

Smart strategies for the transition in coal intensive regions

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Blueprint on Northwest Bohemia energy transition

WP 6 – Task 6.4 / D6.5

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Executive summary

Northwest Bohemia is a region responsible for lignite (brown coal) mining which is important source of energy representing almost 44% of Czech energy mix in 2020. Mining is important not only on national but also on the local level. Despite the fact that only a small percentage of local population is directly employed in the mining sector, mining is supporting local economy both directly (as an employer and GDP producer), but largely also indirectly as an important customer of local business providing various goods and services. Local authorities, plan to repurpose region to other activities among them tourism, other industries such as automotive industry or ceramics and green energy sources. Despite declared effort to use knowledge in energy production gained in the region, and knowing that the renewable energy potential could cover the energy need in the region, it is unlikely to replace completely the coal-based energy generation. Among most often mentioned green energy sources, wind and solar are the main ones, followed with less attention by biomass and geothermal energy. Besides that, more green approaches have been the focus, mainly on: hydrogen production facilities and PSH plants (Pumped Storage Hydropower), based on water level differences between post mining lakes or newly building water storage. However out of the resources mentioned above only already established renewables, mostly biomass wind and solar have been applied in real world in target region.

This report synthetically describes the transition process of North-western Bohemia namely:

- Technological options available and concrete actions
- Roadmap's high priority measures

This Blueprint of future transition of Northwest Bohemia into post coal economy is based on previous TRACER deliverables, namely: D3.2, D3.3, D3.4, D6.1, D6.2, D6.3 and D6.4.

1. Northwest Bohemia common vision statement

A socially affordable transition of Northwest Bohemia from coal towards a sustainable and competitive economic development, supported by R&I will require repurposing of the region, reskilling work force and transformation of the region in terms of environmental condition and infrastructure.

It is noteworthy that environmental issues, both global (associated with global warming related to greenhouse gas production) and, as well, local (associated with negative effect of mining on environment) are perceived as a major incentive for cessation of mining.

Major priorities of the region are transformation to sustainable energy production, tourism and other industries, namely automotive industry.

2. Northwest Bohemia projection of the energy mix

The latest key document at national level providing the framework for future national energy policy is the "State energy conception of the Czech Republic" adopted by Czech government in 2015. The main mission of the State Energy Conception (SEC) is to ensure a reliable, safe and environmentally friendly energy supply for the needs of the population and economy of the Czech Republic at competitive and affordable prices, under standard conditions. At the same time, it must ensure uninterrupted energy supply in crises to the extent necessary for the functioning of the most important components of the state and the survival of the

population. The vision, thus defined, is summarized in a triad of the top strategic goals of the Czech energy industry, which are **security – competitiveness – sustainability**. The conception defines corridors which determine expected and desirable development of energy mix until 2050 (Table 1).

Table 1. Expected development of primary energy sources of the Czech Republic based on SEC, positive values in electricity export import field mean imports, negative values mean exports (SEC, 2015)

Primary energy sources	MU	2010	2015	2020	2025	2030	2035	2040
Black coal	PJ	194.3	184.6	164.2	163.2	143.9	143	136.3
Brown coal	PJ	564.3	505.2	448.8	330.2	307.4	253.5	150
Gas	PJ	336.1	338.9	344.5	348.6	357.9	361.4	381.2
Oil	PJ	378.4	385.8	374.2	366.8	348.7	326.2	301.5
Nuclear	PJ	305.4	343.6	343.6	343.6	343.6	449.2	471.3
Electricity export/import	PJ	-53.8	-80.1	-58.9	-22.3	-11.9	-29.9	-13.3
Other	PJ	10.5	12.9	13.8	17.2	19.5	19.5	19.5
Renewables	PJ	119.1	161.4	195.6	223.9	247.5	273.7	299.8
Total	PJ	1854.3	1852.3	1825.8	1771.2	1756.6	1796.6	1746.3

Source: TRACER-D3.1 Report

As can be seen from Table 1, SEC count on using of coal even in 2040, however recently Coal Commission recommend to government to stop mining coal in 2038, however this was before Ukraine crisis and voices appear now that this decision may be reconsidered, but no resolution have been taken so far. Conception expects decommissioning of old coal-fired power plants (from 2016 to 2025), commencing operation of new nuclear units and replacing decommissioned units Dukovany nuclear power plant with new nuclear units sources (between 2033 and 2037). The main changes in the balance of electricity production are gradual a decrease in production from lignite power plants and an increase in production from nuclear power plants. It is also planned reduction of electricity surplus, which is now realized as export of electricity.

