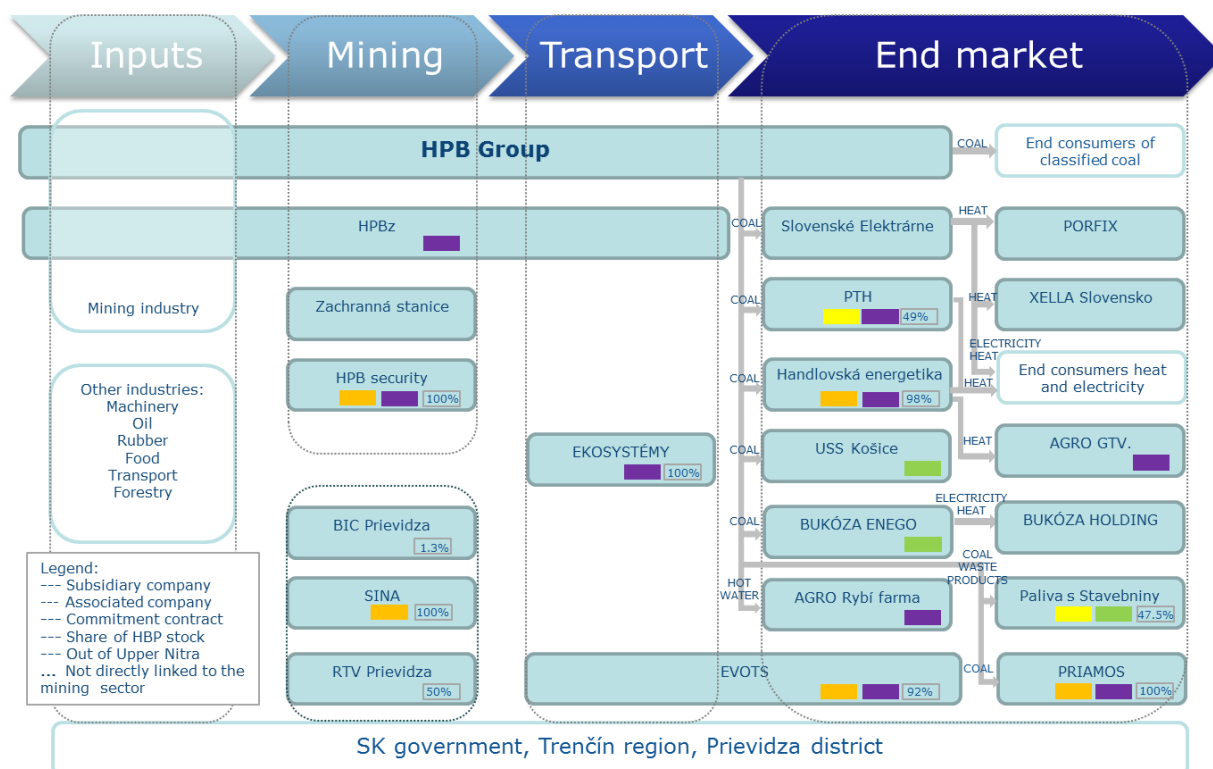
1.2 The coal value chain in Upper Nitra

According to the approach used in this study four segments of the coal value chain can be distinguished (Figure 11):

- Factors of production: INPUTS
- Coal production: MINING
- Trade of final product: TRANSPORT
- Final consumption: END MARKET

The first segment, "inputs", includes the activities related to the provision of the production factors (mining and production equipment land and extraction rights acquisition from the government and land owners); the second segment "production or mining" includes exploration extraction and processing activities both at the surface and underground level; "transport" is the third segment which includes the activities related to the transport services of input materials and final products; the last segment refers to the final markets characterized by economic activities that use coal products and by-products and it-s therefore called "end market". Figure 11 maps the companies of the Upper Nitra that are in various ways linked to each one of the segments of the coal sector value chain and its sub-sectors.

Figure 11. Overview of companies linked to the coal value chain segments in the Upper Nitra region



Source: JRC

In the paragraphs below we give a short description of the activity of the main companies that are directly and indirectly related to the coal industry in the Upper Nitra region.

1.2.1 Factors of production: INPUTS

Equipment and machinery

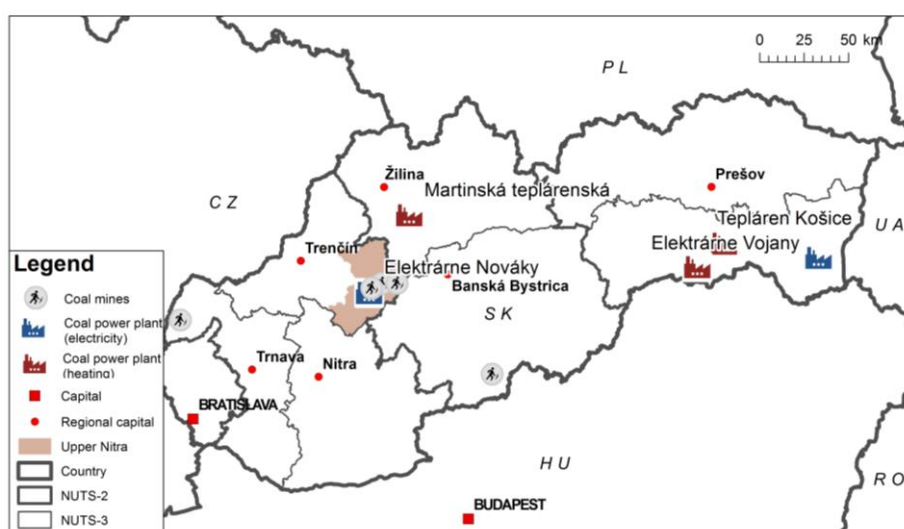
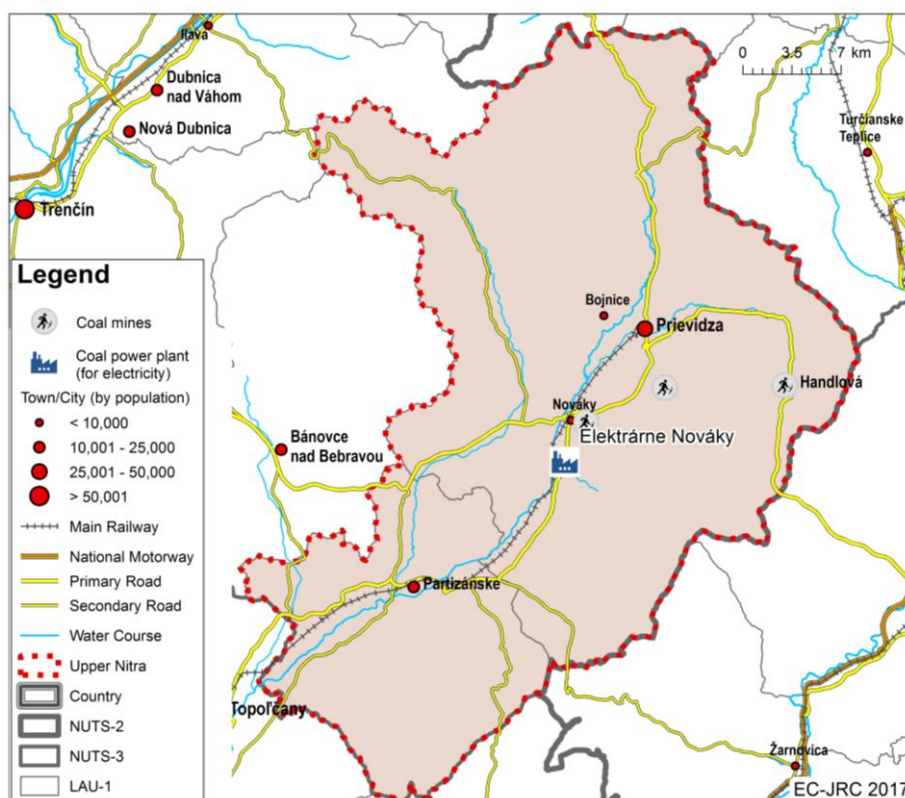
Hornonitrianske bane zamestnanecká a.s. (HBPz a.s.)

HBPz a.s. produce mining mechanized supports and other machinery and equipment. Also it is responsible for the railroad transport. HBPz provides services and maintenance of railway wagons and operates the railway transport of coal to Nováky power plant collaborating with the state railways infrastructure (Hornonitrianske bane Prievidza, 2016). Moreover HBPz has its own freight transport and machines that are primarily used for the construction of tunnels and other requirements linked to HBP. Free transport capacities are deployed in external works such as distribution of stone slabs and aggregates or various construction works.

1.2.2 Coal production: MINING

The most important coal mines in Slovakia are in the Upper Nitra. The deposits of brown coal in the Upper Nitra region are located in three underground collieries at Nováky, Cígel and Handlová (Figure 12). The production of brown coal has been moderately decreasing since 1990 reaching 1.8 Million tonnes in 2016 (EUROSTAT). A total of 229.36 Million tonnes of brown coal was produced by HBP group since the beginning of coal mining (Hornonitrianske bane Prievidza, 2017).

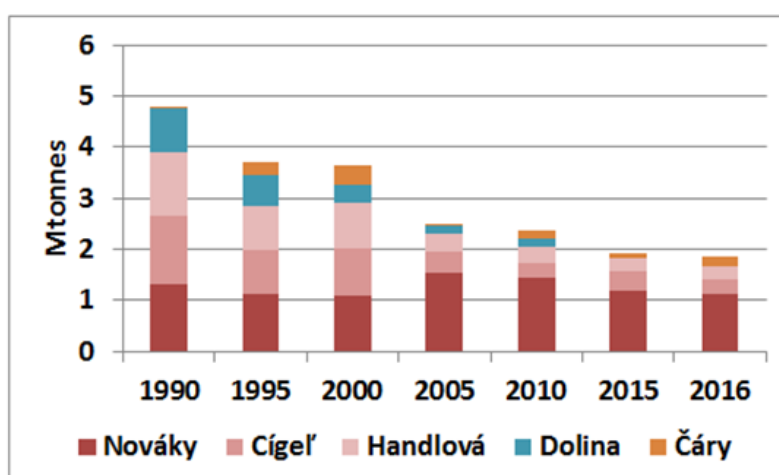
Figure 12. Map of the Slovakian coal mines and power plants



Source: JRC elaboration on (E-PRTR) (EuCoRes) and (USGS).

Figure 13 presents the historical review of coal extraction in all Slovakian collieries. Colliery Dolina ended its activity in 2015 after the Slovakian government agreed on its recession in 2011. Colliery Čáry is located Trnava region and since November 2015 also belongs to the HBP group.

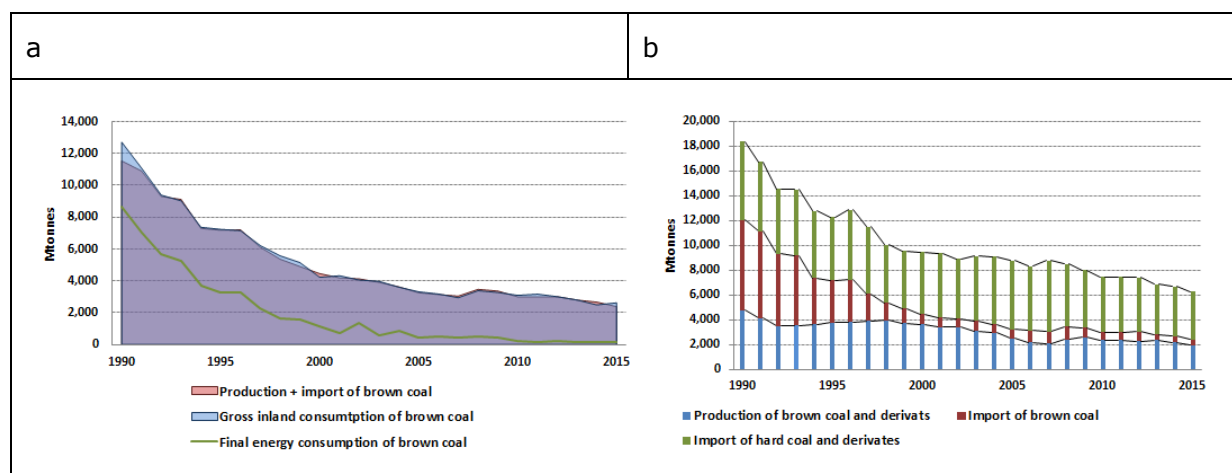
Figure 13. Production of coal in Slovakia (Million tonnes)



Source: (Hornonitranske bane Prievidza, 2017)

Slovakia also imports brown coal mainly from the Czech Republic. Imports of brown coal have been gradually decreasing from 6.3 Million tonnes in 1990 to 0.5 Million tonnes in 2016 (Figure 14a). Slovakia does not have abundant reserves of hard coal. To satisfy the coal demand large amount of hard coal and its derivatives (mainly coke) is imported from Ukraine. The imports of hard coal and derivatives remain stable over time and the hard coal is consumed primarily in the steel industry - U.S Steel Košice - and the thermal power plants in Vojany both in Eastern Slovakia.

Figure 14 a Coal production and imports; b. Brown coal production and consumption



Source: JRC elaboration on (EUROSTAT)

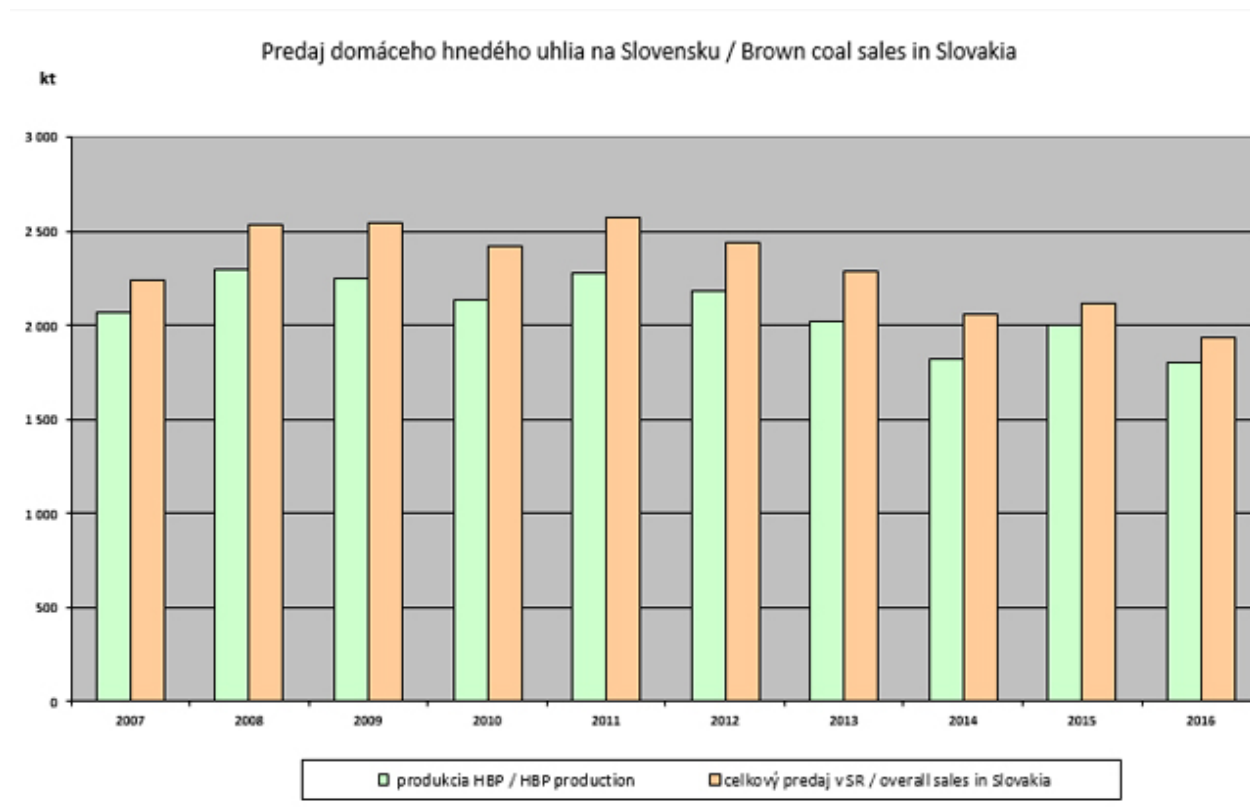
Figure 14b presents the balance between the production plus import of brown coal and the gross inland consumption of brown coal over time. The final energy consumption of the brown coal has been decreasing over time. In 2015 most of the brown coal was used by power producers and energy transformation processes and only 5% was used for final energy consumption.

Coal extraction sector

Hornonitrianske bane Prievidza, a.s. (HBP)

Today HBP is the only coal mine company in the country. It has 100-years of tradition in brown coal mining in Slovakia. The main areas of activity of the company are exploration mining treatment and sale of brown coal. In total in 2015 HBP produced 1,998,195 tonnes of coal of which 26,176 tonnes of a high quality classified coal (Hornonitrianske bane Prievidza, 2016). From 2007 to 2013 HPB coal production was always above 2 Million tonnes while it slightly decreased afterwards (Figure 15) representing a share of national sales never below 80%.

Figure 15. HBP production and sales of brown coal



Source: (Hornonitrianske bane Prievidza)

In 2015 HBP sales of products, services, goods and materials accounted for a volume of EUR 121,764,400 and representing 99.4% of the total revenue (Table 11). The largest volume of sales was achieved for the sale of coal. Labour costs represented the highest share of total costs and reached EUR 54,779,000, which accounted for 44.8% of the total costs of the company. Material consumption represented a share of 19.1% energy consumption 7.7% service 10% and depreciation 9.3% of the total costs.

Table 11. Financial indicators of HBP activity in 2015

Total revenues (EUR)	122,539,939
Total costs (EUR)	122,146,401
Taxes (EUR)	68,440
Profit (EUR)	393,538
Average number of employees	3,486
Average salary (EUR /employee/month)	890
Tangible fixed assets (EUR)	4,201,163
Value added (EUR)	66,672,701
Productivity of mining (tonnes/employee/month)	43.5
Productivity over value added (EUR /employee/month)	1,593
Share of labour costs (%)	82.2

Source: (Hornonitrianske bane Prievidza, 2016)

The company has a movable and immovable property such as land, buildings and equipment. In addition HBP group has a capital share in 11 companies 100% of HBP Security, PRIAMOS, EKOSYSTÉMY, SINA and nearly 100% of HANDLOVSKÁ ENERGETIKA and EVOTS. Likewise HBP is an investor of several recreational and restauration services and supports regional development (Hornonitrianske bane Prievidza, 2016). Table 11 shows the companies which are linked to HBP and grouped according to the value chain segment to which they belong.

Mining rescue service

Hornonitrianske bane a.s. hlavná banská záchranná stanica, odštepny závod

The Main Mining Rescue Station of Prievidza is integrated into the Mining Rescue System of Slovakia. Its main activity is the mining rescue service. Additionally qualified workers carry out other commercial activities such as monitoring of emissions underground chemical analysis of landfills gases (Hornonitrianske bane Prievidza, 2016). They may work at elevated heights and temperatures or operate health threatening substances.

Security service

HBP Security s.r.o

HBP Security s.r.o is a private security agency owned 100% by HBP. It secures HBP sites, infrastructure and equipment (Hornonitrianske bane Prievidza, 2016).

1.2.3 Trade of final product: TRANSPORT

EKOSYSTÉMY s.r.o.

EKOSYSTÉMY s.r.o. is a company that specializes on surface metal treatments. HBP uses its service for repairs and maintenance of wagons and containers surface treatment and technical examination of railway line and wagon trucks (Hornonitrianske bane Prievidza).

EKOSYSTÉMY s.r.o. has commitment contract with HBP and 100% of its shares belongs to HBP (Hornonitrianske bane Prievidza, 2016).

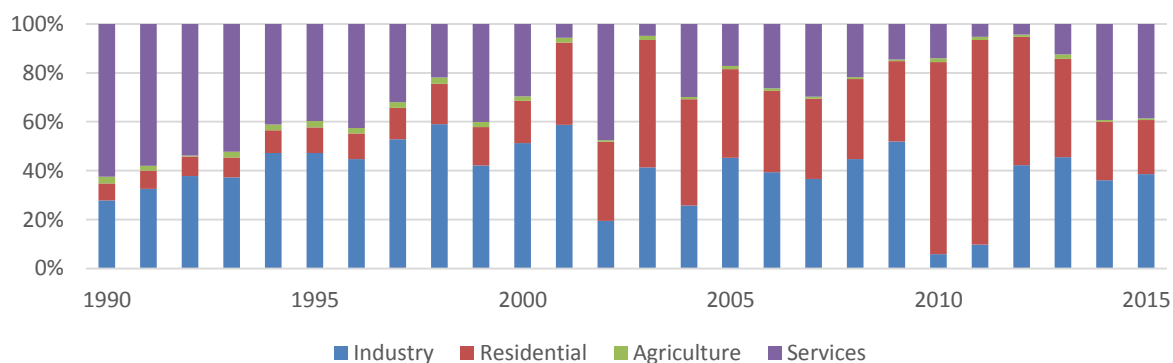
EVOTS s.r.o.

EVOTS s.r.o. is a subsidiary company of HBP a.s. Its main activities are services of freight transport, excavations, demolitions, waste management, retail of goods to the final user and production of concrete from the waste products (Obchodný register).

1.2.4 Final consumption: END MARKET

In 2016 more than 98% of produced coal was used for electricity generation (precisely Combined Heat and Power). Contrary to the hard coal primarily used in the industrial sector the dominant share of final energy consumption of brown coal has been shifting over time among the industry residential sector and services (Figure 16).

Figure 16. Share of final energy consumption of brown coal



Source: JRC, (EUROSTAT)

The biggest customers of HBP a.s. in 2015 were Slovenské elektrárne a. s. owner of the Nováky power plant that purchased 1,883,195 tonnes of brown coal (almost 94% of HBP production) for the power plant Nováky. Another important long-term business partner is Bukóza Energo in Eastern Slovakia which purchased more than 70,000 tonnes of coal in the same year. A small amount of coal around 10,000 tonnes has been delivered to the steel industry at US Steel Košice. Almost 35,000 tonnes of classified coal were sold to individual end users in 2015 (Table 12).