The mix projection includes both heat and power production, cogeneration being an important feature of electricity and thermal-energy production from coal. TRACER target region Northwest Bohemia contributes significantly to the overall country electricity production, namely Ústecký district produces 30% and Karlovarský district 6% of overall electricity production. However important part of coal based energy production even if generated outside target region is based on coal mined in Northwest Bohemia. Nameplate capacity of Power Station in Ústecký district is 3964.6 MW and in Karlovarský district 549 MW. The largest producer of electricity in the Czech Republic is company CEZ a.s., which is partly government owned. CEZ group also operates the largest coal feed plant in the country namely Pocerady, a.s. (CZ0048 1000 MW_{th}, 1970), Detmarovice, (CZ0047, 600 MW, 1975, using mostly black coal), Tusimice (CZ0016, 800 MW, 1974), Prunerov 1 & 2 (CZ0015, 1050 MW, 1981), Ledvice (CZ0011, 770 MW, 1998), and Melník I, II & III (CZ00, 352 / 220 / 500 MW, 1981). Among other large players there is also the noteworthy group Seven energy (Chvaletice, CZ0046, 820 MW, 1977) and Sokolovská uhelá a.s.

In terms of coal importance are namely the CHPPs – cogeneration heat and power plants, a technology often used in the Czech Republic. In the field of electricity generation and supply, transformation is essential by 2040, thus ensuring a change in the structure of production and renewal of the old production plants with significantly higher efficiency, by partial exit

from coal towards the nuclear power, natural gas and renewables. In the coal-energy sector the following transition steps are emphasized in particular:

1. Provide conditions for retrofitting and upgrading the existing large condensation coal-based power units, exclusively as high efficient sources according to best available technical standards and their operation within the SEC horizon, with respect to the availability of brown coal; and without negative impact on coal supplies for other energy efficient systems;
2. Possible new coal-based power units should be oriented to high-efficiency or cogeneration with a minimum annual energy conversion efficiency of 60% or best available technical standards efficiency if any higher, in the overall range of the coal power industry corresponding to the target range solid fuels. Effective penalties for low-efficiency condensation-generated electricity were introduced since 2015 with increasing progress. Within the framework of the Czech Republic's raw material policy, it is underlined to ensure a sufficient supply of brown coal for the needs of heating plants, with preferential access to fuel only to the extent high-efficiency cogeneration production versus condensation sources;

State energetic policy expects also increase proportion of renewables in electricity production. There are also possibilities of fuel substitution namely at small cogeneration units, a significant amount of biomass is already in use today, which can be further increased in the future. The use of household waste fuels can also be increased (See also TRACER deliverable D6.1 for more details).

As already mentioned, the Coal Commission suggest finishing coal exploration in the Czech Republic by 2038. However, the energy concept of both district Karlovarský and Ústecký (Karlovarský district 2020, Ústecký district 2020), has been approved by regional district authorities before that, so it do not reflect, yet, particular time steps of coal abandonment. However, the district authorities explore increasing use of renewables in these districts. Technical potential for wind power generation is estimated at 2,632 MW nameplate capacities in Ústecký distict and at 1,451 MW in Karlovarský district. As for solar energy, after the end of the existing solar plants lifetime it is expected the capacities to be renewed, however, the next construction will be avoiding PV plants on agricultural land. The PV potential is expected to be used especially in brownfields and reclaimed mining areas, where it can reach several hundred MW, and also on the roofs of family and apartment buildings, public administration buildings, etc. In the horizon until 2044, we can expect the construction of new photovoltaic power plants on the roofs of houses with a total output of up to 200 MWp. Also in the Karlovy Vary Region, it is expected that in the coming years, photovoltaics will be installed primarily on the roofs and possibly the facades of buildings. The expected total installed power is 66 MWp. Due to its high occurrence and the potential of its energy use, biomass is the most promising renewable energy source. Regionally, the use of geothermal energy outside of heat pumps is also being considered with the "hot dry rock" (HDR) system. In the subsoil, in the Czech crystalline, there are heat reservoirs composed only of impermeable rock with a sufficiently high temperature depending on the depth. According to preliminary assessments for the conditions of the Czech Republic, the Ústí Region has above-average possibilities of using accumulated water in former mining areas and outside their framework (thanks to the geomorphological layout of the landscape) as a source for the production of electricity through pumped hydroelectric power plants.

A timeline (2025-2040) of Northwest Bohemia energy generation forecasting, by type of fuel, is presented in the Annex to this current Report "Blueprint Benchmark of Northwest Bohemia".