Table 12. Main customers of HBP

Company	Sales in 2015 (tonnes of coal)
Slovenské elektrárne	1,883,195
Bukóza Energo	70,000
US Košice	10,000
Individual end users of classified coal	35,000
Total coal production in 2015	1,998,195

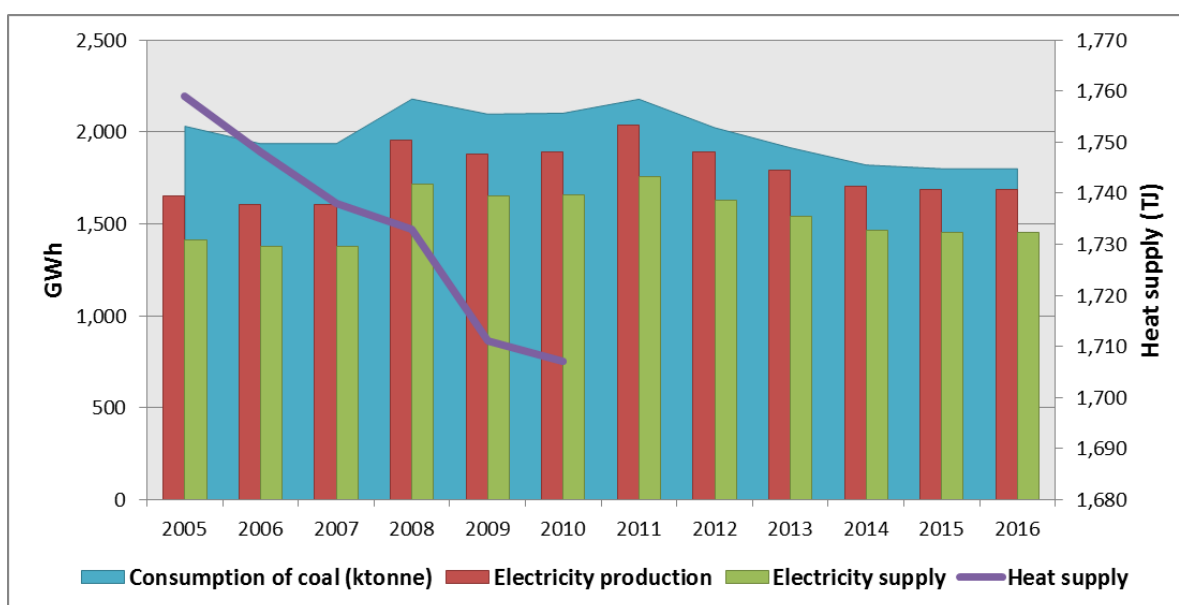
Source: (Hornonitrianske bane Prievidza, 2016)

Electricity and heating sector

Nováky Power Plant

Nováky Power Plant in Zemianske Kostolány is owned by Slovenské elektrárne (SE). With its total installed capacity of 266 Mwe, this is the main source of electricity in the Trenčín region. It covers not only base consumption but also peak demand and any electricity system deviation. Nováky power plant also supplies hot water for central heating systems of the towns of Prievidza, Nováky and Zemianske Kostolány and heat to the surrounding industrial enterprises. The power plant is primarily burning brown coal from Slovak coal mines. The historical trend of electricity and heat production at Nováky power plant are presented in Figure 17. Around 350 employees are employed in Nováky power plant, nearly 93% of them comes from Prievidza district (Ministretstvo hospodárstva Slovenskej Republiky, 2013).

Figure 17. Production and supply of electricity heat supply and coal consumption in SE a. s. – Nováky power plant



Source: JRC elaboration on (Ministerstvo hospodárstva Slovenskej Republiky, 2010) and (Ministry of Economy of the Slovak Republic)

HANDLOVSKÁ ENERGETIKA s.r.o.

The thermal power plant was built in 1911 to serve as the principal source of electricity and steam supply for the collieries in the area. In 1954 the Handlová power plant became a subsidiary company of Nováky power plant. However after a fire in the cooling tower in 1982 electricity production was stopped and today the plant only supplies steam and heat for the town of Handlová (Handlovská Energetika). HBP has 98% shares of HANDLOVSKÁ ENERGETIKA s.r.o. Since the reconstruction of the burner in 2015, the Combined Heat and Power plant has been combusting also biomass.

Prievidzské tepelné hospodárstvo a.s. (PTH a.s.)

The main activity of PTH is production and distribution of heat. The company is responsible for the heat distribution in the city of Prievidza which is mostly supplied by natural gas (Prievidzské tepelné hospodárstvo). Stakeholders of PTH are the city of Prievidza (51%) and HBP (49%).

BUKÓZA ENERGO a.s.

BUKÓZA ENERGO a.s. is producer of electricity and heat and one of the main costumers of HBP. Its production covers the consumption of the BUKÓZA HOLDING Group (production of paper and toiletry) and provides heat and domestic hot water which is distributed to the town Vranov and Topľou (BUKÓZA ENERGO). Vranov nad Topľou is not in the Upper Nitra region.

Retail of coal and waste products

Palivá a stavebniny a.s.

Palivá a stavebniny a.s. is the intermediary of coal and other solid fuels. Palivá a stavebniny a.s. is an associated company of HBP which has 47.5% its shares (Hornonitrianske bane Prievidza, 2016). Apart from the activities linked to HBP it also provides small car repairs retail of different goods and marketing activities. The company is not in the Upper Nitra region.

PRIAMOS a.s.

PRIAMOS a.s. is another subsidiary company of HBP; HBP group owns 100% of its capital. It is the intermediary of coal and waste products from HBP (Hornonitrianske bane Prievidza, 2016).

Agriculture

AGRO GTV s.r.o.

AGRO GTV s.r.o. uses heat produced from HANDLOVSKÁ ENERGETIKA s.r.o. to operate greenhouses. It mainly grows tomato and cucumbers. Today the greenhouses cover 19.1% of the total domestic tomato production (Hornonitrianske bane Prievidza, 2017).

AGRO Rybia Farma s.r.o.

AGRO Rybia Farma s.r.o. uses directly the hot water from the mine to breed and treat African Catfish (Hornonitrianske bane Prievidza, 2017).

Steel industry

U. S. Steel Košice s.r.o.

USS Košice is an integrated steel producer which belongs to the United State Steel Corporation (U. S. Steel Košice). USS Košice uses coal for production of steam in the factory. The company is in Eastern Slovakia.

Production of construction materials

PORFIX a.s. and XELLA Slovensko s.r.o.

These companies are main consumers of the industrial heat produced in Nováky power plant. Their activity is manufacturing of concrete and construction materials (Generálne reditelsvo pre zamestnanost, 2017)

Other services with HPB shares

SINA s.r.o.

HBP is 100% stakeholder of SINA s.r.o. The company provides accommodation housing and restauration services.

BIC Prievidza s.r.o.

BIC Prievidza s.r.o. is a business and consultancy company. It provides courses and professional training and also handles new companies in the HBP group. HBP has 1.3% of its shares.

Regionálna televízia Prievidza s.r.o.

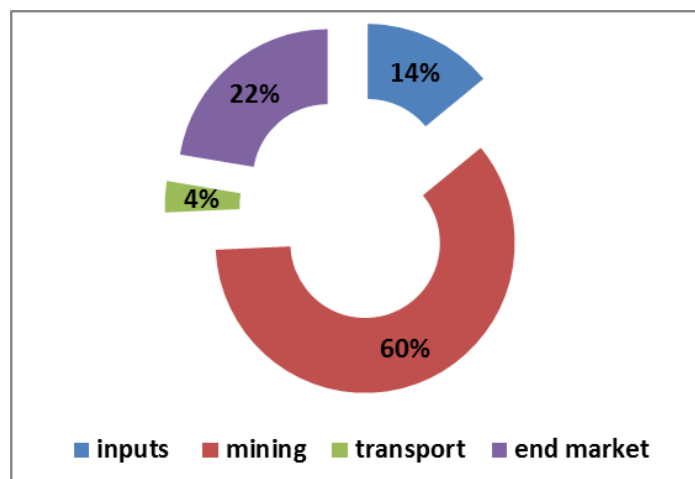
RTV Prievidza is the regional TV channel 50% shared by HBP.

1.3 Overall contribution of the coal industry to economic activity in the Upper Nitra area

Employment and salaries

The 60% of the total employees of the Slovakian mining company HBP and its suppliers and customers companies is active in the mining segment of the value chain. The second segment where employees are more numerous is the end market followed by the segment providing the factors of production and finally the transport.

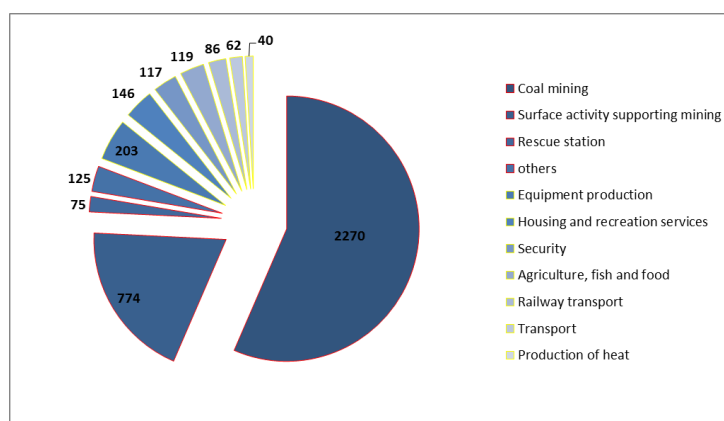
Figure 18. Share of employees of the HBP by coal value chain segment



Source: JRC elaboration on (Hornonitrianske bane Prievidza, 2016)

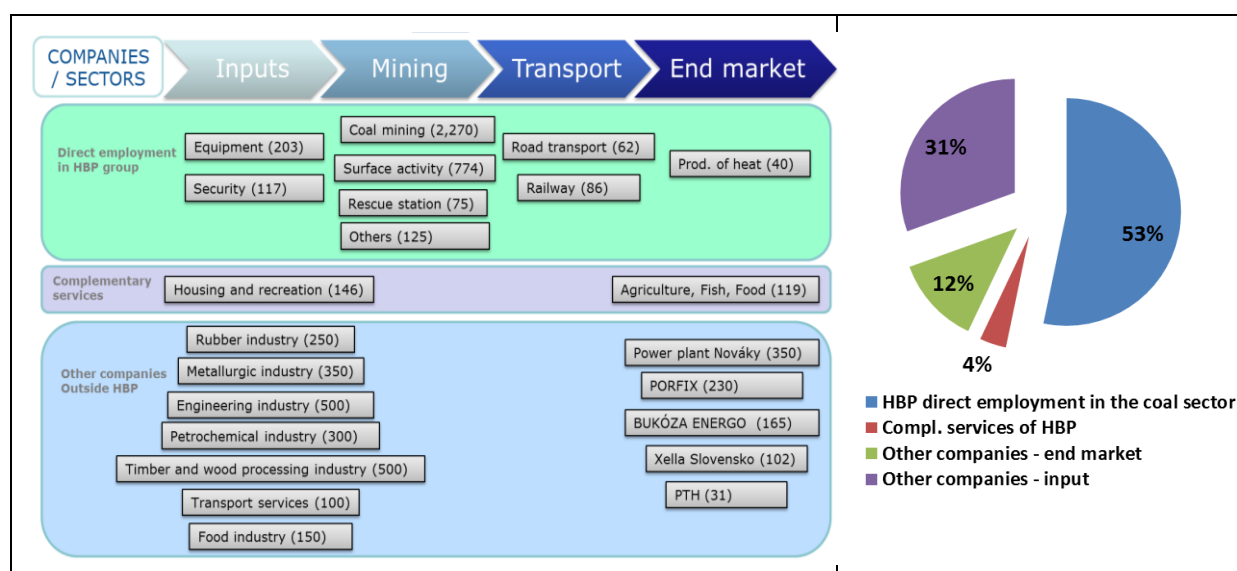
At the end of 2015 in the HBP group worked 4,017 employees out of which 3,329 in HBP 246 in HBPz 46 in AGRO GTV 73 in AGRO Rybia Farma 41 in EKOSYSTÉMY 117 in HBP Security 40 in Handlovská energetika s. r. o. and 125 in other business. 80% of the employment is allocated to the mining activity (Figure 19 blue shaded area with red line) and the rest in complementary services (Figure 19 blue shaded area with yellow line). Figure 20 shows the number of employees of the HBP Group and directly linked companies by each segment of the coal value chain and the companies' sectors of activity. It should be, however, taken in account that input companies outside of the HBP are, due to lack of data, represented by sectors. More detail data are required to define the magnitude of the negative impact on the employment.

Figure 19. Detailed employment in HBP group



Source: (Hornonitrianske bane Prievidza, 2016)

Figure 20. Overview of employment of the HBP and directly linked companies to the mining industry grouped by value chain segments



Source: JRC elaboration on (Generálne riaditeľstvo pre zamestnanosť, 2017)

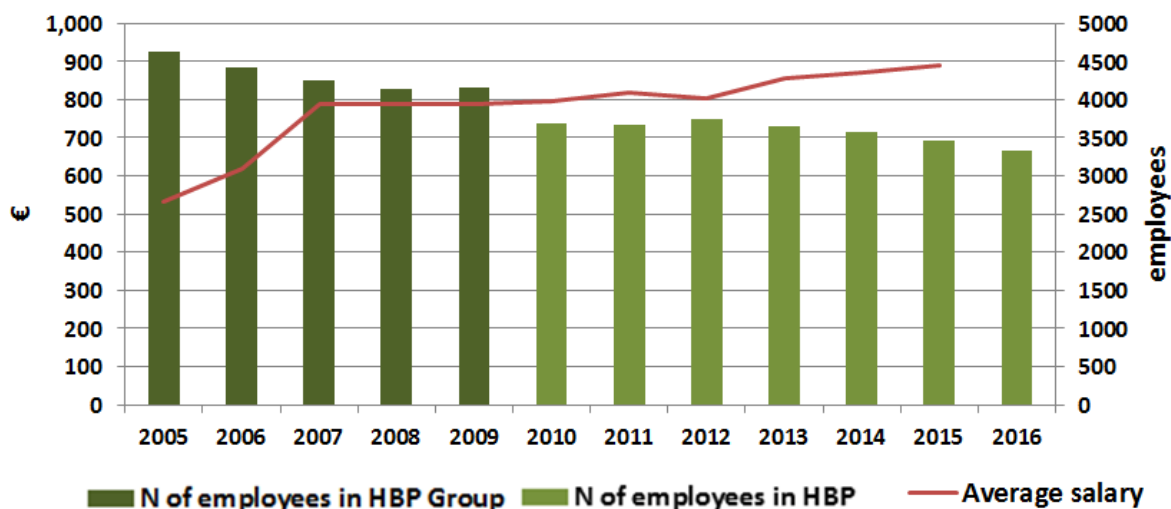
Looking in the mining segment of the value chain, in Table 13 we present different professional skills of the employees. We observe rich portfolio of professions. Some of these professions, such as drivers, electricians, engineers could potentially be less affected to the closer of the mine.

Table 13. Profession skills of the employees at the mining segment of the value chain

Profession	Number
Hoisting engineers and power loaders operators	317
Workers with explosives	208
Operators of welding and metal cutting equipment	516
Drivers of mining trolley locomotive	564
Electricians	329
Operators of excavation machines - engineers, bottomers, explorers	51
Mine surveyors	8
Machinists, serviceman of mining machines and equipment	175
Workers at the rescue station	75
Workers in mines without specific qualification	429
Crane operators, slingers, drivers of engine mine cars	228
Workers on surface without specific qualification	160
Service at the Nováky power plant	59
Administration	125
Together mining, surface activities and support service	3,244
Metal machinists, millers, lathe operators	34
Welders, metal cutters	25
Locksmiths	43
Drivers of engine mine cars, crane operators, slingers	9
Others	92
Together machinists	203
Engine drivers	14
Mine car feeder, train drivers	13
Rail engineers and technicians, operators of machines and equipment	33
Other employees	26
Together rail transport	86
Road transport	62
Heating sector	40
Security service	117
Agro-fish farming	119
Hotels and accommodation services	146
Together services out of mining	773
Together HBP group	4,017

The average salaries increased from an average of EUR 532 a month to almost EUR 900 in correspondence of a reduction in the number of employees from EUR 4,630 in 2005 to EUR 4.171 in 2015 (Figure 21).

Figure 21. Employees in the HBP Group and HBP coal company and average salaries (2005 – 2016)

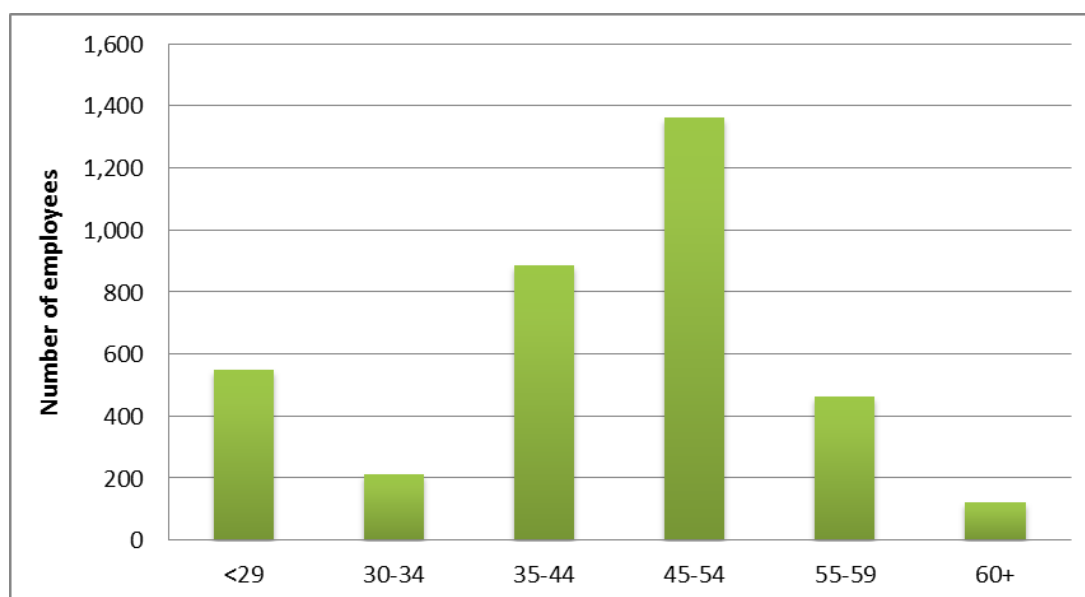


Source: JRC elaboration on (Hornonitrianske bane Prievidza) and (Hornonitrianske bane Prievidza, 2016)

Figure 21 shows that in fact the HBP stimulates the business activity. The company creates indirect economic benefits in the region which in terms of jobs can be quantified in around 4,000 number of jobs at least. This result demonstrates that a planned closure of the mine would have negative impacts of the same magnitude due mainly to the fact that diversification potential of the business in the sectors that are indirectly related to the mining industry may alleviate the socio-economic impacts of a closure plan.

The plan of closing the mine will affect mainly the sectors that are directly related to the mining activity which corresponds to at least 53% of the employment of the HBP group and of complementary business and in general those companies whose business depends mainly to the mining activity. However, the important role in the number of affected employees plays the current age structure of employees. In 2013, HBP reported that 123 of its employees are in the age group of 60+ and 466 in the age between 55 and 59 (Ministretstvo hospodárstva Slovenskej Republiky, 2013). The largest age group of 1365 employees (38%) were between 45-46 years. Taking in account that the number of employees in HBP has been continuously decreasing and the open positions for mining job are not easily occupied the Office of Employment, Social Affairs and Family, Prievidza is expecting that only 10% of miners and 20-30% of employees directly linked to the mining activities will be absorbed by the labour market when the mines its operation (Office of Employment, Social Affairs and Family, Prievidza). Moreover, those companies with a diversified business look to be less at risk in case of mine closure both in terms of possible economic losses and also in terms of lower share of capital at risk. The other segment of the coal value chain the end market is expected to diversify the supply of coal from other sources or through import of coal from abroad.

Figure 22. Number of employees in HBP per age group in 2013.

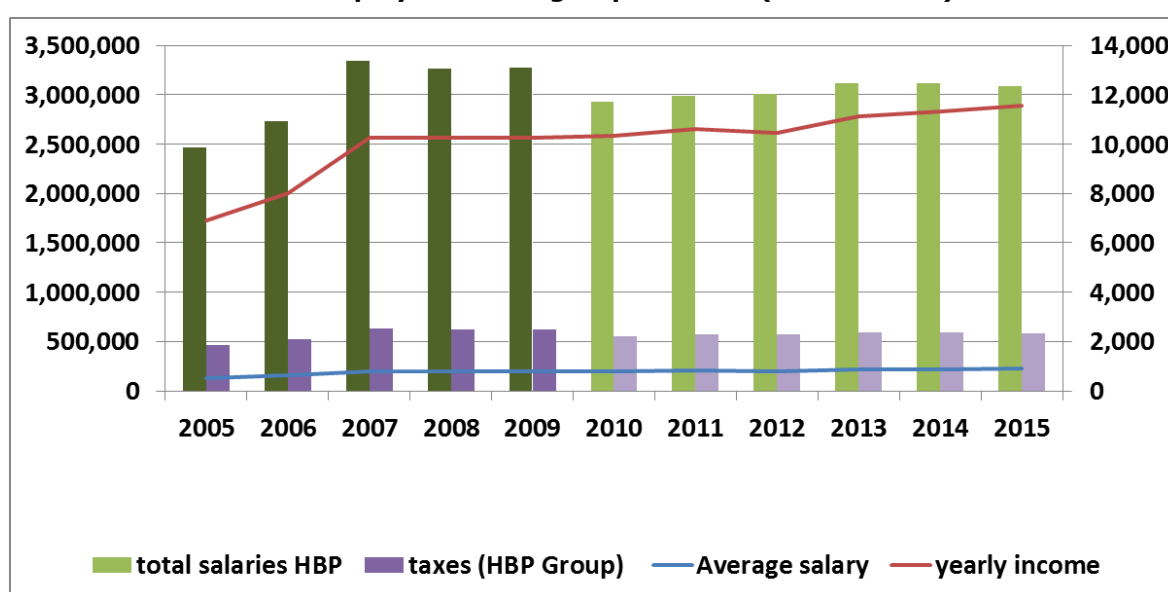


Source: (Ministrestvo hospodárstva Slovenskej Republiky, 2013)

Public revenues

To estimate the public revenues in terms of income taxes collected from the salaries in the coal sector we used information published on the official EU website. The Personal Income Tax Rate in Slovakia stands at 19% in correspondence of an annual income up to 35,022 EUR and at 25% in correspondence of an annual income above 35,022 EUR. For the estimation of the taxes paid on the yearly income from working activities we used the 19% tax rate being the yearly average income much below the threshold of 35,022 EUR. This estimation gives the idea of a part the public revenues gained by the national government from the business activity of the HBP Group.