3. Northwest Bohemia available options meeting the planned energy transition

SEC considered, in substantial extend, possibilities of fuel substitution by biomass, as municipal solid waste and natural gas. The latter seems to be unlikely to hold in relation to Ukrainian crisis and shortage of gas supply in Europe. The incineration of municipal solid waste (Waste to Energy / WtE) will clearly increase, but it will probably play a larger role in terms of waste management than in terms of energy production. However, there is clearly some potential here, nationwide in 2020 almost 1.4 million tons of household waste was used for energy production, which is much less not only in comparison to total waste production but also in comparison with amount that has been landfilled (about 3.8 million tons). Northwest Bohemia declares substantial potential of biomass production outside post mining land, as forest or agriculture wastes. Post mining sites have often lower fertility compared to mature soil.

Despite that, according to earlier study (Frouz et al., 2015) the potential of post mining sites for biomass production ranged from $1.9 \text{ t ha}^{-1}\text{year}^{-1}$ on reclaimed sites to $2.6 \text{ t ha}^{-1}\text{year}^{-1}$ on un-reclaimed sites. These estimates are within the range of biomass production previously reported for spontaneous re-growth forest on abandoned agriculture land (Frouz et al., 2015). The potential production of trees and shrubs on post-mining sites, however, is less than that of poplar coppices on arable land (Werner et al., 2012) or of other short-term rotation plan-stations on former arable land. Despite this, the woody vegetation on post-mining sites has substantial potential for bioenergy use. Moreover, in these sites biomass production can be conveniently combined with soil improvement and sequestration of carbon in soil.

However, the most often mentioned renewables with highest perceiver potential are wind and solar. Related to solar energy use potential, post mining sites in Northwest Bohemia belong to areas with comparatively lower potential compared to the southern and south eastern parts of the Czech Republic. However, irradiation differences inside the country are not large and availability of large areas in post mining sites may be beneficial for solar plants, namely the ones with suitable exposure. In the contrary to solar, wind energy potential in mining areas and their close vicinity in Northwest Bohemia may be comparatively more suitable. In some location in TRACER target area, the density of wind power reach $200\text{-}300 \text{ W/m}^2$ as annual average. Štekl (2006) and also Chalupa and Hanslian (2015), indicated Northwest Bohemia as a suitable region for wind energy use. Economic return of investment in a wind power plant in Ústecký district is estimated to be 13 years.

Another renewable energy potential in the region is using of geothermal energy (dry hot rock) which is explored by a community project in Litoměřice.

Beside energy production there are considered also projects related to environmentally friendly energy storage and conversion. Those include mainly projects proposing technologies using differences in water level between various post mining lakes and or eventually additional reservoirs to store energy in form of hydro power using PSH plants (Pumped Storage Hydropower). Another proposed direction is hydrogen production and use in various energy and industrial application.

The Development strategy of both Ústecký and Karlovarský district (Ústecký district 2020, Karlovarský district 2020), which together form Northwest Bohemia, expect beside focus on green energy generation to focus also on tourism, and various industries among which automotive industry and ceramics are often mentioned.

Socioeconomic transition associated with cessation of mining will bring several fundamental challenges - the creation of new jobs, retraining, commuting, etc., while taking into account exogenous factors (covid crisis, war in Ukraine). Furthermore, it is necessary to respond to

changes in the economic structure as quickly as possible and with maximum support from science, research and innovation. This means modernizing industry and infrastructures and preparing the necessary education system for the new economy, as well as preparing people for the changing labour market. Both districts have the lowest share of workers with university level education in the country and, on the other hand, the highest share of workers with only basic education. This makes transition difficult because substantial proportion of workforce, namely workers with lower level of education and qualification is rather passive in searching new possibilities. This concluding remark is based on the anonymous questionnaires presented by the Economic and Social Council of the Ústí nad Labem Region (HSR, 2021) underlining the followings: Over half of the respondents had a basic education only or high school training without a high school diploma. Overall, 63% of respondents feel that a change in the energy concept will affect their jobs. However, 83% of the respondents intend to stay in their current job for as long as possible. Therefore, 65% of the respondents fear future unemployment. Here it is noteworthy that transition to renewable energy sources will not only create new jobs (Charles University 2021) but also create jobs in higher proportion that require highly qualified workers.

To apply the R&D outputs or new technologies in general, workforce reskilling is certainly needed. This is a process that is already ongoing and many reskilling programs are operating in the target region, mostly in terms of reskilling in various technical specialties. However, these reskilling programs have to be completed by follow-up programs that will allow obtaining the necessary practice in these fields. As it stands for many employers, the workers attending reskilling programs without adequate practice are not particularly attractive to be hire. This is a part of complex issues which include technical infrastructure, workforce qualification, funding, motivation, etc. Also, the absorption capacity of the industry can be negatively affected by the state of local infrastructures, which was affected by extensive mining activities in the past causing inadequate road and railroad systems and other infrastructure issues. These include also damage to ecosystems which may affect the living environment and attractiveness of the region for qualified personnel to move in.