Figure 23. Salaries and taxes paid to the Slovakian public authorities relative to the work force employed in HBP group and HBP (2005 – 2015)



Source: JRC elaboration on (Hornonitrianske bane Prievidza, 2016) , (Hornonitrianske bane Prievidza) , (Slovakian Centre of Statistics, 2017) and (European Union)

Relevant data on the companies' economic and financial activity

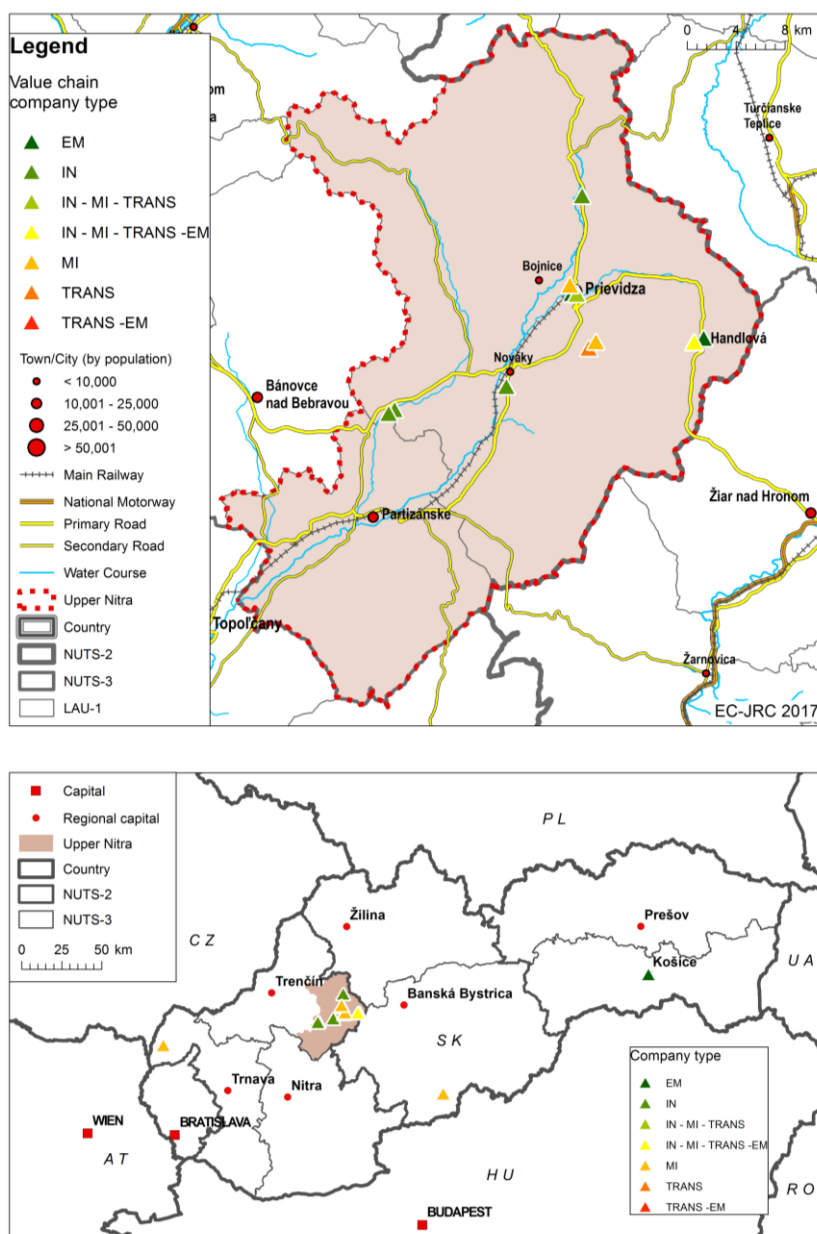
By accessing the data base provided by ORBIS at company levels we were able to identify 20 companies belonging to the coal value chain (Table 14). Figure 24 their location in the region. We aggregated the companies by value chain segment and analysed economic and financial historical data.

Table 14. Companies active in different segments of the coal Value Chain

Company	Type of activity	Value Chain segment
CONTITECH VIBRATION CONTROL SLOVAKIA S. R.O.	Manufacture of other rubber products	INPUTS
FORTISCHEM A. S.	Manufacture of plastics in primary forms	INPUTS
SAARGUMMI SLOVAKIA S.R.O.	Manufacture of other rubber products	INPUTS
SLOVAKTUAL S.R.O.	Manufacture of builders' ware of plastic	INPUTS
VEGUM A.S.	Manufacture of other rubber products	INPUTS
BAŇA ČÁRY A.S.	Mining of brown coal	MINING
BAŇA DOLINA A.S.	Mining of brown coal	MINING
BIC PRIEVIDZA S.R.O.	Other education	MINING
HBP SECURITY S.R.O.	Private security activities	MINING
HORNONITRIANSKE BANE PRIEVIDZA A.S.	Mining of brown coal	MINING
EKOŠYSTÉMY S.R.O.	Machining	TRAN
EVOTS S.R.O. *	Collection of non-hazardous waste	TRAN – END MARKET
HORNONITRIANSKE BANE ZAMESTNANECKÁ A.S. *	Manufacture of machinery for mining quarrying and construction	INPUTS - MINING - TRANS
HORNONITRIANSKE BANE A.S. *	Manufacture of machinery for mining quarrying and construction	INPUTS - MINING – TRAN - END MARKET
AGRO GTV S.R.O.	Growing of vegetables and melons roots and tubers	END MARKET
AGRO RYBIA FARMA S.R.O.	Freshwater aquaculture	END MARKET
HANDLOVSKÁ ENERGETIKA S.R.O.	Steam and air conditioning supply	END MARKET
PALIVÁ A STAVEBNINY A.S.	Other retail sale in non-specialised stores	END MARKET
PRIAMOS A.S. PRIEVIDZA	Agents involved in the sale of a variety of goods	END MARKET
PRIEVIDZSKÉ TEPELNE HOSPODÁRSTVO A.S.	Steam and air conditioning supply	END MARKET

Note: Some companies are active in more than one segment of the value chain. Source: (Bureau van Dijk)

Figure 24. Visualisation of studied companies in the region



Source: JRC

To have an idea of the financial situation of the selected 20 companies we analysed historical data on working capital, cash flow, current liabilities and total assets from the year 2007 to year 2016. The result of the activity was represented by elaborating data on:

- financial revenues operating revenues (turnover) and
- Profit and Loss before tax;

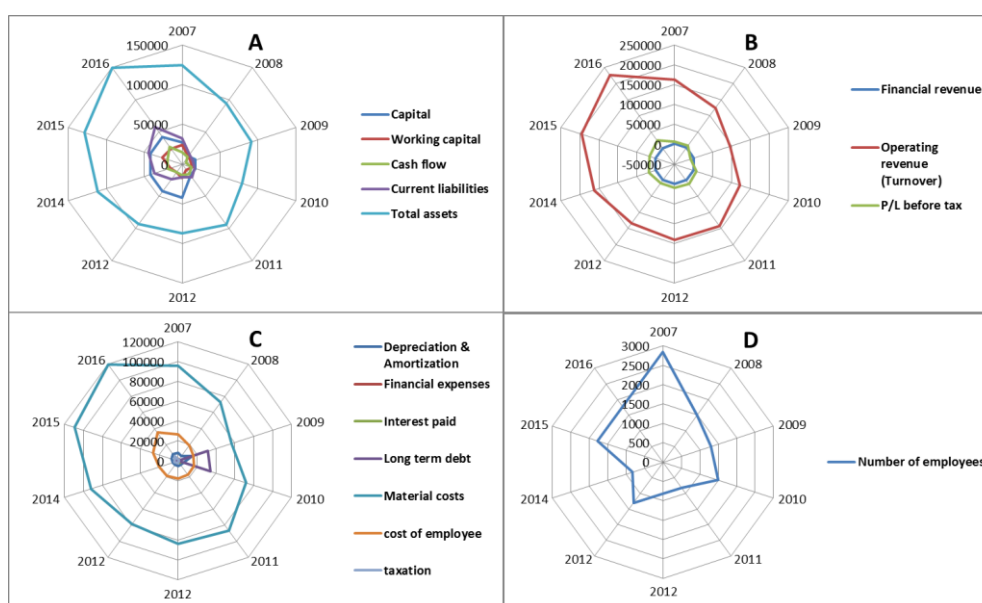
The costs were represented by:

- the depreciation and amortization of the capital;
- financial expenses;
- interest paid;

- long term debts;
- costs for material;
- costs for the employment and
- taxation.

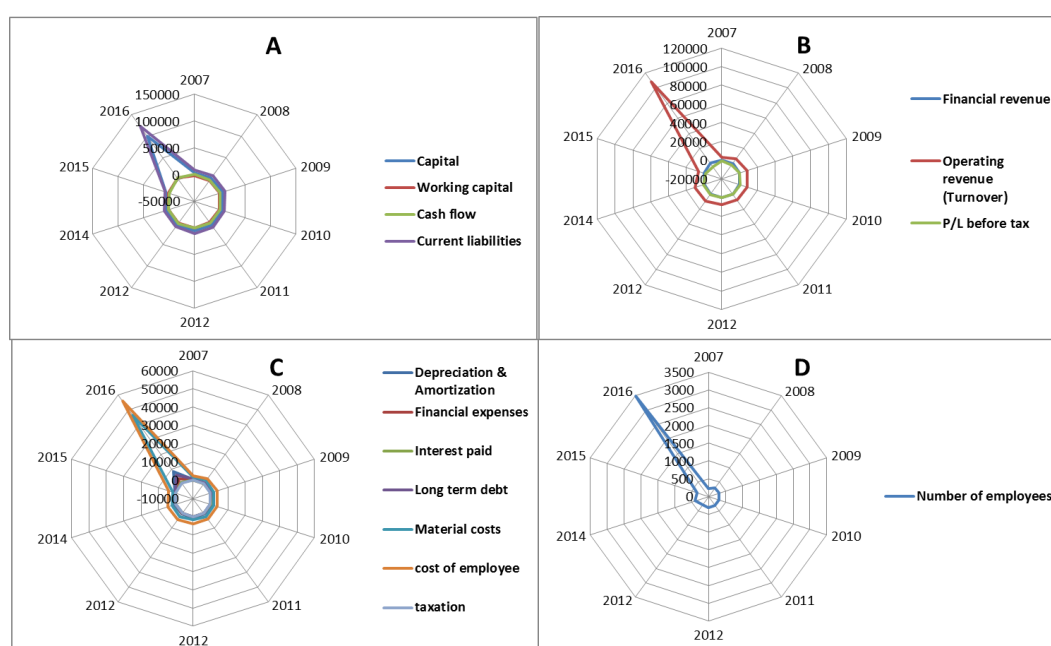
Historical information on the level of employment in the 9 years' time frame was added as an indication of the trend of the activity. Results by value chain segment are summarized in the Figure 25, Figure 26, Figure 27 and Figure 28.

Figure 25. Historical financial results of the companies active in the INPUTS segment of the coal Value Chain. 2007 - 2016



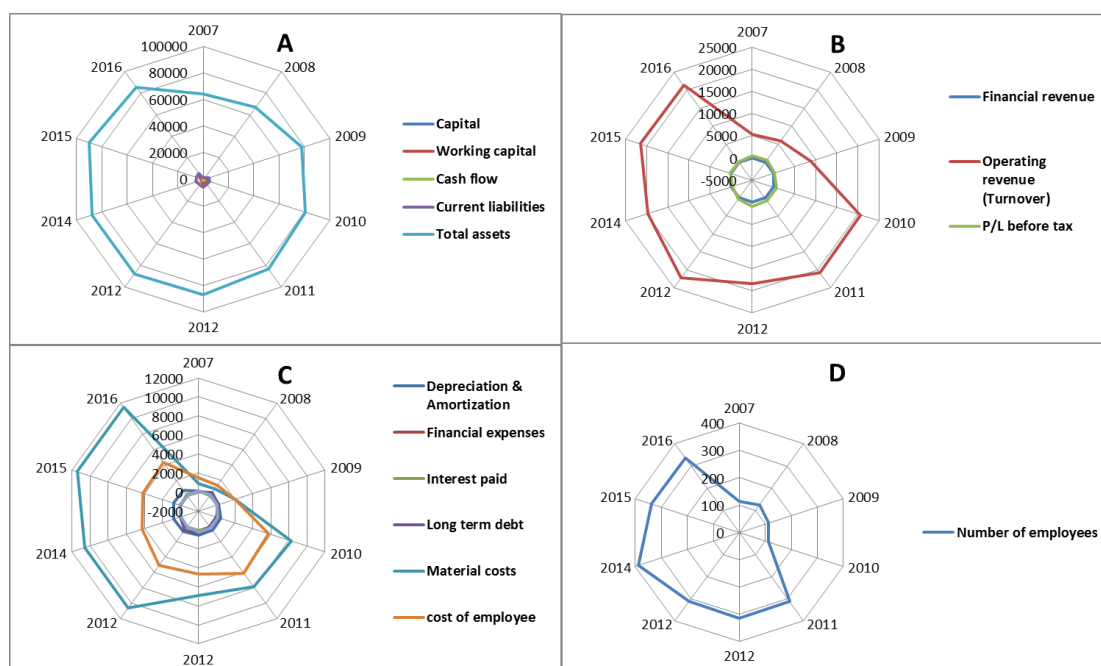
Note: A: financial performance; B: result of the activity; C: costs; D: employment; Source: (Bureau van Dijk)

Figure 26. Historical financial results of the companies active in the MINING segment of the coal Value Chain. 2007 - 2016



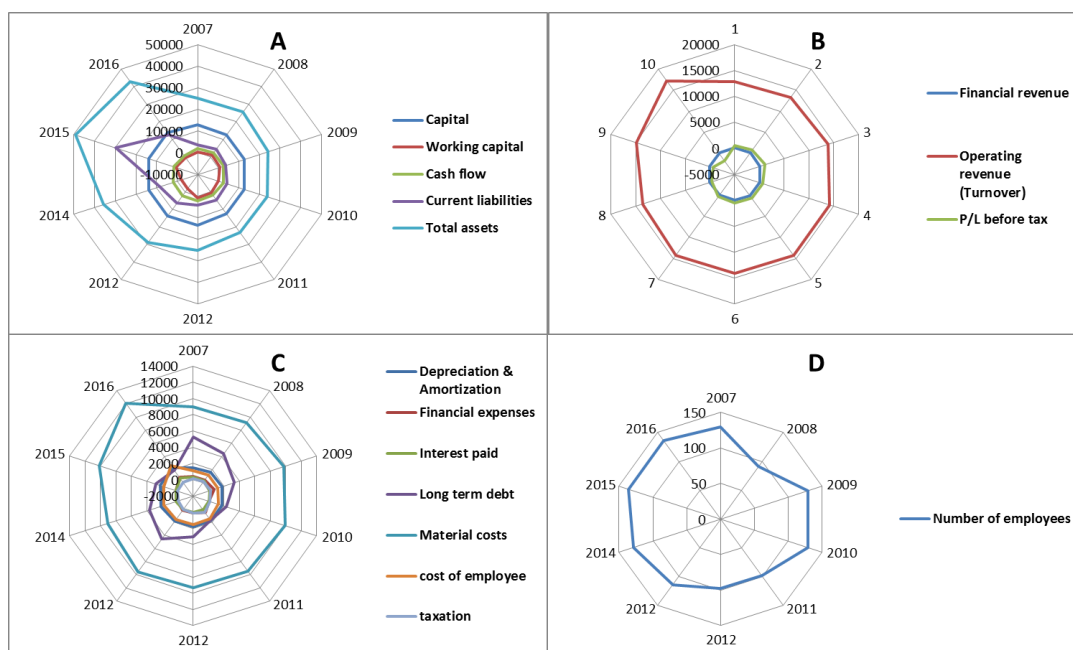
Note: A: financial performance; B: result of the activity; C: costs; D: employment; Source: (Bureau van Dijk)

Figure 27. Historical financial results of the companies active in the TRANSPORT segment of the coal Value Chain. 2007 - 2016



Note: A: financial performance; B: result of the activity; C: costs; D: employment; Source: (Bureau van Dijk)

Figure 28. Historical financial results of the companies active in the END MARKET segment of the coal Value Chain. 2007 - 2016



Note: A: financial performance; B: result of the activity; C: costs; D: employment; Source: (Bureau van Dijk)

1.4 Main conclusions from the value chain analysis

The value chain analysis allows depicting the **complete picture of the mine industry** in Upper Nitra area. Sectors that would be affected the most by the decision of a mine closure in the Upper Nitra region are mainly sectors directly related to the mining

activity, such as coal extraction and maintenance of mining equipment, coal transport and end market business whose activity depends mainly on the coal supply, such as heat and electricity production, and steel industry.

We then map the industry at firm-level activities and trade networks at each segment of the value chain to identify the dynamics of the coal sector and we quantify the main socio-economic variables, such as employment, salaries, public revenues from income taxes, economic and financial results of companies.

The HBP group activity stimulates the business in a big part of the economy in the country creating direct and indirect economic benefits in the Upper Nitra area of around 4,000 jobs at least. Other business activities (e.g. heat production and supply, electricity generation, rubber industry, engineering industry, transport services, food industry) are linked to the coal sector and account for more than additional 3,000 jobs in the area.

The plan of closing the mine will affect mainly the sectors that are directly related to the mining activity which corresponds to at least 53% of the employment of the HBP group and of complementary business and in general those companies whose business depends mainly to the mining activity. However, the **important factor** in the number of affected employees plays the current **age structure of employees and their professional skills**. Taking in account that the number of employees in HBP has been continuously decreasing and the open positions for mining job are not easily occupied the Office of Employment, Social Affairs and Family, Prievidza is expecting that only 10% of miners and 20-30% of employees directly linked to the mining activities will be absorbed by the labour market when the mines close their operation.

The negative impacts from a closure of the mine will depend on diversification potential of the business in the sectors that are directly and indirectly related to the mining industry. Those **companies with a diversified business look to be less at risk in case of mine closure** both in terms of possible economic losses and also in terms of lower share of capital at risk. The end market is expected to diversify the supply of coal from other sources or through import of coal from abroad. We assess this possibility for coal used as fuel for energy purposes.

HIGHLIGHTS FROM THE SOCIO-ECONOMIC ANALYSIS

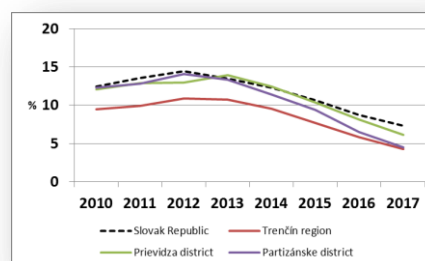
Unemployment

The unemployment rate in Slovakia has been continuously decreasing since 2012 (Figure 29).

Table 15. change in unemployment rate in Slovak Republic – details on Trenčín region

Geographic area	2010	2017	Change
Slovak Republic	12.46	7.35	- 41.01%
Trenčín region	9.51	4.28	- 54.99%
Prievidza district	12.05	6.11	- 49.29%
Partizánske district	12.27	4.49	- 63.41%

Figure 29. Unemployment - Historical trend 2010 – 2017



Imbalances between job vacancies and job seekers

Table 16. Imbalances between job vacancies and job seekers (2017)

Category by profession	Unemployment in Upper Nitra in May 2017		Registered open positions in the Office of Labour, Social Affairs and Family		Employment capacity by district	
	Partizánske	Prievidza	Partizánske	Prievidza	Partizánske	Prievidza
Trade Union	0	2	-	-	-	-
Management	10	72	0	12	0%	17%
Specialists	31	129	11	68	35%	53%
Technicians	56	209	5	43	9%	21%
Administration	46	253	8	32	17%	13%
Service and trades	123	485	48	190	39%	39%
Agriculture, forestry and fishery	11	20	8	1	73%	5%
Qualified craftsman	122	286	303	409	248%	143%
Machine operators	117	341	109	310	93%	91%
Auxiliary not qualified workers	127	532	16	107	13%	20%
Not identified	0	6	-	-	-	-

The capacity to absorb unemployed work force differs by district and by category of profession is presented in Table 16.

Industrial sector

Ranking of the industrial sector in Trenčín region by share of sales (**Trenčiansky samosprávny kraj, 2015**).

<ol style="list-style-type: none"> 1. rubber and plastic products (28.6%) 2. manufacture of electrical equipment (14.9%) 3. manufacture of machinery and equipment (13%) 4. the manufacture of transport equipment (12.1%) 	<p>Share of sales by business activity</p> <p>■ rubber and plastic products ■ manufacture of electrical equipment ■ manufacture of machinery and equipment ■ the manufacture of transport equipment</p>
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Socio-economic analysis through Value Chain approach

We looked into companies, directly and indirectly, related to the mining activities and we categorised them along the whole value chain of the coal industry:

We focus on three main variables of interest: employment, companies' financial flows and public finance.

Employment. Number of employees in 2016 along the whole value chain of the mining activity (both directly and indirectly related).

- HBP group employs 4,017 units

- of which 2,344 work in mining, surface and support services;

NB: 53% of the employees in HBP were aged 45+ in 2013.

- companies linked to the coal mining activities employ 3,028 units,
 - of which 350 are located in the power plant Nováky.

Companies' total financial results from business activity in the period 2007 -2015

- Total assets invested 2.6 billion EUR
- Operating revenues 3.1 billion EUR
- Net income 93.5 million EUR
- Cost of employees 550.6 million EUR
- Interest paid 21.96 million EUR

Public finance

To assess the impact on the public finance from the direct and indirect coal mine business activity we considered the income taxes paid by the employees of the HBP Group and the taxes paid by the companies directly and indirectly linked to the coal mine value chain, for a total of 20 companies, in the period from 2007 to 2015:

Income taxes: 5.3 million EUR

Taxes on sales: 27.8 million EUR.

Main conclusions

- The collection of data is a tedious part of this type of analysis and can represent a major challenge.
- The main socio-economic variables that are considered for the analysis are: employment; salaries; public revenues from income taxes; economic and financial results of the companies in the sector.
- The coal industry Value Chain analysis allows mapping the firm-level activities and trade networks from production to the end consumption.
- The coal industry in Slovakia stimulates the business activity in a big part of the economy creating indirect economic benefits in the Nitra region of around 4,000 jobs at least.
- The magnitude of the negative impacts from a closure of the mine will depend on diversification potential of the businesses in the different sectors that are indirectly related to the mining industry.
- The plan of closing the mine will affect mainly the sectors that are directly related to the mining activity which corresponds to at least 50% of the employment of the HBP group.
- Those companies with a diversified business look to be less at risk in case of mine closure both in terms of possible economic losses and also in terms of lower share of capital at risk.

1.5 Further studies

The work above identifies the main business activities that would be involved in the decision of the closure of the coal mine in the Slovakian region of Upper Nitra and assesses the related socio-economic features. The decision of mine closure affects

different economic activities in different ways. In fact the more diversified is the business of the companies that are part of the value chain of the coal industry and the wider is the geographical perimeter of their activity the lower is the loss to be expected in terms of private and social benefits. To be able to refine the results of the value chain analysis proposed in this report the analysis of impacts can be improved through the ad-hoc calibration of an input-output model to quantify how a change in the operation of the mine - i.e. closure or requalification for other uses - impacts the variables on interest (employment private benefits and public finance). This type of analysis is sometimes done through surveys used to interview people belonging to representative groups that live and work in the area of the mine.

Further works may address the economic and social impacts brought about by the activities foreseen in a mine closure plan and their quantification. After the identification of the type of activities that are involved in the closure process the assessment should address the requirements in terms of capital to be invested human resources specialised companies, etc. that would be involved in the process. This analysis would give the idea of the potential economic activity that would be created by the implementation of a mine closure plan and its social impacts: employment economic private benefits and public finance.

Possible approach to the analysis of a geothermal investment project as an alternative to coal mine in the energy transition phase in Upper Nitra region, SK

The value chain analysis made in this document supports the preparatory work to be done in case of a mine closure and a reconversion of the regional industrial sector. The information aggregated by value chain segment help in decomposing a problem that is complex *per se*.

The value chain segment analysis helps also to improve the awareness on the potential of the site rehabilitation with the installation of new companies and the creation of a new industrial polo.

As for example, if we want to analyse the socio-economic impacts (mainly change in the number of employees in the region, profitability opportunities for new investments and potential benefits for the public finance) of a geothermal power plant as an alternative to the coal mining plant, we can use the value chain approach and find possible correspondences between the structure and characteristics of the coal mine value chain and those of the geothermal technology. These correspondences shall help in understanding the path to the transition from coal to geothermal energy production, the needed energy source, human and financial capital, infrastructure (to be reused or add new), collateral services from cross sectors providing support services and potential end consumers.

This exercise can be reproduced with any other investment project alternative to coal mine, provided the availability of ad-hoc detailed data.

1.6 Energy insights on mine closure in the Slovakian region of Upper Nitra

1.6.1 Scenarios for the Energy system in Slovak Republic

The future scenarios for the energy system of Slovakia can foresee different trajectories. Concerns about the security of energy supply and the import dependence can be motivated and indigenous coal may play a strategic role. Employment is also another relevant factor, as well as occupational hazards and public health and environment complement the list of the policy areas that are intertwined in the future choices regarding the planning for the territory of Horna Nitra.

Disentangle or assess all the possible trade-offs to support the design of future options is beyond the limit of this work, although some scenarios analysing energy aspects are presented within this section. Building on the bundle of information received from the Slovak authorities and made available to the study we define some input data in the specifications of the scenarios:

1. *Coal Nováky 2030* is a first scenario extending the status quo until 2030: under the current setting, the coal mines as the main customer of indigenous coal, the Nováky power plant continue their activity until 2030. Under the *Coal Nováky 2030* case, the production of coal as fuel is subsidized through a Feed-In Tariff. The value of 80.37 EUR/MWh is assumed to model the Feed-In Tariff for cogeneration of electricity and heat, as happens in the Nováky plant.
2. *Phase out 2023* is the second scenario foreseeing the closure of both the mining activities and of the thermal electric plant of Nováky in 2023.

Methodology and approach

The modelling exercise is performed using the JRC EU TIMES model, an integrated assessment model developed at the JRC of the EC (Simoes S., Nijs W., Ruiz Castillo P., Sgobbi A., Radu D., Bolat P., Thiel C., Peteves E., 2013).

It is based on a techno-economic perspective. JRC EU TIMES is a partial equilibrium model of the energy system, that characterizes the technologies involved in the different steps of the supply chain of energy sources, taking into account their main economic and physical attributes. The technologies used for the trade, or the mining of energy commodities (as coal mines), the processes transforming energy products or commodities in other products (as refineries, thermal electricity plants or transforming stations in electricity grids) and the delivery to end use sectors are represented in such model, providing cost-efficient combinations of technological factors that would cover the demands of energy services. Such demands are projected in the long run and are functions of demography, macroeconomic growth of other factors. JRC-EU-TIMES is aligned to EUCO30 in order to include the proposed 2030 targets from the winter package.

One of the possible uses of this tool is to explore how the energy sources and the relative supply chain through trade and infrastructures for transmission and distribution satisfy the demand of energy services of the different sectors of the economy. The techno-economic representation of market and policy facts allows to support the description of expected consequences on the energy mix.

Among the capabilities of this tool there is also the possibility to provide some estimates about the environmental implications of energy systems. The main type of emissions generated by energy technologies are accounted, to provide information about the future environmental pressures induced by the energy system under specific scenarios. In this study we focus on the Slovak regions, but JRC EU TIMES is a model that covers all EU countries and some neighbour countries⁹. The spatial granularity of the tool allows describing processes at country-wide level, but does not allow entering in spatial details as local bottlenecks on substations of the transmission or distribution power system. The power grid in the area in proximity to the Nováky power plant would not provide the same continuity of supply in absence of the power plant. The model, most likely may not reveal vulnerabilities on the local distribution grid. The Slovak TSO assessed that the completion of the works on the Bystričany power node that is expected sometime

⁹ The regions of the model are AT (Austria), BE (Belgium), BG (Bulgaria), CY (Cyprus), CZ (Czech Republic), DE (Germany), DK (Denmark), EE (Estonia), ES (Spain), FI (Finland), FR (France), EL (Greece), HU (Hungary), IE (Ireland), IT (Italy), LT (Lithuania), LU (Luxembourg), LV (Latvia), MT (Malta), NL (Netherlands), PL (Poland), PT (Portugal), RO (Romania), SE (Sweden), SI (Slovenia), SK (Slovakia), UK (United Kingdom), CH (Switzerland), NO (Norway), IS (Iceland), HR (Croatia), AL (Albania), BA (Bosnia), KS (Kosovo), ME (Montenegro), MK (FYROM), RS (Serbia)

between 2021–23. For this reason the assumption of the closure of the plant and the coal mines is set to 2023 in the phase-out scenarios.

Some general features about the structure of the energy system, according to the data provided by the Slovak authorities, are presented in Table 17 and regarding the coal consumption in Figure 30.

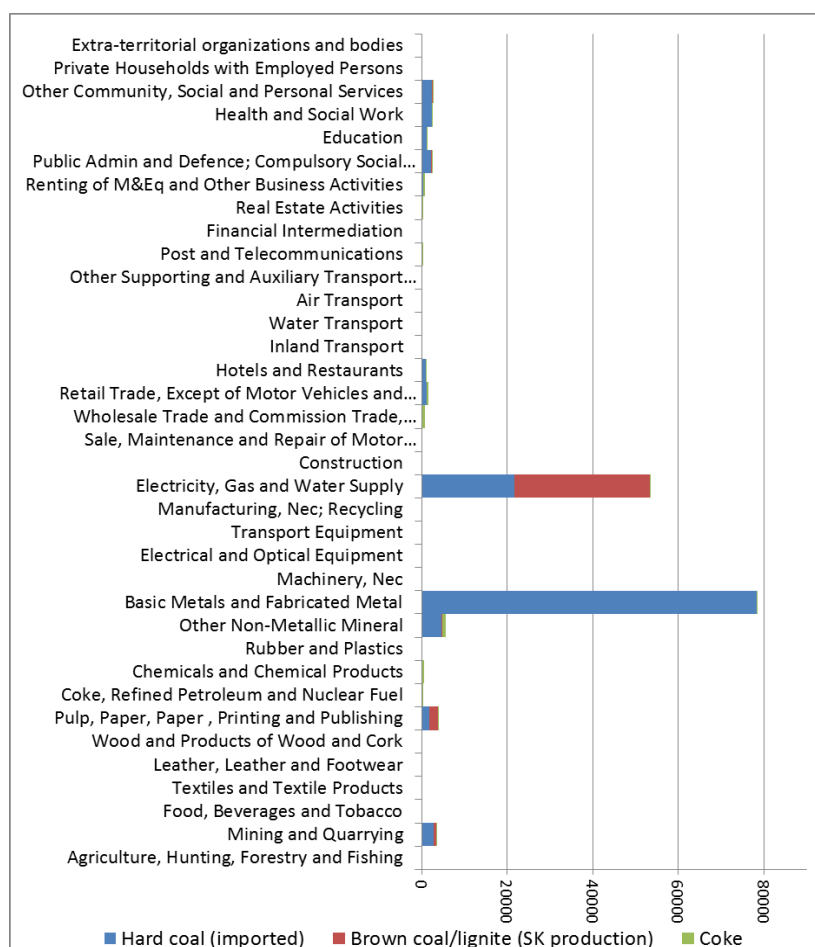
Table 17. Energy mix, Installed capacities for power generation and Gross inland consumption

Energy mix in 2015		Installed capacity 2015			Gross demand consumption		
	%		MW	%		MWh	%
Nuclear	23.7	Hydro	2537	33	Nuclear	14774	49
RES ¹⁰ and Waste	10.9	Nuclear	1940	25	Hydro	4844	16
Electricity import	1.3	Other RES	14		Fossil	5319	18
Coal	20	Wind	3		RES	2430	8
Oil	20.4	Biofuel	105	1	Others	85	
Natural gas	23.8	Biomass	224	3	Balance	2651	9
		Solar	530	7			
		Mixed fuels	422	5			
		Oil	255	3			
		Natura gas	1121	14			
		Hard coal	220	3			
		Lignite	458	6			
		Total	7848		Total	30.1TWh	

Source: data provided by Slovak authorities.

¹⁰ RES: Renewable Energy Sources

Figure 30. The use of coal energy by the sectors of the economy in Slovak Republic GWh



Source: WIOD database

The milestone years of the scenarios are the steps on which is structured the total time horizon of the scenario. All the results that are annual refers to the Middle year of each time periods.

Table 18. Time periods used for modelling the scenarios *Coal Nováky 2030 and Phase out 2023*

Time period	1	2	3	4	5	6
Start	2010	2011	2013	2018	2023	2028
Mid	2010	2011	2015	2020	2025	2030
End	2010	2012	2017	2022	2027	2032
Duration (years)	1	2	5	5	5	5

Source: JRC.

Subsidy to the electricity generated by coal

Under a first scenario, we assume the Nováky power plant active, fed by the coal mines, with a yearly average of 5.58 PJ (1.55 TWh) until 2030. Both the mining and the power production receive a subsidization¹¹ measure in the form of a Feed-In Tariff scheme, taken into account in the modelling. One issue of interest in the analysis is to determine

¹¹ On the overall landscape of all the subsidization measure the following collection comprehend also the support to the renewable energy sources. Data available at URL: <http://www.res-legal.eu/search-by-country/slovakia/single/s/res-e/t/promotion/aid/feed-in-tariff-6/lastp/187/>

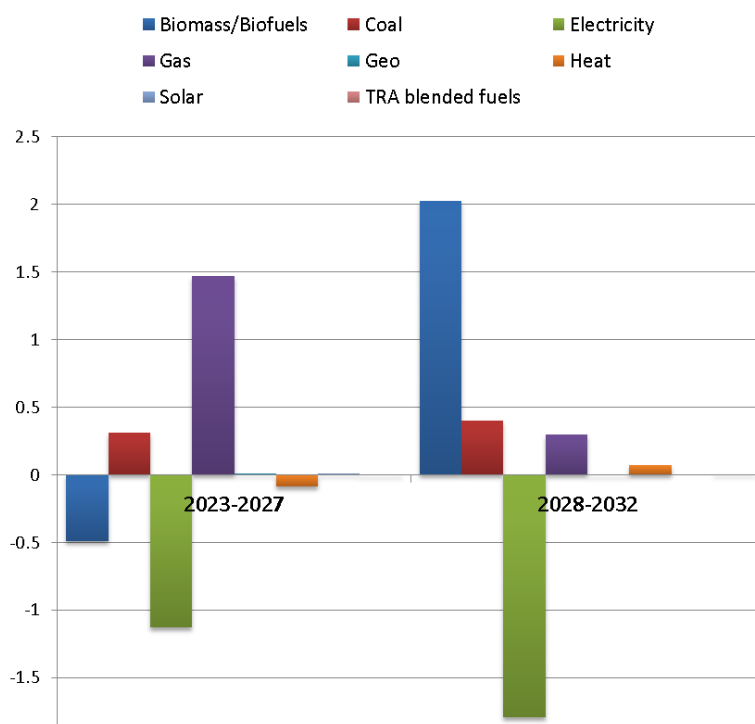
to which extent the closure of the mines of coal in the Trenčín area and of the Nováky power plant would affect the rest of the energy system.

Results

The overall surcharge imposed to the system by the Feed-In Tariff scheme on coal is calculated comparing the costs of the system (unconstrained), not subject to any subsidization phasing out in 2023, with the corresponding costs under the Coal Nováky 2030. According to our results, the whole Slovakian energy system under subsidization spends a present value of EUR 99.84 million of additional fixed costs, EUR 40.93 million in capital costs, and EUR 247.68 million of variable costs that would not be required in absence of the subsidy. This assessment is obtained discounting respect to the beginning of the time horizon (2010) all the costs that are referred to subsequent years until 2032. Given that the two scenarios fully overlap until the year 2023, it means that all the differences in the components of the total system energy costs of EUR 388.45 million (accounting for the entire collection of energy sources and technologies required by the Slovak economy) are referred to the period 2023-2032.

When operating, the main output of the Nováky Plant is about 15,500 GWh (5.58 PJ). If we look at the upstream of the supply chain, the coal production by the Slovakian coal mines is 25 PJ (0.858 MTce). The differences between the two scenarios in the use of fuels for total; final consumption are shown in figure 31. It maps the changes in the way the end use sectors consume the different fuel types. A reduction of 1.13 PJ in 2023-2027 period and 1.79 PJ in 2028-2032 is the difference in the consumption of electricity induced by the phase-out, but interestingly enough the system still may increase the direct demand of coal of 0.31/0.39 PJ respectively in the two periods.

Figure 31. Changes in the consumption of the end use sectors in PJ

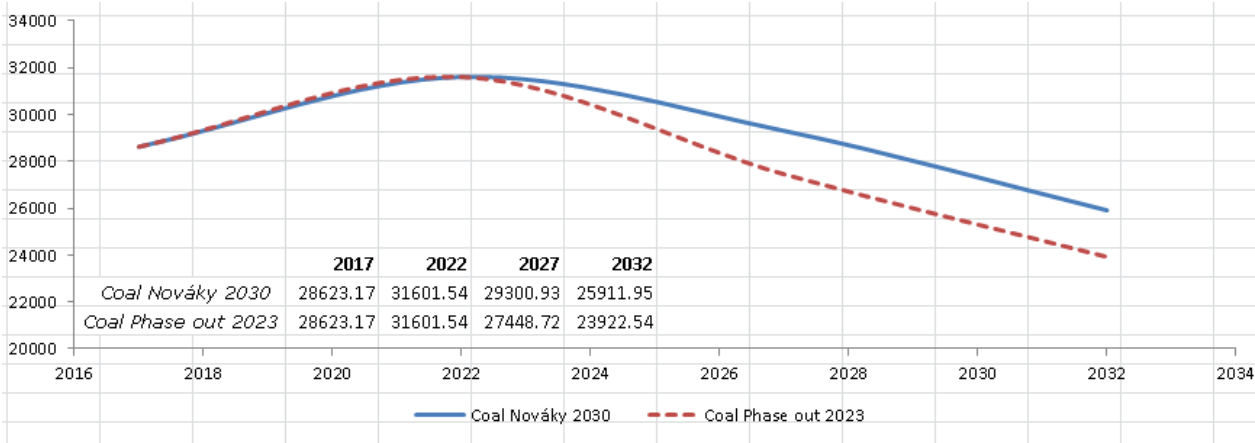


Source: JRC.

Figure 31 points out how in different time steps the Slovakian energy system uses less electricity: under the Phase-out scenario in the 2023-2027 natural gas acts as main alternative, with a less relevant role in 2028-2032 when the consumption of biomass and biofuels is 2 PJ higher in the phase-out scenario.

In terms of total CO₂ emission of the energy system, no reduction in CO₂ emission is observed until 2022. Later, under the phasing-out coal in 2023 scenario results show a reduction of 6.32% for the period 2023-2027 and of 7.67% in 2028-2032.

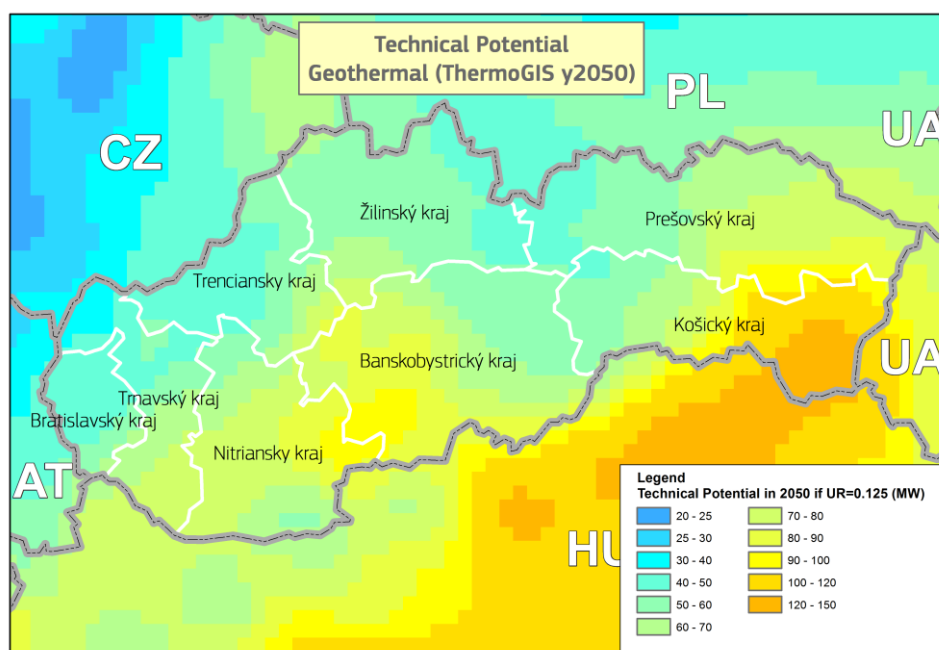
Figure 32. Emission trends (KTon of CO2eq generated by the energy system of Slovakia)



Source: JRC.

More results and scenario are actually under scrutiny in order to provide more insights on the effects of the phase-out of coal in Slovakia. One crucial area that is suitable for a follow up is specifically the heat sector and the definition of potentials. In the JRC-EU-TIMES the geothermal energy is now assumed to have a potential and the deployment of innovative enhanced technological options is considered to be near in time but with some uncertainty. In order to explore such uncertainty a cautious and detailed follow up of this analysis is necessary. We can preliminary introduce some of the key information that will be used to further develop the application of the JRC-EU-TIMES on the study of the geothermal use for heating in Slovakia.

Figure 33. Map of geothermal potential in Slovak Republic



Source: (ThermoGIS website, 2018)

Slovakia is rich in low enthalpy source of geothermal energy accessible by conventional technology that could find synergy in the residential sector as district heating purposes.

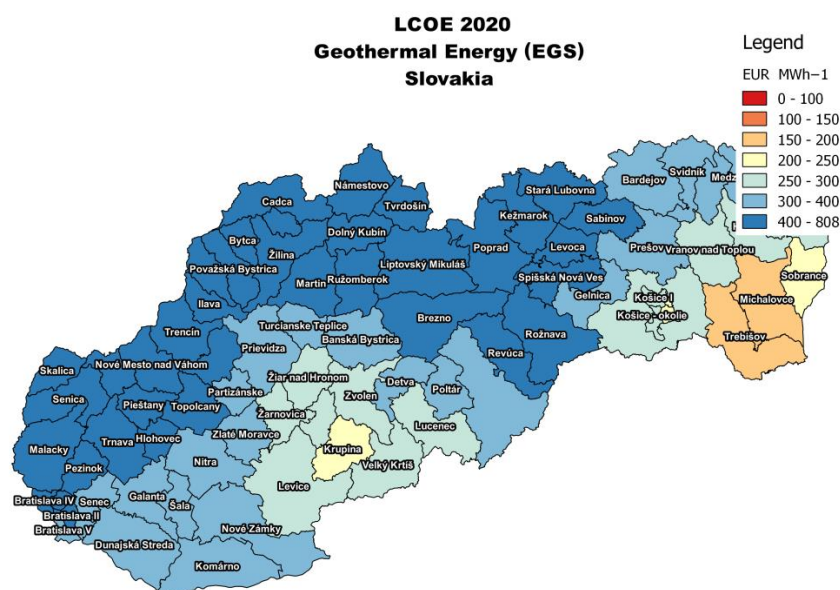
A limitation of the current modelling exercise with JRC-EU-TIMES is that future investments in heat production capacity are systematically undervalued when compared with electricity production. Therefore, any further modelling for analysing to which extent geothermal energy could match local needs should take into account:

- that electricity is more appreciated in terms of market value,
- that electricity is normally more subsidized than heat;
- that the quantification of investments in heat production (which should be technically and economically feasible) should take into consideration a considerable amount of factors (i.e. spatially structured constraints that refers to the characteristics of residential and commercial buildings, the presence of heat infrastructures, and the cost competitiveness of locally alternative heat sources).