Coal Commission proposed the end of the coal in the Czech Republic in 2038, so major effort related to this can be expected in next decade. However coal mining in the Czech Republic has been gradually decreasing since 1990s. To help solve problems associated with this transition towards post coal economy, Czech government initiated RE: START program to facilitate an open and publicly discussed process of restructuring the three districts, by involving hundreds of actors.. The program, managed at governmental level, is subject to regular evaluation and updating, flexibly responding to socio-economic developments in the regions concerned. As a result, the government and regions are given a transparent, systemic and long-term tool to address the specific problems of a large area. This eliminates the fact that dozens of regional actors submit individual requirements which, when implemented separately, are usually not subject to impact assessment and often require the adoption of non-systematic exceptions. The program created in this way is also positively evaluated by the European Commission, which continuously monitors the progress of the RE: START program and supports it in the framework of the Platform for Coal Regions in Transition.

On January 1, 2019, new implementation policies came into force, responding to the need for several changes. The Office of the Government Plenipotentiary was abolished, the coordinating role at central level being transferred to the Ministry for Regional Development, which included the new established National Executive Team RE: START. At the same time, in accordance with the principle of subsidiarity, the involvement of individual regions was strengthened through the Regional Permanent Conferences. The aim of the new implementation structure is to maintain a centrally coordinated approach of the transition process, while maximizing the absorption capacity for EU and other available funds in the territory and strengthening the individual approach at regions' level.

The 3rd updated Action Plan related to employment is currently approved based on the principles defined by the Strategic Framework for Economic Restructuring of the Ústí, Moravian-Silesian and Karlovy Vary District. It is a set of concrete measures, in the form of financial support or systemic changes that the government requires the relevant ministers to implement. Funds are allocated through individual grant programs/ministries/managing bodies of operational programs. Proposed measures will be implemented until 2030. The implementation of all measures to this extent represents a claim for funds amounting to CZK 10,090 million. See also TRACER deliverables D3.2, D6.1 and D6.2 for more details.

4. Northwest Bohemia high priority measures and concrete actions

As already mentioned, focus on transition towards renewable energy production and storage, automotive and other industries and tourism is a major priority of Northwest Bohemia. This transition will require several steps: introduction of new technologies, capacity building, and reskilling of workforce and application of effective reclamation measures, which will eliminate and or substantially reduce negative effects of mining on environment. All these steps clearly require investment. All of these components of transitions are urgent and they have to run basically in parallel. However, in all of them some changes in approach can be expected over time. As concern reclamation, this effort recently follows up material deposition on external heap and this phase will follow basically until cessation of mining around 2040. While the mining cessation occur in individual mining locations, intensive work on reclamation of mining pits and internal heaps will become prevalent, a phase that basically started and it will intensify in next decade (2023-2033). After solving major environmental problems, building of functional landscape and its associated infrastructure, which will fit to repurposing of the region, will follow. This final effort can be expected to peak in decade from 2040 till 2050.

Development of green energy and other industry in large extend correspond with this development of post mining landscape. Recently new business projects started, using specific opportunities of post mining land, such as windmill farms or BMW testing facility in Podružňohorská heap. These activities largely related to infrastructure which is a by-product of mining activity. Larger investments and decentralized development of new enterprises can be expected in next decade and particularly since 2040, in relation to building new mining unaffected infrastructure.

Similarly reskilling workforce will have several phases. Recently the major problem is reskilling of existing workforce which directly or indirectly depends on mining. This process is driven by gradual decrease of jobs in mining and associated industry will be here until complete cessation of mining let say till 2040. At the same time, there is a need to focus on young generation, to prepare workforce fit for occupation which requires higher qualification and high added value. This reskilling process has to be associated with the support for R&I in the region, this target region being the least developed in the Czech Republic. If we do not want to lose next generation this process also has to start more or less immediately, and it will likely intensify over time.

A correlation between Northwest Bohemia region's high priority measures and concrete actions recommended to be put in practice and scheduled on a proposed time-line (2030-2050), is presented in the Annex to this current Report "Blueprint Benchmark of Northwest Bohemia".