As a first step in the direction of better characterizing the modelling of the geothermal sector we provide in Figure 33 the potentials and in Figure 34 the levelized costs of geothermal electricity.

Currently, 27 hydro geothermal areas have been identified as prospective for geothermal energy, accounting for 34% of the country territory (Fendek, et al., 2015). The total potential of geothermal energy in Slovakia reaches 5,200 MWt (Bartko, et al., 2014). However, only 18% of this potential has been actually used. Most of the geothermal reservoirs have temperature at the well head lower than 100°C which is more favorable for direct heating purposes rather than for electricity production. Geothermal wells in Slovakia are dominantly used for recreational purposes (68.7%), to a lesser extent for agriculture (18.7%), heating of buildings (11.5%) and ground source heat pumps (1.1%).

Figure 34. Levelized costs of geothermal electricity



Source: JRC

Slovakia targets, in its National Renewable Action Plan 14.6%, Renewable Energy Sources in heating and cooling in 2020, including geothermal. At present, there are three successful cases of geothermal district heating systems in Slovakia. In all of them the geothermal energy used for the base load heat and natural gas boilers are used as a peak and back up source (Halás, 2015). The oldest is in Galanta and has been in operation since 1996. The installed capacity of the geothermal plant is 8 MWt and it supplies heat for 1,236 flats together with the public service sector and the hospital in Galanta city. The geothermal system continues its operation and is recognized as well design project producing heat in economically and environmentally friendly manner. Two more such systems started operation in 2011 and 2012 in Šaľa and Sered', respectively.

1.6.2 Impact of the mine closure on the electricity system

In the policy outlook from 2016 the Ministry of Economy foresees supporting the mining activity at least until 2030 at around 1.8 Million tonnes/year (Ministry of Economy of the Slovak Republic). Regarding electricity system, mining activities in Nováky are required to supply brown coal power plant. According to ministry, at least 223 MWe¹² plant capacity should be operational to maintain security of electricity supply at current levels.

Following ENTSO-E¹³, 223 MWe is the total capacity of the remaining coal power plants in Slovakia expected by 2020 (ENTSO-E, 2016). This capacity also remains in 2030 projections under ENTSO-E Vision 3.

Supporting de-carbonisation trends in Europe, the ENTSO-E scenarios are further adapted and compared in terms of social welfare. For this aim, a European wide unit commitment and economic dispatch model is used. The following scenarios are proposed as summarized in Table 19 for a preliminary analysis. The reference scenario corresponds to previously studied scenario called *Coal Nováky 2030*: extending the status quo until 2030 and scenario 1 corresponds to the *Phase out 2023*: foreseeing the closure of both the mining activities and of the thermal electric plant of Nováky, correspondingly. Scenario 2 and 3 assume geothermal technology in mature state to provide electricity.

¹² Electric power in MW

¹³ ENTSO-E: European Network of Transmission System Operators for Electricity

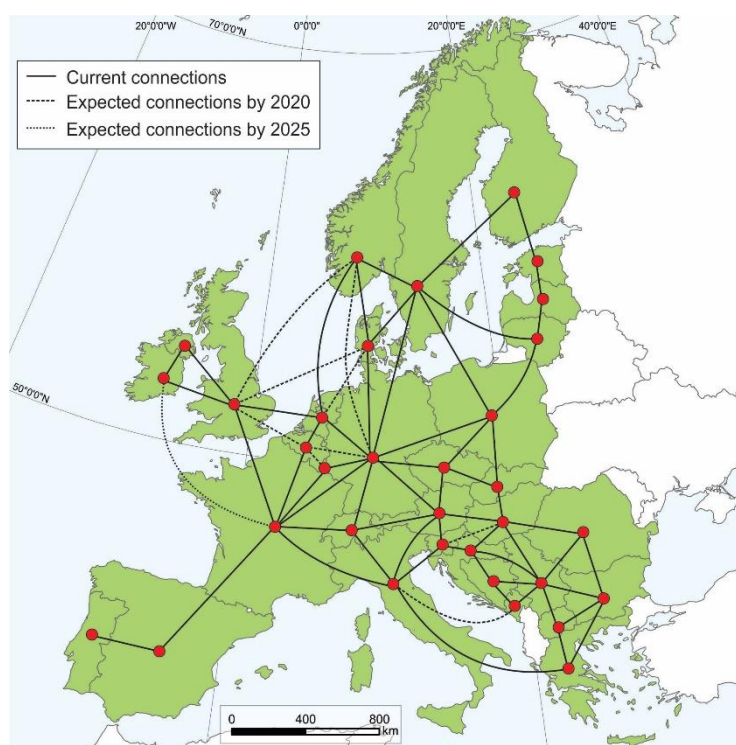
Table 19. Power system development scenarios

Scenario	Year	ENTSO-E	Nováky plant	New geothermal plant
Reference	2030	Vision 3	Yes	No
1	2030	Vision 3	No	No
2	2030	Vision 3	No	110 MW
3	2030	Vision 3	No	223 MW

Note that this is only a first presumption on Slovakia's power system development scenarios, and should be further adjusted to match the Member States' policy frameworks aiming at phasing out carbon-rich fuels in power generation.

Power system model

The modelling exercise is performed using the European power dispatch model developed at the JRC of the EC. The model is comprised of (i) 33 European countries¹⁴ (modelled as one power node per country) and (ii) the cross-border transmission connections between these countries. The modelled countries and their cross-border connections are shown in Figure 35.

Figure 35. Coverage of the European power dispatch model

Source: JRC

The model is developed for the PLEXOS power market simulation software (<https://energyexemplar.com/>), where it can forecast and manage operating costs and provide an accurate asset performance valuation for power generation and transmission, for various electricity system development scenarios. An electricity system can be analysed over various time periods. A time series modelling is generally applied (e.g.,

¹⁴ Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Former Yugoslav Republic of Macedonia, Germany, Great Britain, Greece, Hungary, Ireland (and North Ireland as separated region), Italy, Latvia, Lithuania, Luxembourg, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden and Switzerland

one-year period at an hourly time step) using deterministic programming techniques that aim to minimise an objective function subject to the expected cost of electricity dispatch, at the same time providing the necessary power and keeping the number of constraints, i.e. power plant availability, outages and characteristics, power reserves, power transmission constraints and fuel/emissions prices.

Aggregated net generation capacities, as well as cross-border power trading capacities, hourly electricity demand profiles, fuel and CO₂ prices for the 2020 and 2030 scenarios are obtained from the ENTSO-E TYNDP2016¹⁵ modelling data (ENTSO-E, 2016).

Wind and solar hourly generation profiles for the modelled countries are obtained from an open database – <http://renewables.ninja/> (Pfenninger S., Staffell I., 2016) (Pfenninger S., Staffell I., 2016); whereas monthly water inflow profiles for the hydro power plants are extracted from the historical generation records of Eurostat (EUROSTAT). Weather data for Renewable Energy Sources is taken from historical records of 2012 as the weather conditions (wind, solar irradiance and water inflow) in Europe are similar to those in 2016 (EUROSTAT).

The main properties and constraints of the modelled generation technologies within the European power dispatch model source from the JRC report on projected energy technology indicators (JRC, 2014). Outage rates for power generators are obtained from the World Energy Council (World Energy Council).

Modelling results

Modelling results on cross-border flows and the generation mix for Slovakia in 2030 are listed in Table 20. As expected, Scenario 1 (comparing with reference) leads to higher imports and higher generation from some power plants (biomass and pumped hydro) as the absence of a 223 MW brown coal power plant should be covered. Only electricity production from gas-fired power plant is lower in Scenario 1 comparing with Reference. This is due to provision of emergency power reserves: in the reference scenario the brown coal power plant also contributed in provision of reserves; in Scenario 1 the gas-fired plant takes over reserve provision done previously by the brown coal plant. This puts additional constraints on generation flexibility and capacity. In scenarios 2 and 3, due to new geothermal power plant, power balance in Slovakia improves as net imports are lower.

Table 20. Cross-border flows and generation mix in Slovakia: 2030

	Reference	Scenario 1	Scenario 2	Scenario 3
<i>Net power imports, GWh</i>	<i>12,348</i>	<i>12,532</i>	<i>11,903</i>	<i>11,219</i>
CZ-->SK	48	50	44	40
HU-->SK	12,226	12,405	11,787	11,114
PL-->SK	74	77	72	65
<i>Power generation, GWh</i>	<i>34,132</i>	<i>33,805</i>	<i>34,691</i>	<i>35,594</i>
Wind	403	403	403	403
Solar	866	866	866	866
Hydro	6,095	6,095	6,095	6,095
Pump hydro	93	107	105	100
Geothermal	0	0	924	1,856
Natural gas	5,288	5,189	5,189	5,189
Brown coal	283	0	0	0
Biomass	322	364	328	304

¹⁵ TYNDP: Ten-Year Network Development Plan

Uranium	20,781	20,781	20,781	20,781
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The impact of the mine closure on the Slovakian welfare is gauged by assessing the impact of price changes on society. The socio-economic welfare is an indicator of the wealth (or happiness) of a country and in our analysis is defined as the sum of consumer and producer surplus. That is

$$\text{Socio-economic welfare} = \text{consumer surplus} + \text{producer surplus}$$

1) Consumer surplus is the increase in utility (well-being, happiness or satisfaction) from consuming electricity services. For example, if after the switching to a new production method, electricity costs less, consumers will use more electricity services or they will use electricity savings for other consumption with an increase in their satisfaction.

2) The producer surplus is the profits of the electricity producer.

For our purpose, the indicator gauges how much the wealth of a country (society) changes when a condition in the energy system changes. For example, if we are interested in how much the welfare changes when the country switches to a new production method, then, the indicator monetizes this increase (decrease) of wealth using electricity prices as a numeraire by which the welfare value is computed.

Table 21 shows the electricity prices for each scenario (Reference, 1, 2, and 3).

Table 21. Electricity price in 2030

		Reference	Scenario 1	Scenario 2	Scenario 3
Country	Fiscal Year	Price (€/MWh)	Price (€/MWh)	Price (€/MWh)	Price (€/MWh)
SK	2030	51.30	51.57	51.21	50.94

Table 21 shows that the electricity price increases in Scenario 1, mainly due to the effect of importing electricity from other regions, while it decreases in in other two scenarios (2 and 3), mainly because of the reductions in the production costs. On the one hand the demand of electricity produced in neighbouring countries increase, driving the price of electricity in these countries up. On the other hand, production of cheap electricity from geothermal will reduce the price of electricity.

Moreover, for each scenario (1, 2, and 3) we calculate the impact of the decision to phase out coal on socio-economic welfare, as a difference between the assumed scenario (1, 2 and 3) and a Reference scenario. Reference scenario is baseline scenario as proposed by ENTSO-E. Modelling results are presented in Table 22. These are annual values representing changes in social welfare, also known as total surplus. In other words, the change in social welfare (or surplus) is the difference between the value of socio-economic welfare in Scenario 1, 2 or 3 and the relative value in the baseline scenario.

Table 22. Changes in social welfare (total surplus) in 2030, million EUR per year

	Scenario 1	Scenario 2	Scenario 3
Δ Socio-economic welfare, Europe	3.76	4.14	6.22
Δ Socio-economic welfare, Slovakia	-7.72	14.43	36.73
Δ Consumer surplus, Slovakia	-2.97	2.41	6.08
Δ Producer surplus, Slovakia	-4.75	12.02	30.65

In general, Table 22 shows an increase in socio-economic welfare in Europe in all three 2030 scenarios. In Slovakia the socio-economic welfare drops in Scenario 1, but increases in other two scenarios (2 and 3). Table 22 shows that even a relatively small change in the power system of one country does indeed affect other European countries, as they are strongly connected through power transmission lines and cables.

Social welfare: Computation of social welfare figures for the first year after the phase out

Our proposal is to provide a further integration between techno economic assessment, and social and environmental dimensions based on some concepts:

- A cost-benefit analysis framework enables to amalgamate monetary indicators with other quantitative factors. It offers a shared perspective for linking techno economic (market) and socio economic facts.
- Social costs and social benefits should be monetized with dedicated mechanisms.
- Market data (system of prices) and non-market data (effects not captured by markets) are mandatory.

This preliminary assessment incorporates costs determined by the power market, with further relevant economic values:

-6.99 M EUR – Loss of social welfare in the Slovakian electricity market of in 2023. Phasing out the Nováky power plant will generate lower revenues for electricity suppliers and utility for consumers. Source: JRC analysis with power system model PLEXOS

-50.8 M EUR – Wage/unemployment benefits to the workers, for one year. We assume that these social costs are paid by society as a whole. They might be considered as proxy of the costs for financing skills for capacity building of ex-miners.

+53.3 M EUR – Avoided subsidies in electricity feed-in tariffs due to the use of indigenous coal

+166.47 M EUR – Avoided health and environmental externalities. Environmental and health effects estimated by the European Environmental Agency, specifically for the Nováky power plant. Value of Life Year (VOLY) is the methodology employed for defining the impact in terms of life expectancy It has to be stressed that this value is the lowest of the analysis and the relevant cost can range up to 3 times higher, i.e. 500 M EUR (see details below).

Hence, the market and non-market social welfare consequences of the phase-out of Nováky power plant and the coal mines in the first year can be valued at +162 M EUR for the year after the phase out. Taken into consideration the large uncertainty in the estimation of the yearly cost of health and environmental damage, it can easily be concluded that the net impact to the social welfare from the closure of the power plant and the coal mines is **positive and at least of the order of 160-170 M EUR yearly**.

What are external effects?

In the functioning of market mechanisms it frequently happens that economic activities that are in line with regulations provide as well unintended collateral (or external) effects. They do not necessarily represent violations of rules and standards, which would imply the application of sanctions. Externalities produce some influence on other economic actors (external) and they do not have the nature of violation, but rather of unintended consequence. Market prices fail in associating the value of the external effects to their sources.

Whenever big externalities arise, economic actors may have interest in internalizing them, i.e. explicitly assessing their value, to take decisions or expressing balances of costs and benefits. This is the case of companies demanding for subsidization if provide beneficial services to the society that is beyond their commercial mission. This can be also the case of firms or consumers receiving disturbances or "disamenities" not captured by prices. An externality can go from producer to producer, from producer to consumer, or vice versa in whatever possible combination.

In the case of the Coal regions in transition the discussion over the phase out drives to the need of keeping into political consideration the advantages for the society of securing the jobs of mining. For the society as a whole, the security of occupational opportunities and full employment produce advantages that go beyond the simple exchange of labor for wages. The subsidy paid as a support to maintain such jobs in the public interest is an implicit evaluation of how much the society is willing to pay for such advantage, or to prevent the disamenities of having higher unemployment.

Externalities

The focus is on the

- job creation (and destruction);
- the consequences of pollution affecting the built environment and ecological habitats (at local level, as in the case of emission lowering the quality of air and water, and at a global level, as in the case of greenhouse gas emissions);
- the implications on the health of inhabitants (e.g. not miners)
- in security of energy supply for a country or for a specific geographical area

An external effect can be an environmental consequence of production or consumption processes. Linked to environmental consequences, the deterioration of health conditions of citizens that receive emissions. Even when some standard are enforced and respected, some consumers or companies may suffer from some inconvenience or disturbances that are economically measurable. In the literature exists a wide range of applied evaluation cases that aim at putting monetary amount to provide a snapshot of the size of the externalities. Unfortunately it does not exist an overall inventory of all the externalities. Many evaluations have been built ad hoc on those cases where the externality is big and can create problems. Some research initiatives of projects as ExterneE, CASES project funded by the European Commission has just the goal to provide monetary values for common cases of energy and industrial infrastructures.

Markets for electricity and energy

Techno economic modelling provides the way to analyse the markets of energy services and commodities. Market prices here assign value to a commodity (e.g. coal) depending on the needs of the consumers and the profit maximisation of producers. The JRC modelling tools offer a base for capturing how these forces interact with technological components. Techno-economic models are able to provide an aggregate indicator of the profits made by producer and of the advantages rewarding consumers.

Health and environmental effects

Regarding the estimates of aggregated damage costs 2008-2012, expressed in Million € are provided for Industrial facilities causing the highest damage costs to health and the environment by the European Environment Agency (EEA, accessible at <https://www.eea.europa.eu/data-and-maps/daviz/industrial-facilities-causing-the-highest-damage>)

As the Nováky power plant is assessed as the 18th most polluting facility in Europe, it is listed in the European Environment Agency dataset with an estimated monetary cost of the health and environmental damage for a 5 years period ranging between 1814 and 5346 M EUR. The low-high range of damage cost values reflects a) the different approaches used to value health impacts from air pollution and b) the range of values used to estimate CO₂ related damage costs. In the following, the low value is considered, taking however into account that there is very large uncertainty in the estimation of health and environmental damage and indeed the estimations may range from this value up to 3 times higher.

Table 23. Ranges for the monetary valuation of aggregated (environmental and health) damage costs of the Nováky power plant

Time horizon of the damage	Aggregated damage (M EUR) (VOLY method)	Capacity MWe
5 years damage	1814.0	Plant with full capacity 486 MW
1 year damage*	362.8	Plant with full capacity 486 MW
1 year damage**	166.47	Plant actual capacity 223 MW

*adjustment to resize for the time duration

**adjustment to take into account of the reduction in capacity

Assuming the closure of the plant, the economic benefit resulting from avoiding the environmental and health damage would worth between 166.47 and 500 M EUR/year

Assumption for inclusion of externalities

- Worst scenario (lowest value): the economic benefit resulting from avoiding the environmental and health damage is 166.47 M EUR/year

Cost-benefit over the 30 years horizon

The cost-benefit analysis is a standard method to assess the economic feasibility of a project for a society as a whole. It does not say if the project is financially profitable for merchant investors. For the purpose of assessing the financial viability of the decision in hand we should analyse the ownership of the investor (state-owned, merchant regulated-merchant) which is outside the scope of the report. For our purpose, a cost-benefit analysis is performed in order to see if the phase-out of the coal mine is welfare improving for the society as a whole. For this purpose, the following three more assumptions are used

- Social discount rate: 4%
- Lifecycle for geothermal power plant: 30 years
- Benefit (cash-flows) constant over a 30 years period

Table 24. Changes in Present values of 30 years cash-flows for Scenario 1, 2 and 3 compare to reference scenario

		Scenario 1	Scenario 2	Scenario 3
PV	Δ Socio-economic welfare, Slovakia	-133.494	249.524	635.136

Assumption about the cash outflows (costs)

- The investment cost is paid one-shot at the beginning of operations.
 - Investment cost for 111 MW geothermal power plant: 4,470 EUR per kW * 111,000 kW = 496 M EUR
 - Investment cost for 223 MW geothermal power plant: 4,470 EUR per kW * 223,000 kW = 997 M EUR
- Operation and Maintenance (O&M) costs are costs for operating and maintaining generation plants
 - Fixed O&M for 111 MW geothermal power plant: 4.8 EUR per MW per h * 111 MW * 8,760 h = 5 M EUR/year
 - Fixed O&M for 223MW geothermal power plant: 4.8 EUR per MW per h * 223 MW * 8,760 h = 10 M EUR/year
- Discount rate for O&M: $i=4\%, 5\%, 6\%, 7\%$

Table 25 presents the net present value of the socio-economic welfare for Scenario 1, 2, and 3 for different assumed O&M discount rate.

Table 25. Net present value of the socio-economic welfare

ΔSocio-economic Welfare, Slovakia	Scenario 1	Scenario 2	Scenario 3
$i=4\%$	-133.494	-333.46	-534.92
$i=5\%$	-133.494	-323.46	-515.725
$i=6\%$	-133.494	-315.824	-499.648
$i=7\%$	-133.494	-309.045	-486.09

Assuming the closure of the plant, the economic benefit resulting from avoiding the environmental and health damage would worth between 173.935 and 512.6 M EUR/year

Assumption for inclusion of externalities

- Worst scenario: the economic benefit resulting from avoiding the environmental and health damage is 166.47 M EUR/year
- Damage discount rate: 4%

If there was no switching to geothermal and the production of electricity was carried out by the coal plant, the present value of the environmental and health damage from pollution for 30 years would be 3007.69 M EUR.

Table 26. Changes in Net present value for Scenario 1, 2 and 3 compare to reference scenario including the economic benefit resulting from avoiding the environmental and health damage in million EUR

NPV Δ Social Welfare Slovakia including env. and health benefit (worst scenario)	Scenario 1	Scenario 2	Scenario 3
i=4%	2,874	2,674	2,472

The health and environmental costs are the same for all three scenarios. The differences we observe among results are driven by the investment costs for the new geothermal capacity. Scenario 3 assumes higher investment costs in the geothermal capacity compare to scenario 2 (see assumptions above). Therefore the overall benefit is smaller. Scenario 1 does not include any additional investment costs.

1.6.3 Main conclusions of the energy system analysis

Using an in-house energy system model **we present insights to the energy sector** focusing on **alternatives to the coal combusting sources** from a techno-economic perspective.

In the first study, we look at the **entire collection of energy sources and technologies** required by the Slovak economy under two scenarios:

Scenario Coal Nováky 2030: extending the status quo until 2030

Scenario Phase out 2023: foreseeing the closure of both the mining activities and of the thermal electric plant of Nováky in 2023.

Main results are i) Phasing out coal mining and operation of power plant brings **reduction of CO₂** emission by 6.32% in 2025 and of 7.67% in 2030; ii) Decrease of the **total system energy costs** of 388.45 M EUR in case of Phase out 2023 compare to power plant Nováky in operation until 2030.

The phase out scenario fits well the trajectory of a low carbon scenario presented by the JRC-EU-TIMES. This means the phase out is what should be done searching for optimal intervention to reduce emission of the energy sector

In the second part of the analysis, we provide **additional insights on** the transition towards coal-free **electricity** in Slovakia.

We test the technical adequacy of the operation of the European system using electricity dispatch model under four different scenarios:

- Reference Scenario: 2030 ENTSO-E Vision3
- Scenario 1: without 223 MW lignite (brown coal) in Slovakia
- Scenario 2: without 223 MW lignite and with new 111 MW geothermal capacity in Slovakia
- Scenario 3: without 223 MW lignite and with new 223 MW geothermal in Slovakia

Technical and economical parameters from the model are used to calculate consumer surplus and electricity producer surplus.

Additionally, we estimate the economic benefit resulting from **avoiding the environmental and health impact** of operation of the power plant. The market and non-market social welfare consequences **of the phase-out of Nováky** power plant and the coal mines in the first year can be valued at **+114.98 M EUR** for the year after the phase out.

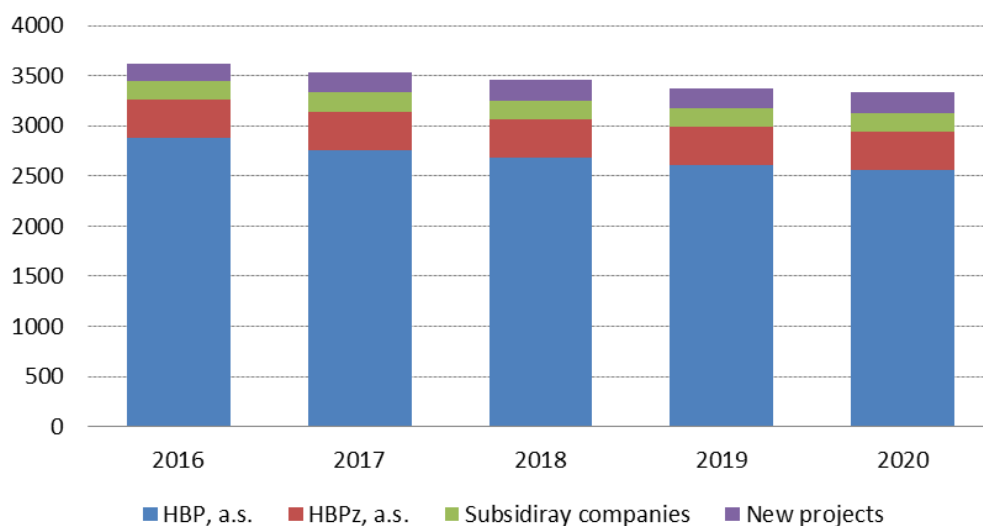
Finally, we provide **cost - benefit analysis** to include investment costs for the installation of new geothermal capacity. We define changes in net present value including the economic benefit resulting from avoiding the environmental and health damage compare to reference scenario of 2,874 M EUR for scenario 1, 2,674 M EUR for scenario 2 and 2,472 M EUR for Scenario 3. Positive values reveal an **estimate on what the society could gain when the power plant phases out**.

1.7 Potential for economic growth in the region

Closure of the mine would also have a significant impact on employment directly in the mining companies and in the power plant that uses domestic coal and indirectly in a chain of suppliers of different goods and services. Therefore the governmental support for continuing coal mining also protects the jobs in the mining activity (and in the region). Within this context the Slovakian Ministry of Economy prepared a document covering possible programs for creating new jobs in the region of Upper Nitra in cooperation with Hornonitrianske bane Prievidza in 2011 (Ministrestvo hospodárstva Slovenskej Republiky, 2013).

Figure 36 shows the prospective employment in HBP. Also the Trenčín region stated that its priority is to support creation and maintenance of jobs in the Upper Nitra attract new investors and reinforce traditional industries. The final solution is a complex issue that needs to take into account local demands financial requirements barriers existing socio-economic situation and many more. Table 27 summarizes some potential for economic growth and proposed plans for the Upper Nitra.

Figure 36. Expected evolution of employment in HBP



Source: JRC elaboration on (Ministrestvo hospodárstva Slovenskej Republiky, 2013)

Table 27. The main potential for economic growth in the region and proposed plans.

Potential	Plans
Free space for industrial parks and zones	Better infrastructure among districts and highway to larger cities
Long tradition in engineering electrical and rubber and textile production	Logistic center for biomass
Geothermal springs for spa and tourism development	Modernisation of Nováky Power Plant - biomass burning
Potential for biomass growth and usage.	French fries production
Space and capacity to build R&D and research centers and start-ups/ enough high educated professionals in population.	Fruit grove
Location of the region between west and east of Slovakia	Spa and tourism development
Good cover of hospitals schools and other social infrastructure	

Source: (Ministretstvo hospodárstva Slovenskej Republiky, 2013), (Trenčiansky samosprávny kraj, 2015), (Hornonitrianske bane Prievidza, 2017)

According to some material made publicly available by HBP on possibilities of employment development in the Upper Nitra region there is high potential of job creation in various business sectors. According to the document in case of economical support to the region more than 900 new jobs have the potential to be created within the frame of Hornonitrianske mines group development projects and more than 2,600 within the frame of other development projects - outside of Hornonitrianske mines group.

Table 28. Job creation potential in the Upper Nitra region

<i>Within the frame of Hornonitrianske mines groups development projects</i>	
Machinery industry in BME branch – other operation	+ 200 employees
Railway wagons overhauling (Ekosystémy branch)	+ 100 employees
Greenhouses expansion (Agro GTV branch)	+ 50 employees
French Fries production project +	+ 100 employees
Fruit grove project	+ 50 employees
Logistic biomass centre project	+ 200 employees
Machinery industry in BME branch – other operation	+ 200 employees
Total possibilities of employment	+ 900 employees
<i>Within the frame of other development projects - outside of Hornonitrianske mines group</i>	
Highway Trenčín - Prievidza - Žiar nad Hronom construction	
Fluid boiler FK2 in Nováky Power Plant construction (municipal waste + biomass + coal)	+ 200 employees
Company BROSE project - extension 2. and 3. phase	+ 800 employees
Theme park in Bojnice construction project	+ 600 employees
Spa development on Upper Nitra (Bojnice)	+ 200 employees
Other prepared road projects + tourism development	+ 800 employees
Total possibilities of employment	+ 2600 employees

Source: (Hornonitrianske bane Prievidza, 2017)

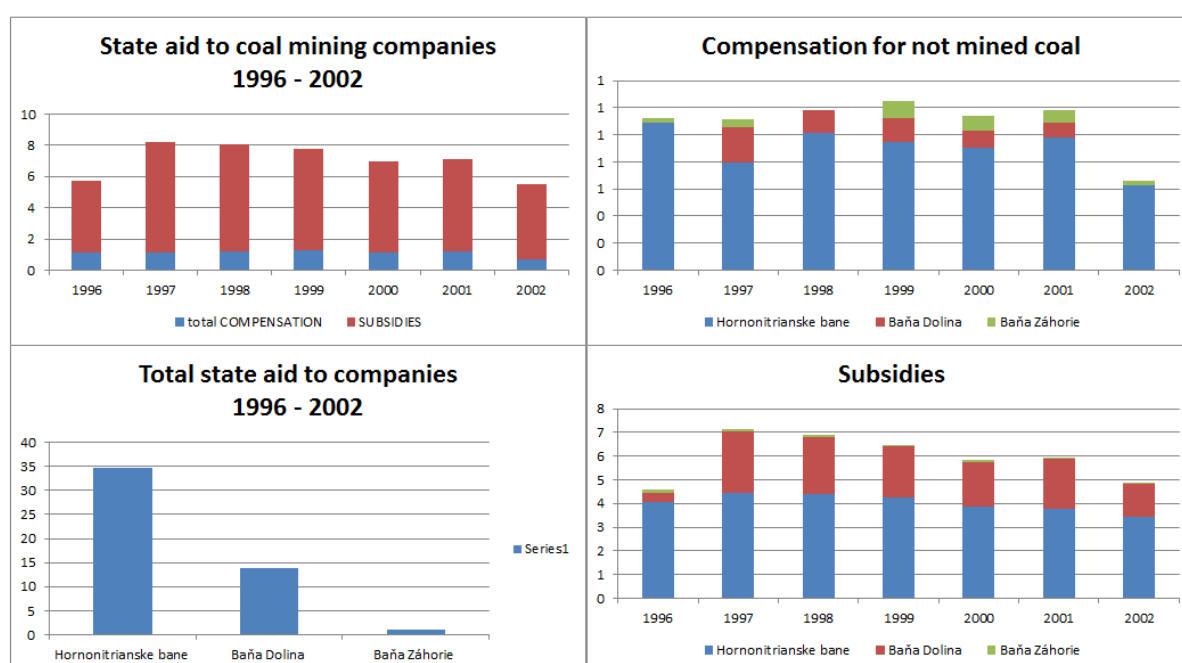
1.8 Historical state aid to coal mining sector

Example when Baňa Dolina was closed:

The Slovakian government agreed on recession of Baňa Dolina in 2011. The mine finished its activity in 2015. It was the first large mine closed in Slovakia caused by low economical effectivity. Figure 62 presents the governmental subsidy to coal mining and share to Baňa Dolina. Since 1997 the mine had not been autonomous to recover its costs.

Some figures on the financial support granted to the coal mine sector in Slovakia could be retrieved from the reports by the ministry of economics of the country. Financial flows decreased steadily from 1989 to 1995 (Figure 62). In total the aid to the coal sector was EUR 28.1 million.

**Figure 37. State aid to coal mining sector 1996 – 2002 – million EUR
(Conversion SKK 1 = Euro 0.03)**



Source: JRC elaboration on (Ministerstvo hospodárstva Slovenskej Republiky, 2010) and (Trend, 2004)

Table 29. Total aid of the ministry of Economy to coal mines 2004 – 2010 (EUR)

Companies	2004 - 2010
HBP a. s. Prievidza:	24,147,332
Baňa Dolina a. s. Veľký Krtíš	4,022,096
Baňa Čáry a. s. Čáry*	0
total	28,169,428

* for the period 2008 - 2010

Source: (Ministerstvo hospodárstva Slovenskej Republiky, 2010)

Proposed approach to support the process of socio-economic change in the pilot region

1.9 Smart specialisation (S3) as an instrument for economic transformation in coal regions

Smart specialisation strategies were originally designed as an instrument for better prioritisation of European Regional Development Fund (ERDF) spending on research, development and innovation that builds on the existing strengths and advantages, but looks to generate more value added by application of knowledge and innovation activities.

European regions and EU member states have prepared smart specialisation strategies as an *ex ante conditionality* for ERDF in the programming period 2014-2020. The present proposal, based on analysis of specific needs and opportunities in Slovak NUTS3 region of Trenčín, seeks to apply the S3 methodology in the specific context of coal transition territories, but does not replace the existing smart specialisation and other strategic documents.

Multi-dimensional challenges for coal regions

Coal transition constitutes a significant challenge for Europe that has three dimensions:

- **Economic**, where a regional economy has to modernize and transform from a coal industry that is no longer competitive to other sectors,
- **Societal**, where social change is needed for occupational restructuring in places, where heavy industry is often strongly embedded in the local identity,
- **Environmental** – meaning a strong impact of energy transformation on climate change.

As smart specialisation is a strategy for knowledge-based economic modernisation, there is a valid case to apply the S3 methodology in coal transition regions in Europe. However, in order to achieve success, certain key factors need to be taken into consideration.

Modernisation of traditional economies

Structural change of an economy is a difficult and complicated process with different paths that can be taken or that may naturally happen. For each of them there are examples in Europe that can be analysed for better understanding such processes. Possible transformation paths include:

- **Modernisation of the sector** - finding new markets for the present product that only need a small modification of the existing workforce competences. For coal it can be clean coal technologies, new uses in cosmetics and medicine, etc.
- **Allowing for collapse of the coal sector and the emergence of natural spillovers** – possibly the best solution in purely economic terms, but with high social costs. Mitigation actions can be taken in order to retrain and reemploy the workforce.
- **Support new emerging sectors that will slowly change the structure of economy** – solution that needs high investment as new sectors usually need different workforce competences and, as innovative and risky, are not guaranteed to succeed. Space for experimentation needs to be provided, which can result in political risk in case of a failure.

Key success factors for application of S3 methodology

- **Strategic outlook** – As EU regions/Member States already have smart specialisation strategies in place, any new process with a strategic dimension

must take them into account, together with any other valid national or regional level strategies, as they provide a long-term strategic perspective for the territory.

- **Place-based policy** – smart specialisation is in fact a regional innovation policy concept, which means that it is an intervention into regional innovation ecosystem that cannot be undertaken without the active participation of key actors. It should be implemented at the level where sufficient endogenous potential is generated.
- **Local ownership** – smart specialisation is a bottom-up approach based on mobilisation of stakeholders and active involvement of regional governments. These partners should have a leading role throughout the smart specialisation process, during diagnostic, planning, implementation and monitoring phases.
- **Long-term focus** – structural transformation of an economy and social change are long-term processes that have to be appropriately planned and managed during years rather than months.
- **Capacity building** – smart specialisation strategies cannot be designed nor implemented externally, but they require strong involvement of public authorities and stakeholders. Therefore, institutional capacity should be strengthened from the very beginning, with external experts or bodies playing only an advisory role.
- **Learning and sharing** – the smart specialisation approach is based on continuous territorial and institutional learning, starting from monitoring and evaluation of policies to analysis of new trends and the exchange of good practices with other regions.
- **Policy mix** – one of the strengths of smart specialisation approach is the combination of different instruments and financing sources, including public and private investors. It is worth noticing that, however S3 is obligatorily connected with Thematic Objective (TO1 - Research and Innovation) and there are often preferences concerning TO3 (SME Competitiveness), in case of energy transition TO4 (Low Carbon Economy) actions can be explored as an additional financing source.

Additional aspects of smart specialisation in coal regions

There are additional considerations that should be taken into account when applying S3 methodology in coal transition regions:

- **Transitions imply not merely a change of policies but a transformation of the underlying economic, social and political systems.** International experiences show that system transformations require transfers of authority (and shifts in political/administrative hierarchies), changes in legislation and other framework conditions (OECD, 2015). Resistance to change needs to be prepared for and actively managed. Smart specialisation has helped initiate reforms in governance systems, and indeed incorporates the issue of transfer of authority (at least partially) to the community of stakeholders performing the entrepreneurial discovery process, which is at the basis of the identification of policy priorities. Nevertheless, the application of the method with regard to broader transformational challenges would need adaptation and fine-tuning.
- **The transition is not just about innovation policy.** In fact, traditional "innovation" policy makers (innovation agencies etc.) are poorly positioned to bring about systemic change: they are too close to the "incumbents" of the existing system(s), to effectively challenge their interests. In this context, smart specialisation can offer –via guidance, methodological support and case studies– valid suggestions to broaden the array of involved stakeholders beyond the 'usual suspects' (this would benefit in particular those regions having weak governance systems).
- **Greater need for public intervention and increased complexity of multi-level governance** – Public interventions across a wide range of policy areas are necessary. As issues of national energy policy mix are decided at national level,

and smart specialisation is a place-based approach, the dialogue between national and regional authorities is necessary. Moreover, there is a need for interinstitutional cooperation (inter-ministerial/departmental). Because of this, the degree of within-government coordination required is near-impossible to achieve without leadership and sustained impulse at the highest possible political level and across the whole sequence of multi-level governance actors.

- **Public investments in infrastructure, particularly when they support the creation of local markets, can be important elements of a transition.** The required infrastructure investments go beyond the remit of traditional innovation policy as they are likely to include large scale investments in environmental renewal/waste disposal, transport and communication, among many others. Decisions on prospective infrastructure investments inevitably begin with the identification of user needs, which can be facilitated using participatory methods.
- **Strong need for wider involvement of civic society** – as phasing out of an industry sector induces societal changes (requalification, unemployment etc.) and impacts territorial identity (embedded competences), the involvement of local communities in the S3 process is of key importance.
- **Identification of individual transformation models** – carbon-intensive regions and countries can choose different energy transition paths (phasing-out coal, clean coal technologies, renewables etc.), so while the general S3 methodology can be applied to support their transformation, it will need adaptation to the specific needs of each case.
- **Not everything can happen at once** - interventions need to be situated across time. Crucially, not all sequences are equal. Complementarities, conditionalities and other compositional characteristics of systems, mean that some policy interventions and investments must happen before others, e.g. transformation in production (securing jobs at risk) need to happen first as they can help finance and sustain transformation in consumption. Situating policy interventions in time is not trivial but can be crucial to effectiveness. Timing needs to be supported by evidence, as sequence is particularly susceptible to electoral-cycle driven political interference. When borrowing from international examples, it is important to take a macro-historical (rather than a static) and multi-level view of transition experiences.

In complex cases, like transformation of coal regions, there is a need for a more **targeted expert support and guidance**. The methodology tested first in Eastern Macedonia and Thrace, and subsequently developed in the JRC **Lagging Regions project** is proposed here as the basis for a specific, hands-on approach – it is described in detail in the JRC technical report "Implementing RIS3 in the Region of Eastern Macedonia and Thrace: towards a RIS3 toolbox" (Boden, M., Dos Santos, P., Haegeman, K., Marinelli, E. & Valero, S., 2016).

1.10 General overview of the smart specialisation methodology

The smart specialisation process, especially including additional focus on societal change (as described earlier) can take 1-2 years. If the process is to be methodologically correct there is a need to involve appropriate financial and organizational resources, both on JRC and pilot region's side. The approach described below is treated as a pilot, experimental action, and can be updated during the implementation. In order to proceed to any next stage, the involvement of Slovak partners (as described below) will be necessary. After the testing phase and necessary updates, the methodology can be applied in other coal regions in Europe.

Table 30. Proposed methodology for the pilot region

Stage	Description	Expected results	JRC support (S3 and energy experts)	Input from Slovak partners
I. Political and institutional framework				
1. Clear definition of the energy policy and planned energy mix	In order to plan the economic transition along the coal value chain, clear understanding of planned end result is needed – should the existing industries connected with coal be transformed, modernised or phased out? Energy transition scenarios can help decision-making in this case.	Defined energy policy and planned energy mix for the country	Development of energy transition scenarios, consultation of national energy mix	Decisions concerning energy policy taken by the national government
2. Identification of partners	In order to guarantee local ownership, appropriate partners at regional and/or national level have to be identified. They should be representatives of public authorities with power to design, launch, implement and monitor innovation policies and mobilise stakeholders.	Identified contact persons and decision-makers that can manage the smart specialisation process	Consult the choice of best partners	Appoint and empower appropriate entities – decision-makers and operational team
3. Identification of strategic mandates	Existing smart specialisation and other valid strategies should be analysed in order to identify priorities and sectors that are already supported, the actions already taken and possible synergies.	Clear picture of existing priorities, possible synergies and need to update strategic documents (if any)	Methodological support and consultation	Work of operational team on policy analysis
II. Diagnosis				
4. Detailed analysis of economic, innovative and scientific potential	S3 diagnosis is an analysis of economic, innovative and scientific potential. Analysis of economic potential should include regional specialisation and economic concentration patterns based on employment, value added and number of companies in different sectors. Other important aspects are national and international competitiveness of different sectors, preferably at NACE4 level. Innovative potential assessment is based on R&D&I performance of different sectors (Community Innovation	Evidence-based definition of possible transformation paths for the pilot regions	Expert support for the analysis of specialisation	Provision of statistical data and involvement of local experts, so capacity is built for future updates of the strategy

	Survey (CIS)-type data). Scientific potential analyses the ability of R&D sector to contribute to knowledge-based industrial transformation. Sources of data include bibliometrics and patents.			
5. Identification of good practice and possible barriers	Examples of successful and unsuccessful transformation examples that can be an inspiration for the development of vision for the pilot region but also indicate possible barriers	Identification of possible partners/ experts for interregional cooperation	Organisation of a good practice sharing workshop	Providing venue and logistics for the workshop and mobilising appropriate stakeholders to take part
III. Stakeholders involvement				
6. Entrepreneurial Discovery Process (EDP)	Qualitative analysis and organized dialogue with business sector, representatives of research community and public authorities.	Verification of the preliminary transformation paths; definition of main trends and challenges, elaboration of vision of development and identification of necessary policy actions and instruments to be implemented	Expert support for the design and moderation of stakeholder workshops	Participation of the relevant stakeholders (including the political decision-makers) in EDP meetings, organization of meeting venues and logistics, promotion of events
IV. Skills and social transition				
7. Definition of needed changes in skills profile	Analysis of business needs focused on definition of skills profile needed for the economic transformation. The analysis should include the identification of embedded competences of the workforce connected with the coal industry as well as the definition of the options for their best application in new industries, retraining and requalification and new competences and skills needed.	In-depth understanding of skills needed to implement the defined vision of transformation of the region	Expert support for the design and execution of the study	Implementation of the results in existing strategies and Operational Programmes concerning education (new national education strategy, Operational Programme Education 2014-2020) and other available implementation instruments
8. Social change management	Involvement of wider civic society in the discussion on possible paths of modernisation, done according to the "participation ladder" – information (wider awareness campaign),	Public acceptance of the chosen transformation path	Expert support and help to identify moderators for the process	Openness to involve citizens in decision-making process, consequence in

	consultation (participation of civic leaders and NGOs in the debate), co-deciding and co-management.			implementation of the decisions (in order not to damage the public trust) and organization of meeting venues and logistics, promotion of events
V. Smart Specialisation Strategy and Implementation Plan				
9. Preparation of S3 coal transition strategy	Document with long-term transformation vision for the pilot regions, concrete actions to be taken and financial plan		Methodological support and consultation	Cooperation of decision-makers, operational team, local experts and stakeholders in preparation of the document plus its formal approval.
10. Implementation system	Definition of organizational structure able to deliver the implementation and monitoring of S3 coal transition strategy plus sound financing system to enable the implementation	Clear division of responsibilities for the implementation of S3 coal transition strategy, nomination of coordinating body and providing necessary financial resources to implement the planned actions	Involvement of JRC team with practical implementation experience in advisory and mentoring capacity	Nominating appropriate institutions and people able to ensure the implementation of S3 coal transition strategy at regional level and providing necessary financial and organizational resources

Source: (Boden, M., Dos Santos, P., Haegeman, K., Marinelli, E. & Valero, S., 2016)

In case more intensive expert support is needed, it is suggested to use the Lagging Regions methodology (Boden, M., Dos Santos, P., Haegeman, K., Marinelli, E. & Valero, S., 2016).

I. Political and institutional framework

Stage 1: Clear definition of the energy policy and planned energy mix

Definition of the energy policy and planned energy mix is the task of national governments. However, knowledge of the final decisions taken is necessary for the further steps in the transition process at regional level – it should be known if the future focus will be on other energy sources, renewables, etc., as it influences the definition of the industrial transformation path. In order to help take such decisions, JRC can offer

transition scenario analysis of the Slovakian energy system. An example of such an analysis is presented in section 1.6.

The sections above present only a preliminary first analysis of the development of Slovakia's energy system development. This can be further adapted to match national energy policy frameworks and future power system operator projections aiming at e.g. phasing out carbon-rich fuels in power generation, demand side restrictions or subsidy to the new technology options. The main challenge of the analyses is data availability. Therefore, by the end of each study a concrete list of data required for the potential improvement of further analysis is presented.