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ANNEX - Blueprint Benchmark of Northwest Bohemia

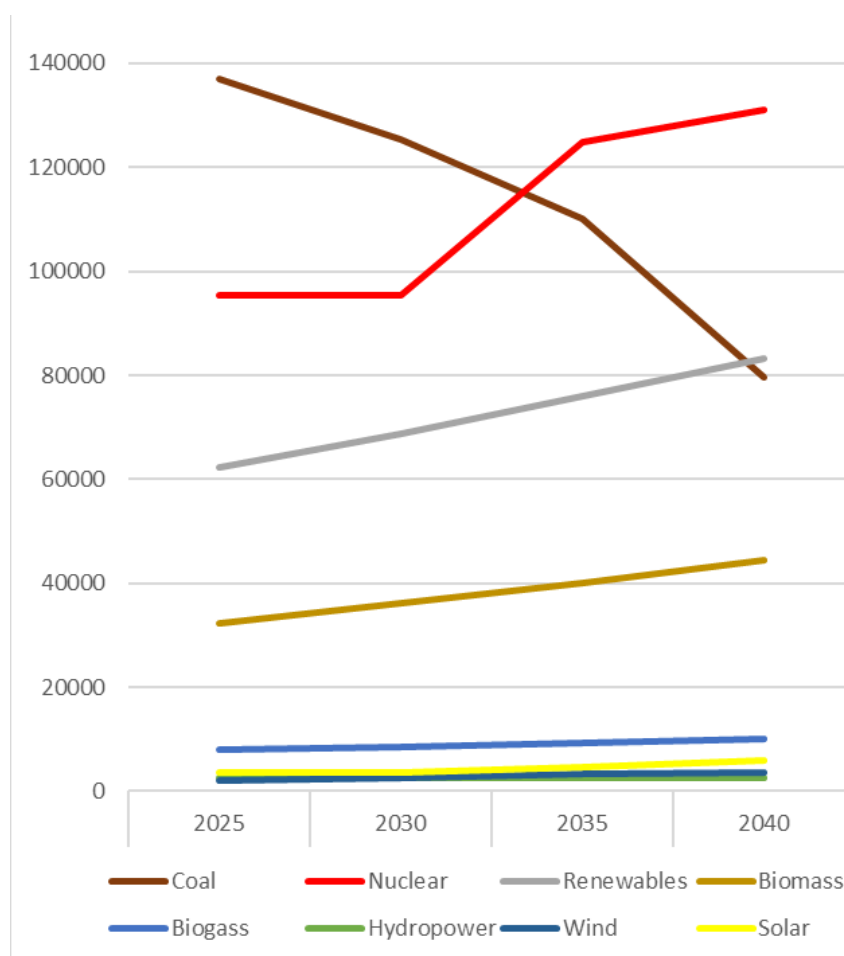
CZECH REPUBLIC

Northwest Bohemia CZ (CZ04)



SURFACE (km ²)	2021
POPULATION (inhabitants)	8,649
GDP PER CAPITA (EUR)	1,081,061
DIRECT EMPLOYMENT IN THE COAL INDUSTRY (power and/or heat generation, mining) (persons c. 2.5% of workforce)	15,180
UNEMPLOYMENT RATE (%)	13.7 thousand
	4.5

TIMELINE OF NORTHWEST BOHEMIA ENERGY GENERATION FORECASTING BY TYPE OF FUEL (GWh)



JOB CREATION POTENTIAL DURING THE DECARBONISATION PROCESS

TOTAL ESTIMATED NEW POSITION IN YEARS 2030/2040	HYDRO ¹	SOLAR PV ¹	WIND ²	BIOMASS ³
	32	3900	3300	1019

1 Charles University 2021 – based on green scenario and assumption that solar and hydro energy will be equally distributed by area of the country

2 Czech society for wind energy 2016

https://www.csve.cz/pdf/cz/TZ_Vetrna_energetika_pracovni_mista_30_8_2016.pdf assuming Northwest Bohemia is a dominant region for new wind power installation

3 Biom 3/2020 <https://biom.cz>

NORTHWEST BOHEMIA ENERGY TRANSITION TIMELINE

YEARS	PRIORITY MEASURES / AREAS	CONCRETE KEY ACTIONS	TECHNOLOGIES / SYSTEMS / SERVICES	MILESTONES
2030	Reskilling elimination of negative effect of mining social justice, new business	Reskilling workforce Landscape restoration	Increasing renewables Introducing new energy savings technologies	Expected coal phase out 2038
2040	New business support, reclamation after mine closures, new business support	Reskilling workforce Landscape restoration Support of new industry	Increasing renewables Introducing new energy savings technologies	Achieving level of other CZ region in employment and education indicators Landscape and social reconstruction
2050	Support economic growth, education focus on high added value economy	Infrastructure support Support new business Research and education support	Increasing renewables Introducing new energy savings technologies	Landscape and infrastructure reconstruction