Stage 2: Identification of partners

At the present stage, the key partners for discussion and further definition of the project are national Slovak authorities and representatives of the self-governing region of Trenčín. At national level, the units (ministries/departments) responsible for:

1. energy policy,
2. economic/industrial policy,
3. innovation, smart specialisation and operational programmes,
4. regional development,
5. higher and vocational education,

have to be involved. The level of involvement needs to be both at decision-making and operational level.

At regional (NUTS 3)¹⁶ level, representatives of units responsible for economy, education and integrated regional development strategy have to be involved. Also, involvement of local authorities can be beneficial to the process.

After the detailed definition of the project and the approach at the institutional level, also external stakeholders should be involved, including especially:

- national and regional statistics offices,
- relevant representatives of business (to be specified after the detailed mapping exercise),
- relevant representatives of research sector and higher education,
- relevant representatives of vocational education,
- civic society and NGOs.

The detailed identification of partners needs to be performed together with Slovak partners.

Stage 3: Identification of strategic mandates

Slovakia has a national Research and Innovation Smart Specialisation Strategy Strategy (RIS3). The following S3 domains have been registered in the Eye@RIS3 Tool¹⁷:

- Automotive & mechanical engineering industries,
- Production and processing of iron and steel,
- ICT and Services,
- Consumer electronics and electrical equipment.

¹⁶ NUTS: Nomenclature of Territorial Units for Statistics: <http://ec.europa.eu/eurostat/web/nuts>

¹⁷ The Eye@RIS3 tool visualises public investment priorities for innovation across Europe. Available at <http://s3platform.jrc.ec.europa.eu/map>

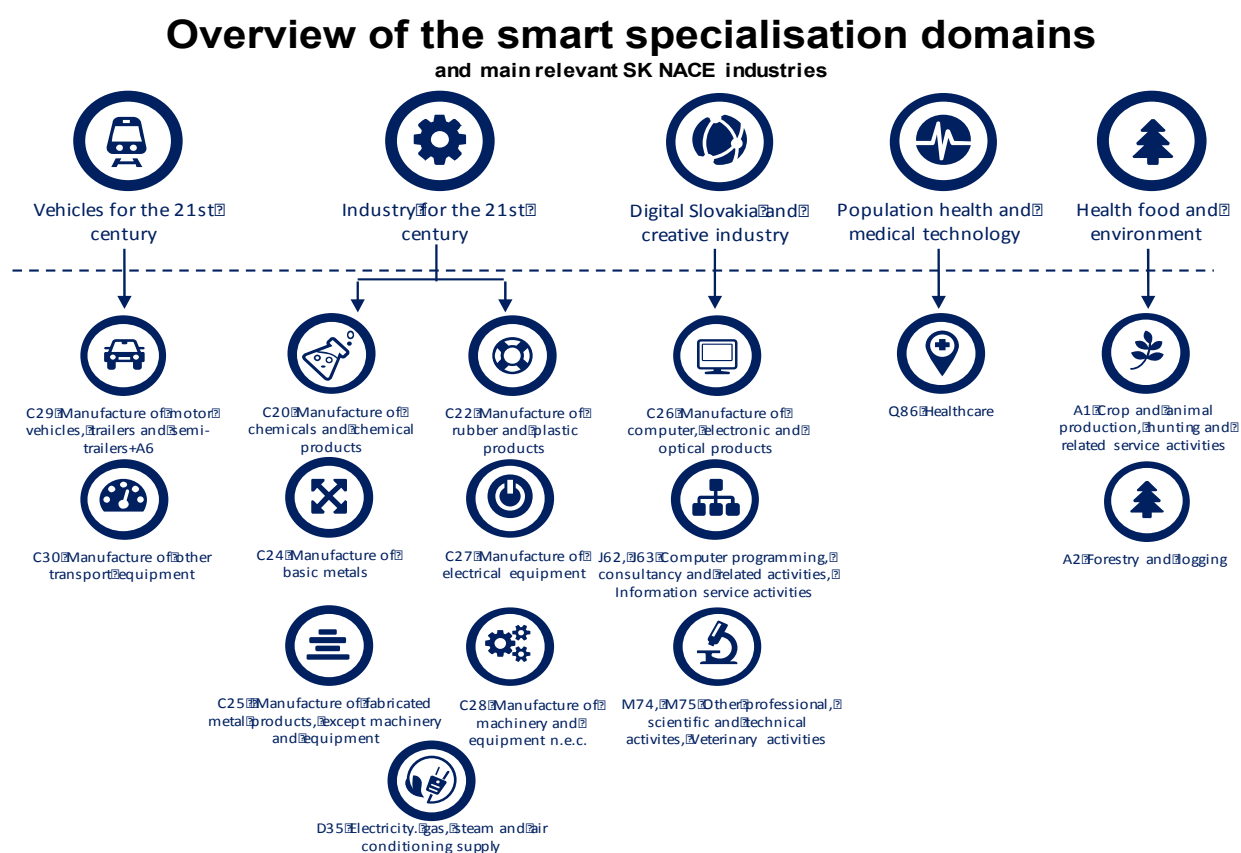
There are no priorities directly connected with energy at national level.

In the more recent RIS3 Implementation Plan for the Slovak Republic, the following smart specialisation domains are mentioned:

- Vehicles for the 21st century,
- Industry for the 21st century,
- Digital Slovakia and creative industry,
- Population health and medical technology,
- Healthy food and environment.

The detailed overview of these domains (Figure 38) also does not include any energy transition related priorities, but some of the industries mentioned in the domain *Industry for the 21st century* can be a part of coal industry value chain (see below).

Figure 38. Smart specialisation domains in Slovakia



Source: (Republic)

As mentioned above, the priority domains of the Slovakian Smart Specialisation Strategy do not include energy or coal. Slovak regions (self-governing regions, NUTS 3) have regional integrated territorial strategies. Also, there are regional components of European Regional Development Fund (ERDF) and European Social Fund (ESF) Operational Programmes. The objectives of the strategy for Trenčín region and relevant Operational Programmes that can have significance for the proposed approach are shown in Box 1. They have to be taken into account during the preparation of S3 coal transition strategy. The in-depth analysis performed during the proposed process can induce a need of changes in these documents.

Box 1: Regional integrated territorial strategy for NUTS3 Trenčiansky kraj (TK)

Strategic part for the territory of NUTS3 Trenčiansky kraj

Global objective: Contribute to improved quality of life and ensure sustainable provision of public services with an impact on balanced and sustainable territorial development; economic, territorial and social cohesion of TK.

Strategic priority 2: Easier access to more efficient and better services

1) **Investment priority 2.2:** Funding of education, training, expertise, skills and lifelong learning by development of education and training infrastructure

- a) Specific objective 2.2.3: Increasing the share of specialized secondary school students attending practical courses

Strategic priority 4: Improving the quality of life in TK with focus on the environment

- **Investment priority 4.1:** Support of energy-efficiency, smart energy management and use of energy from renewables in public infrastructures including public building and in residential sector

Strategic part for the territory of Trenčín functional urban area

Strategic priority 3: Mobilisation of creative industries in TK

- **Investment priority 3.1:** Supporting employment-friendly growth through the development of endogenous potential as part of a territorial strategy for specific areas, including the conversion of declining industrial regions and enhancement of accessibility to, and development of, specific natural and cultural resources.
- Specific objective 3.2: Stimulating the promotion of sustainable employment and job creation in the cultural and creative industry by creating a conducive environment for the development of creative talent and non-technological innovation.

**Strategic part for the scope of operational programme Quality of environment
(applicable to Trenčín region)**

- **Investment priority 3.1** Promoting investment to address specific risks, ensuring disaster resilience and developing disaster management
 - a. Specific objective 3.1.1: Increasing the level of preparedness to manage emergencies affected by climate change
 - b. Specific objective 3.1.2: Increasing the effectiveness of preventive and adaptation measures to eliminate environmental risks (except for flood protection measures)
 - c. Specific objective 3.1.3: Increasing the effectiveness of management of emergencies affected by climate change
- **Investment priority 4.1** Promoting the production and distribution of energy derived from renewable sources
 - a. Specific objective 4.1.1: Increasing the share of RES in gross final energy consumption of the SR
- **Investment priority 4.2** Promoting energy efficiency and renewable energy use in enterprises
 - a. Specific objective 4.2.1: Reduction of energy intensity and increasing the use of RES in enterprises
- **Investment priority 4.3** Supporting energy efficiency, smart energy management and renewable energy use in public infrastructure, including in public buildings, and in the housing sector
 - a. Specific objective 4.3.1: Reduction of energy consumption in the operation of public buildings
- **Investment priority 4.4** Promoting low-carbon strategies for all types of territories, in particular for urban areas, including the promotion of sustainable multimodal urban mobility and mitigation-relevant adaptation measures
 - a. Specific objective 4.4.1: Increasing the number of local plans and measures related to the low-carbon strategy for all types of territories
- **Investment priority 4.5** Promoting the use of high-efficiency co-generation of heat and power based on useful heat demand
 - a. Specific objective 4.5.1: Development of more efficient district heating systems based on useful heat demand

**Strategic part for the scope of operational programme Human resources
(applicable to Trenčín region)**

- **Investment priority 1.2** Improving the labour market relevance of education and training systems, facilitating the transition from education to work, and strengthening vocational education and training systems and their quality, including through mechanisms for skills anticipation, adaptation of curricula and the establishment and development of work-based learning systems, including dual learning systems and apprenticeship schemes.
 - a. Specific objective 1.2.1 Improving the quality of vocational education and training while reflecting the labour market needs
- **Investment priority 1.3** Improving the quality and efficiency of, and access to tertiary and equivalent education with a view to increasing participation and attainment level, especially for disadvantaged groups.
 - a. Specific objective 1.3.1 Increase the quality of tertiary education and development of human resources in the area of research and development with a view to establishing a link between tertiary education and the needs of the labour market
- **Investment priority 1.4** Enhancing equal access to lifelong learning for all age groups in formal, non-formal and informal settings, upgrading the knowledge, skills and competences of the workforce, and promoting flexible learning pathways including through career guidance and validation of acquired competences.
 - a. Specific objective 1.4.1 Improving the quality and effectiveness of lifelong learning with an emphasis on the development of core competences and enhancing and upgrading skills.
- **Investment priority 3.1** Access to employment for job-seekers and inactive people, including the long-term unemployed and people far from the labour market, also through local employment initiatives and support for labour mobility
 - a. Specific objective 3.1.1 Increase employment, employability, and reduce unemployment with special emphasis on the long-term unemployed, low-qualified, elderly, and disabled persons
- **Investment priority 3.3** Modernisation of labour market institutions such as public and private employment services and improving of the matching labour market needs, including through actions that enhance transnational labour mobility, as well as through mobility schemes and better cooperation between institutions and relevant stakeholders.
 - a. Specific objective 3.3.1 Increasing the quality and capacity of public employment services to the corresponding level in relation to the changing needs and requirements of the labour market, multinational work mobility, and increasing the participation of partners and private employment services on the solution of problems in the area of employment

II. Diagnosis

Stage 4: Detailed analysis of economic, innovative and scientific potential

Smart specialisation approach requires a specific type of analysis with detailed indicators that allow for an in-depth understanding of specific development challenges. Such data is not available in publicly accessible statistics and has to be obtained in cooperation with national or regional statistical offices.

Table 31: Preliminary analysis of economic, innovative and scientific potential

Economic potential			
Part of analysis	Indicators – NUTS 2/3 level	Data needs	Data sources
Since the coal mine is a major employer in both NUTS2 regions, its closure will affect the economic landscape of the territory. In order to better understand the significance of the change, a detailed analysis is needed to understand the economic structure and chances for future growth. Analysis of specialisation, concentration and growth dynamics can be useful here (it would have to be performed for all Slovak regions in order to understand specific niches and distinguishing features of the pilot region).	<ul style="list-style-type: none"> Location quotients (LQ) for employment, value added and number of companies LQ 10-year dynamics Shares of different sectors in the economy (employment and gross value added) Compound annual growth rate Structure of exports by product groups 	<ul style="list-style-type: none"> NACE rev 4 data on employment, value added and number of companies , preferably in 10-year spans Export in million EUR by product groups 	The regionalised NACE rev 4 data can be provided by national or regional statistics offices. The involvement of local partners is a part of capacity-building exercise. Export data is usually in Ministry of Finance (tbc for Slovakia)
Innovative and research potential			
Part of analysis	Indicators – NUTS 2/3 level	Data needs	Data sources
This part of analysis is to show the innovation potential of different industry sectors and to help choose the most promising ones	Community Innovation Survey (CIS) indicators by sectors	Regionalised CIS data by NACE rev 4 sectors	National or regional statistics offices.
Mapping of research sector should help identify key public and private R&D stakeholders in the areas matching the economic profile of the region	Patent analysis and bibliometrics	Patents and publications per area of science or subclass	International databases, National Patent Office

Additional dimension: Social changes concerning embedded competences and territorial identity			
Part of analysis	Indicators – NUTS 2/3 level	Data needs	Data sources
Significant economic changes induce social processes connected with change of careers, the social acceptance for change of dominant vocation (especially important in regions with heavy industry, where service jobs are often considered humiliating), challenges for vocational and higher education, etc.	Data on wages and unemployment, study on transversal competences (possible to use in other sectors) Entrepreneurship indicators Structure of vocational and higher education	Registered unemployment by age groups and gender, long-term unemployment, number of companies per 1,000 inhabitants, students in vocational schools per type of course, university students and R&D staff by domain. In case of available budget and long-term approach, dedicated study on workforce competences will be needed	National and regional statistics offices. Dedicated study done by experts

Source: JRC

Stage 5: Identification of good practice and possible barriers

This stage aims to provide inspiration and possible future development models drawn from regions that experienced or are in the process of undergoing energy transition or in the process of phasing out coal. Exchange of experience and lessons learnt from managing structural change typically take place in an interactive workshop with invited experts and presentation of best practices. Also other pilot regions representatives could take part in the discussion as a preparation for the transition process in their territories.

Case studies of other countries and regions engaged in the transition from coal could be examined, and relevant stakeholders from these regions gathered together to share experiences and identify good practices. In addition, the JRC can analyse the S3 priorities chosen in those European regions that are more dependent on carbon-intensive industries or on coal mining. Synergies in research activities across these coal and carbon-intensive regions in the EU could be explored.

III. Stakeholders involvement

Stage 6: Entrepreneurial discovery

Entrepreneurial discovery should provide the qualitative dimension of the results of quantitative, statistical analysis. This can be achieved in many ways. The key elements of the Entrepreneurial Discovery Process (EDP) process are:

- Identification of relevant stakeholders,
- Mobilisation of the stakeholders,
- In-depth or focus interviews,
- A series of workshops during which a common vision, policy mix and monitoring indicators will be developed.

The process should be moderated by experts and facilitators with very good understanding of S3 methodology and sectorial knowledge, especially concerning energy transition issue. Looking at previous experience, the language can become a problem during the interaction with stakeholders – therefore, either a translation service or a local team will have to be involved during the interviews and workshops.

Structured stakeholder engagement and the provision of tailored methodological guidance in the EDP are at the core of the JRC's work on targeted support to so called "Lagging Regions." It is essential to ensure that the process is methodologically robust and sufficiently detailed, that it takes place in a sustainable but flexible manner and can be continuously improved, by identifying elements that could be further strengthened.

Box 2 below presents examples where the JRC has supported the implementation of the EDP, contributing to a positive change in the partner regions' attitude towards innovation and their visions for long-term transformation.

**Box 2: EDP in North East and North West regions of Romania
and in Eastern Macedonia and Thrace of Greece**

In the **North East and North West regions of Romania**, the structured approach to the EDP devised by JRC was readily assimilated by the two Regional Development Agencies, and duly replicated by them. In addition to underpinning the ongoing refinement of regional strategies, the approach provides a formal framework for linking up disparate projects, identifying their complementarities, and supporting the potential advancement.

As a result, for the first time, a sizeable part of regional innovation investments are allocated in the form of integrated and multidisciplinary project portfolios. Better integration through the EDP has provided the basis for effective coordination at all stages of implementation. The expectation is that the new project portfolios can contribute to a better capitalisation of regional education competences, research infrastructure, increasing the performance of industries with comparative advantages, and addressing societal challenges to reduce the gap between the remaining regions and the other regions of Romania and Europe. Integrated investments identified in the course of the EDP activities will also help increase the number of research projects that are more market-oriented, increase the number of interactions between academia and industry, increase the volume of private investment for research and innovation, develop transfer services technologically, develop new professional competences adapted to the new markets.

In **Eastern Macedonia and Thrace (Greece)**, the EDP required not only introducing, for the first time, participatory dialogue in research, and innovation policy-making, but also building trust among all the key stakeholders. This mechanism required that stakeholders taking part in the EDP be kept informed of policy outcomes. This was made possible through two types of events:

- EDP focus groups: a set of six dedicated sectoral events, aimed at generating innovative ideas through interaction between business, public and research sectors within the S3 priorities;
- Project Development Labs: a set of two events aimed at processing the EDP ideas and moving them towards implementation, identifying funding opportunities and action plans for policy. During the second Project Development Lab in particular, policy-makers presented to actors of the triple helix the draft calls for proposals, which were developed in light of the EDP focus groups. Stakeholders could comment on those, as well as develop their ideas further with the support of experts in R&D funds.

Policy-makers in this region needed to take on new responsibilities for research and innovation policies. These new competences pushed the Managing Authority of the ERDF Operational Programmes to develop, together with the JRC, skills in participatory leadership to pursue EDP in different sectors. Through the EDP focus groups, the region defined in detail its priority areas and building on that, analysed the administrative and legal aspects necessary to write effective calls for proposals. This involved interactions with the national government, the European Commission and experts in the field. Furthermore, throughout this process, stakeholders themselves noted that a better awareness of relevant actors (through updated databases and appropriate avenues for interaction) was necessary for conducting a proper EDP.

Source: (Boden, M., Dos Santos, P., Haegeman, K., Marinelli, E. & Valero, S., 2016)

IV. Skills and social transition

Stage 7: Definition of needed changes in skills profile

Territories where the heavy industry is present, often face serious societal challenges when such an activity collapses or is phased out. This is connected with embedded competences (tradition and status connected with working in heavy industry, that is often the main employer in the area) and resulting strong territorial identity. Experience from other countries (e.g. Poland) shows that miners and other people employed in the coal industry are often reluctant to undertake other type of employment, and they see work in trade and services and humiliating. Therefore, it is important to analyse and plan skills transition as well as it is possible, taking into account the following factors:

- Transversality of competences – meaning their applicability in other sectors with more value added,
- Detailed understanding of business needs in terms of needed job profile, both in short and long term (from quick retraining, to the introduction of new educational paths).

The pilot region already mentioned in its strategic documents (see Stage 3) the need to improve vocational education and address the needs of labour market. The planned and already undertaken actions should be taken into account during the definition of future skills profile. The present skills profile of Trenčín region has been described in section 2.1.4 (diagnosis).

It is worth noting that Slovakia has recently introduced a 10-year education strategy and Slovak Smart Specialisation Strategy addresses the educational challenges in one of its strategic objectives: *Improving the quality of human resources for an innovative Slovakia*. As Slovakia has the highest unemployment rate of low-qualified people in the EU (34.4% compared to EU average of 16.3% in 2015), and a very big number of low value added jobs (third lowest in the Euro area) – a need for better vocational education and more knowledge-intensive jobs can be clearly seen.

Stage 8: Social change management

As mentioned in the previous chapters, the economic transformation of the size predicted in coal transition regions has a significant social impact and can cause many negative consequences. It is important to involve wider civic society in the discussion and choice of future development paths. Key stages of such a process would be:

- Wide informational and awareness-building campaign showing the reasons and possible results of phasing out coal,
- Dialogue with civic society and non-governmental organisations,
- Inclusion of activists and opinion leaders into the decision-making process,
- Providing support to groups directly affected by energy transition process (good practices from Ruhr area).

V. Smart Specialisation Strategy and Implementation Plan

Stage 9: Preparation of S3 coal transition strategy

S3 coal transition strategy should be a document that is a part of strategic framework at national and regional level. It is important that there is an ownership of the document at

regional and national level and strong commitment to the implementation. As a wide array of the stakeholders is planned to be involved in the process, there will be social expectations connected with its implementation. It was already mentioned in the previous chapters of this report, how important it is that the Slovak partners are actively involved in the process at each stage.

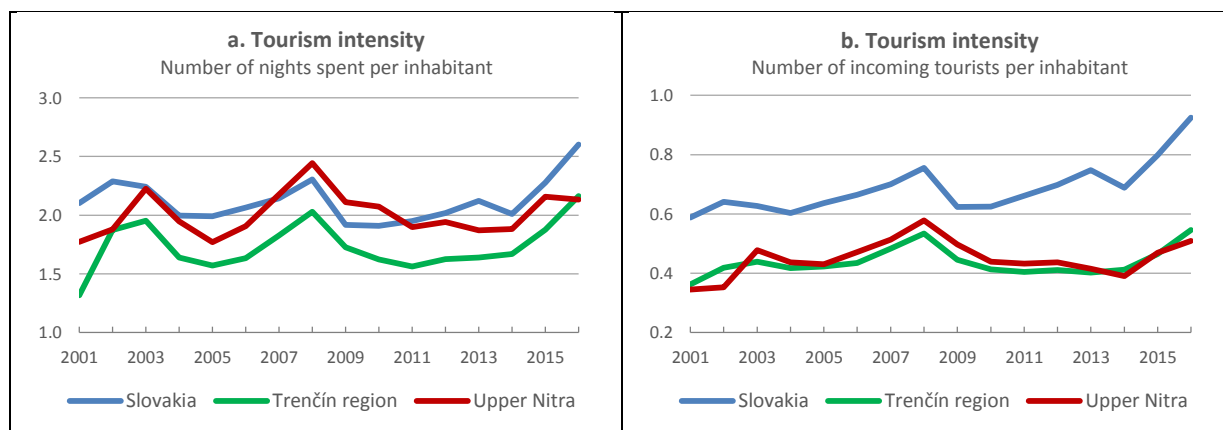
Stage 10: Definition of implementation and monitoring system

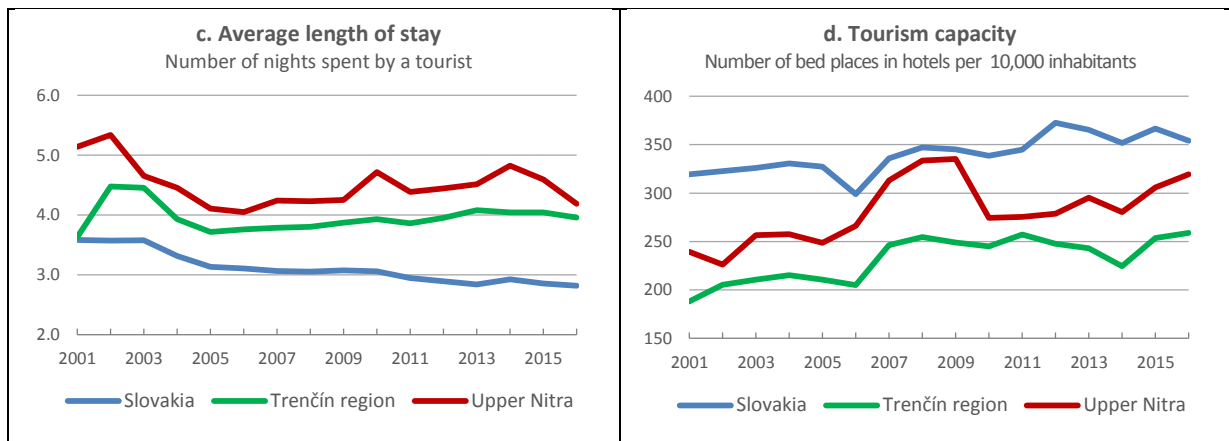
The S3 coal transition strategy document must have a defined implementation system with a clear division of responsibilities, financing sources and expected results. While the development of the implementation system will be mostly institutional task, the monitoring indicators should be developed together with the stakeholders.

An example of potential for possible further developments

Further developing the tourism sector can be an important part of the attempt to sectorally diversify the region. Nationwide tourism accounts for under 3% of Slovak GDP and about 5% of employment (OECD, 2014). Insofar as is discernible from the tourism indicators that are available at the regional level (number of incoming tourists, number of nights spent per inhabitant, the importance of tourism, the importance of tourism in Upper Nitra has been above the regional average of Trenčín region, but somewhat below the Slovak average in the last 15 years. The financial crisis of 2008 might have had a negative impact on tourism development, but signs of recovery can be observed again in the last five years (Figure 39 a-d). Upper Nitra has several important attractions (Figure 41), the main ones being clustered in the town of Bojnice (therapeutic and wellness spa, the national zoological garden and a preserved medieval castle). The same area is also the major hotspot of touristic accommodation (Figure 40). Other attractions or potential attractions are scattered around Upper Nitra – historical monuments, minor museum, protected natural areas, industrial monuments, sports and recreation facilities.

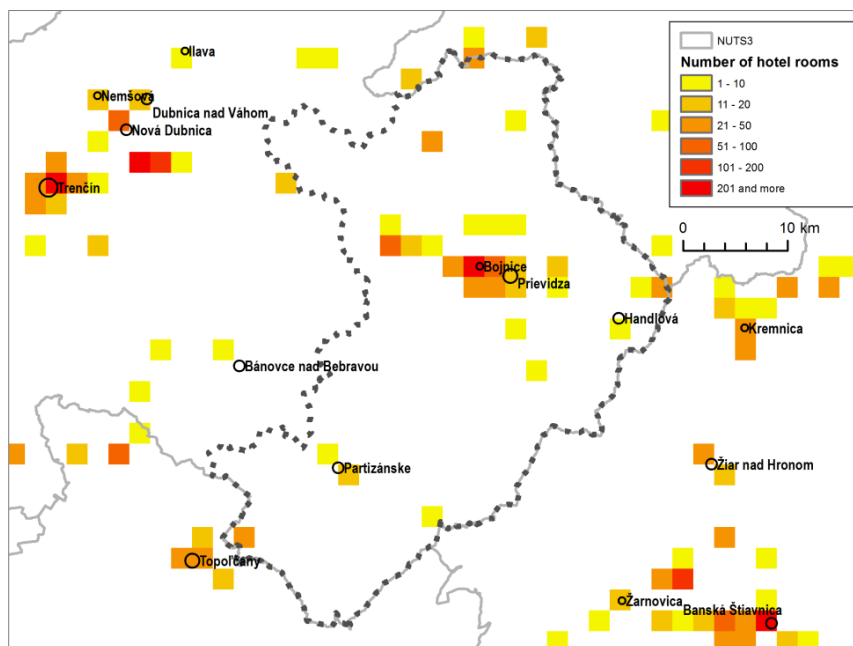
Figure 39. Tourism indicators for the pilot region in years 2001-2016





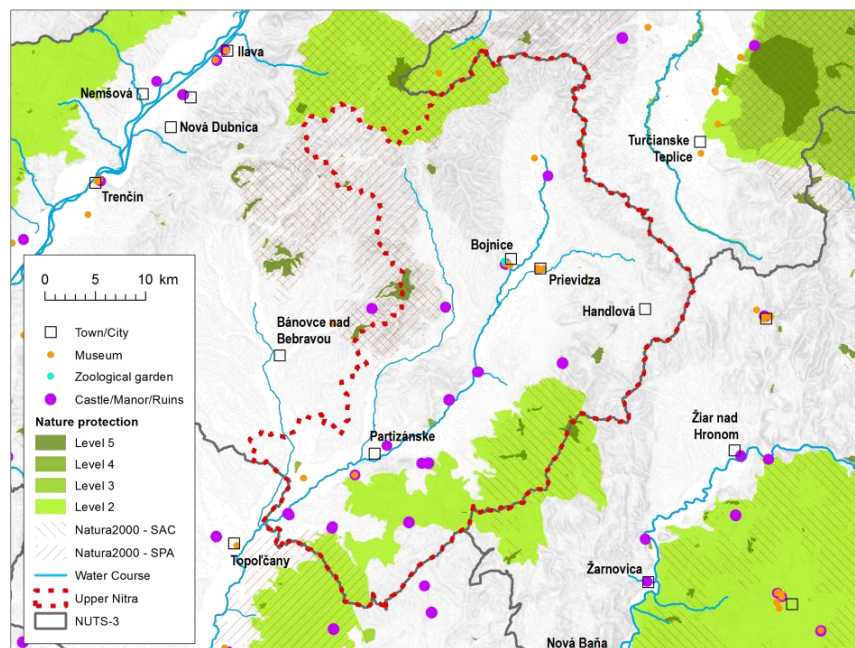
Source: (Statistical Office of the Slovak Republic, 2017)

Figure 40. Capacity of touristic accommodation at local level



Source: JRC elaboration on (Booking.com, 2016)

Figure 41. Cultural and natural heritage as potential touristic attractions



Source: JRC elaboration on (Ministerstvo životného prostredia SR, 2017) (EuroGeographics, 2016) (OpenStreetMap contributors, 2017)

One of the key obstacles to tourism growth in Upper Nitra –the inferior accessibility compared to other regions– will likely gradually diminish thanks to the planned motorway network upgrades. Other investments are no less important, such as the education and training of the workforce in the HORECA (hotels, restaurants and catering) sector.

Investment in the maintenance of existing attractions (e.g. the Bojnice ZOO and spa) could be accompanied by differentiation of tourist attractions and products to address challenges as seasonality, volatile demand and decreasing cost-competitiveness due to economic development (OECD, 2006).

Potential attraction diversification could build on potential existing of the region:

- Stepping up existing nature conservation to create more valuable, interconnected areas of wild nature;
- Preserving traditional agriculture in the less favourable hilly landscape might contribute to keep biodiversity and promote agrotourism;
- Part of the industrial heritage of Upper Nitra might become a target of conservation efforts and become tourist attractions (Handlova coal mines, Bata complex in Partizanske).

Innovation can also be an important part of efforts to support growth in the tourism sector. Innovation can result in the development of new tourist products and services, and/or the stronger differentiation of existing products. In doing so it can help address challenges faced by tourism sectors in many EU member states with respect to high seasonality, volatile demand, or the erosion of their cost-competitiveness due to economic development. Both technological (ICTs for e.g. augmented reality visits) and non-technological forms of innovation investment (organisational innovation, marketing and design) and their combinations can be relevant. International experience underscores the important of long-term planning and shows that the mix of instruments used and paths to development can be very diverse (OECD, 2006). While the state cannot influence which particular innovations will succeed, it can play a key role as a co-producer of innovations in tourism and in the provision of necessary infrastructure.

Mine and heavy-industry conversion to attractions can be found elsewhere in Europe. The European Route of Industrial Heritage (European Route of Industrial Heritage website, 2018) lists many of these cases, as well as other types of industrial heritage.

- The ironworks of Lower area of Vítkovice in Ostrava, Czech Republic, have been recently converted to a successful touristic attraction (Radio Praha website, 2018) (Dolní Vítkovice website, 2018);
- Zollverein coal mine and industrial complex in Ruhr Valley Germany (Wikipedia, Zollverein Coal Mine Industrial Complex, 2018);
- Be mine mining museum near Hasselt in Belgium (Mine Museum website, 2018)
- Former mine science and art centre in Walbrzych, Poland (Centrum Nauki i Sztuki Stara Kopalnia website, 2018).

1.11 Proposed approach to skills transition

1.11.1 Introduction

The employment effects of alternative energy source deployment in the EU are visible with for instance jobs in coal power production lost while many more are created in wind or solar production. Transitioning out of coal production is a challenging and multifaceted process (Wirth P., Černič Mali B., Fischer W., 2012). Social, environmental, and economic site specificities and the post mining potential of each site must be taken into account when setting goals and designing phasing-out interventions that will have long lasting effects on the socio-economic wellbeing of the affected areas. Multi-stakeholder consultations and community engagement are common practice in coal mine closure processes (Stacey J., Naude A., Hermanus M., and Frankel P., 2010), as – due to the high territorial concentration of coal production – mine closures have a significant impact on the local/regional economy as well as on the identity of the population of the area and the current set-up of their communities and family networks (Caldecott B., 2017). This is particularly true because the jobs losses, due to mine closures, have an impact on the areas that is likely to persist over many years, affecting not only the workers that lose their jobs but also prospective workers that will find themselves in a market where former miners compete for the same position and the primary economic sector of the area has vanished (Marot M., Černič Mali B., 2012).

When looking at Slovakia, the share of employment in mining and quarrying (a larger industry compared to coal mining alone) has remained quite stable in the last 9 years, from 0.26% in 2008 to 0.28 in 2016 (which is higher than the EU28 average: from 0.16% in 2008 to 0.13% in 2016). The trend observed in many developed countries (like the UK, Germany or the EU) is one of a decline in employment in and output of coal mines, due to increased competition from developing regions, increased resource efficiency, price decline of alternative energy sources and a move towards greener technologies (like solar and wind). This means that we should expect that employment in coal mines in Slovakia is likely to decrease and this raises the issue of how to deal with the human capital implications of the industry restructuring.

The human resource challenge of moving towards low carbon energy production lies on the training of the additional workforce needed in the next few years (Georgakaki A., von Estorff U., Peteves S.D., 2014). In addition, re-skilling and up-skilling those that have lost or will lose their jobs in the supply chain of fossil fuels is vital for society and the economy. Enhanced cooperation and coordination of integrated public/private resources would be needed, especially in the areas where the market does not provide appropriate solutions (Georgakaki A., von Estorff U., Peteves S.D., 2014). Based on the experience in countries like Germany and USA, the transition out of coal production, needs focused policy support by the public sector with policies that go beyond training of coal miners. In

the absence of well-designed demand and supply side policies there is a high risk that coal miners will massively end up in (very) long term unemployment.

1.11.2 Mine closure implications

Mine closure is recurrent in the history of many countries. Whether as a result of automation, investment in alternative energy producing technologies or simply as a result of the discovery of a new, bigger, easier and cheaper ways to mine coal field, the hard to swallow reality is that coal jobs are disappearing in developed countries. Furthermore, 1-3 dependent service jobs will be lost once a relatively well paid mining job is lost. Experience shows that redundancy payments are not efficient in supporting workers to transition from mining to other activities and can even be detrimental to their future employment prospects, if too generous (Caldecott B., 2017). A number of measures can be adopted to make the most of the transition time horizon so as to reduce the impact of job losses on individuals that are harder to move to alternative posts (e.g. workers aged 35-45). It will also help maximise the opportunity for on the job upskilling; but then a longer time perspective is of critical importance.

Anticipation and participatory planning of a transition strategy are considered key factors to reduce conflicts and resistance to change along the transition processes (Greenpeace, 2016). By careful planning the future of a coal production area based on its post-mining potential, skill needs identification can be performed and - accordingly skills - matching policies as well as human capital development interventions can be designed (G., 2010). Establishing a well-defined link between skills needs anticipation and regional development policies is thus essential to ensure the effectiveness of any active labour market policy targeted to the re-skilling of coal miners (European Commission, 2015). Activation measures through investment in human capital (i.e. vocational education and training as well as basic education) must be designed in synergy with regional development prospects and measures, i.e. taking into account the local reality.

In this case the age dimension becomes significant, since re-skilling of a much older than the average workforce, becomes quite different. Reskilling and reallocating younger workers may prove easier, when reskilling of relatively older workers may be wrong since it may bring less benefits (by definition, if their remaining years in employment are few, the benefits of their reallocation into employment will be smaller). For older workers, it may be more effective and reasonable just to provide them support income and encourage other types of reallocation, such as self-employment. In any case, any re-skilling strategy for miners affected by restructuring should pay a lot of attention to age.

1.11.3 Training initiatives for laid-off coal miners

It is clear that adequate funding, both towards training and subsistence costs, for an interim period would be needed. In addition, specific training on resume and interview techniques as well as further help with job placements is also needed. All coal miners can learn new skills and can choose from a wide variety of training opportunities like telecoms and electrical technology maintenance, alternative energy areas, sustainable agriculture, food production, tourism, nutrition, customer service and even software coding. Looking at the tasks profile of mining occupations, these involve a high degree of physical tasks (both strength and dexterity), and the most similar occupations would probably be similarly physical ones such as construction, agricultural or gardening, some types of manufacturing jobs, physical service jobs such as janitors etc. Orienting former miners to such occupations would probably be easier in terms of re-training and re-skilling, since they would already possess some key competences for those types of tasks because of their mining experience.

Digital skills are very important in the transition towards a Digital Life; even more so when acquiring such skills one also develops transversal skills such as creativity,

entrepreneurship and learning-to-learn which are also vital. It is thus very important to make sure that job seekers can certify their existing skills in ways that are fully trusted by the market. Collaborative platforms may be useful in supporting ex coal miners search for paid work, including digital work. In fact there are examples from USA of coal miners that have lost their job and that have learned to become proficient in computer coding. Coding is a skill that can be learnt, is currently in great demand and can be easily outsourced, and miners are well endowed to be trained because they are technical workers, team players, with good solving problem skills who are used to focus on the output of their job which does not forgive mistakes. Moreover, coding training is widely available with books, tutorials, hands-on video lessons and post-secondary education MOOCs at affordable prices.

Another option is that of adopting a role of remote training manager for still on the job colleagues or even as 'the human element' in the online training of robotic artificial intelligence applications. Currently all of the big tech companies (i.e. Google, Facebook, Twitter, Amazon. etc.) use human experts to help train/monitor/evaluate their automatic algorithmic solutions. Training and ensuing employment from the alternative energy technology companies which are in need of jobs is another likely match. More specifically solar companies may be interested to hire ex coal miners for solar installation jobs (i.e. assembling and maintenance); specific examples of this already exist in the USA (Edward L.P; Joshua P.M., 2016) and estimates as to how much it may cost to re-train all the laid-off staff – including janitors or structural engineers – amount to anywhere between \$180 million and \$1.8 billion for the total of 150,000 coal miner force. The integration efforts would be more successful if highly targeted at the workers most likely to benefit. In general, that means younger workers with some postsecondary education who are motivated to follow through, and who are able and willing to relocate to places with more job opportunities. Even in this case the co-location of regions with a failing coal mining industry and an expanding solar power industry are minimal. However, it is not always possible to use job seekers' old skills to deploy in new jobs and there are other industries that are fast-growing. Evidently, not everyone will be fit for a coding job; appropriate assessment tools may be used to better understand what specific skills a person has acquired so as to ensure a match for all reskilling efforts.

Box 3: Example of potential transversal competencies strategy

An additional skills transition strategy could be to look for transversal expertise and competencies (see Section 3.2, Stage 7), seeking for their applicability in other sectors.

Such an example has already been identified in Slovakia, using mining and drilling skills in enhanced geothermal technologies, to enable sustainable transition from coal mining activity to renewable energy production while reducing economic, social and environmental hazards of the transition. Some mining workforce, especially mid-level staff, operators, electrical and mechanical engineers, can be easily requalified for geothermal energy and trained for the deployment of this technology. In addition, former coal mining areas can be utilised to reduce drilling operations costs.

Other similar examples should be identified and discussed with energy technologies experts and other relevant stakeholders in the region in order to explore the best options for energy and skills transition, having in mind also the best economic, social and environmental impacts. This exercise could be done in cooperation with other EU coal regions in transition. A potential demonstration project could be envisaged after this stage.

Source: JRC

Several other transition strategies are also possible. A recent Dutch study (Gales B., Hölsgens R., 2017) proposes a number of transition initiatives (see Table 32).

Table 32. Transition strategies — Typology (the Netherlands)

Compensation or grandfathering (backward-looking)	Structural adjustment assistance (forward-looking, narrow)	Adaptive support (forward-looking, broad)
Consumers/ households		
Low price policies dominate, but levels managed to what the sub-markets will bear. A tradition of managing consumption, e.g. with building norms as instruments. Major changes like exit out of coal subsidised. Competitiveness the leading idea, but adaptations e.g. of the once stimulated energy-intensive production or electricity generation subsidised.	Substantial subsidies for entry into gas as the alternative to domestic coal production. The shift out of carbons contentious and part of a tottering political climate.	Seed subsidising; Advice on energy efficiency.
Workers		
Promise of no job-loss, which did not exclude job-losses later. A long-lasting pension problem, as the Dutch system is capital based, despite subsidies. Long-lasting problems with occupational hazards. No specific policies in the context of recent coal use or the exit from carbons more generally.	Miners taken out the labour market and younger generations massively trained. Loss of income and costs of employers covered partially.	Limited well-being funding.
Communities		
Local authorities were mostly covered by general programmes, which targeted communities for help in structural change programmes for the exit of gas building-up in response to the earth-quake problem. Repairs etc. are a charge of the producer, Reduction of extraction, the constraints of action and extra programmes are political issues.	Former mining regions targeted in regional programmes. Funding of infrastructural projects, roads in particular. Funding of industrial relocation and in the promotion of tourism. Establishment of university nearby, of the Open University in the region and growth of tertiary schools contributed to human capital building.	Community projects, largely educational. Limiting the effects of policy changes a major outlay of labour market funding.
Corporations		
Involvement of the State coal Mines in the gas industry. Exit subsidies for the private companies. After-math (subsidence) met out of special funds fed by the companies. Issues beyond the period of liability (rising mine water) contentious, but likely with a role for the Exchequer. The costs of natural gas extraction are born by the producer. Reduction of gas extraction reduces state-income.	Much room to invest in another future. Successful shift of the State Mines in chemicals. Former private mines became or were absorbed by investment institutions, but left the region. Important reallocation of (semi-) government offices. Gas is extracted by oil-companies, which can diversify.	Corporatist environment.

Source: Table content by the author(s) (Gales B., Hölsgens R., 2017). Table concept by Fergus Green.

1.11.4 On-going EU initiatives

At European level, relevant guidance has been established by the Council Recommendation of 19 December 2016 on Upskilling Pathways: New Opportunities for Adults, which though targeting the low skilled population, can be taken as a reference when designing re-skilling pathways for the coal workers in transition. Coal miners indeed most often suffer from skills shortages, as few educational opportunities are available to them, as often coal production is highly concentrated in areas where coal mining makes up the main economic activity (Caldecott B., 2017).

The Upskilling Pathways Recommendation invites member States to put in place strategies that provide adults with a low level of skills, knowledge and competences, the opportunity acquire basic skills as well as a wider set of transversal competences, relevant for the labour market and active participation in society, building on Recommendation 2006/962/EC on key competences for lifelong learning. Upskilling Pathways are ideally three legged, and build on skills assessment; provision of a tailored, flexible and quality learning offer; and validation and recognition of skills acquired (no matter the context).

In the case of coal miners' upskilling, a skills audit would allow to identify the skills that a miner has already acquired beyond those that are strictly coal mining specific, and any gaps that need to be filled in order to bring them up to a required level, so that a plan for the next steps in training and the support offered. The training offer shall be tailored to the actual needs of each individual to fill the specific skills 'gaps' identified through the skills assessment and flexible enough to be engaging for adult learners. No matter the form (non-formal and informal learning) that the training plan takes, it is critical that upskilling pathway is completed by the validation of the learning with a view to a qualification.

Example of good practices showcasing possible ways to implement Upskilling Pathways are here:

http://ec.europa.eu/employment_social/skills/good%20practice%20examples%20upskilling%20pathways.xlsx

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List of acronyms

a.s.	Akciová spoločnosť ("joint-stock company")
CIS	Community Innovation Survey
EC	European Commission
EDP	Entrepreneurial Discovery Process
EM	End Market
ENTSO-E	European Network of Transmission System Operators for Electricity
ERDF	European Regional Development Fund
ESF	European Social Fund
EU	European Union
HBP	Hornonitrianske bane Prievidza
ICT	Information and Communications Technology
IN	Input
JRC	Joint Research Centre
KET	Key Enabling Technology
LQ	Location Quotients
MI	Mining
NACE	Statistical classification of economic activities in the European Community
NGO	Non-Governmental Organisation
NUTS	Nomenclature of Territorial Units for Statistics
O&M	Operation and Maintenance
RES	Renewable Energy Source
RIS3	Research and Innovation Smart Specialisation Strategy
R&D	Research and Development
SE	Slovenské Elektrárne (Nováky Power Plant)
SME	Small and medium-sized enterprise
s.r.o.	Spoločnosť s ručením obmedzeným ("company with limited liability")
S3	Smart specialisation
TO	Thematic Objective
TYNDP	Ten-Year Network Development Plan
VOLY	Value of Life Year

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