Smart strategies for the transition in coal intensive regions

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Report on the current role of coal mining and related policies in the TRACER target regions

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TRACER website: www.tracer-h2020.eu

Contents

Abbreviations

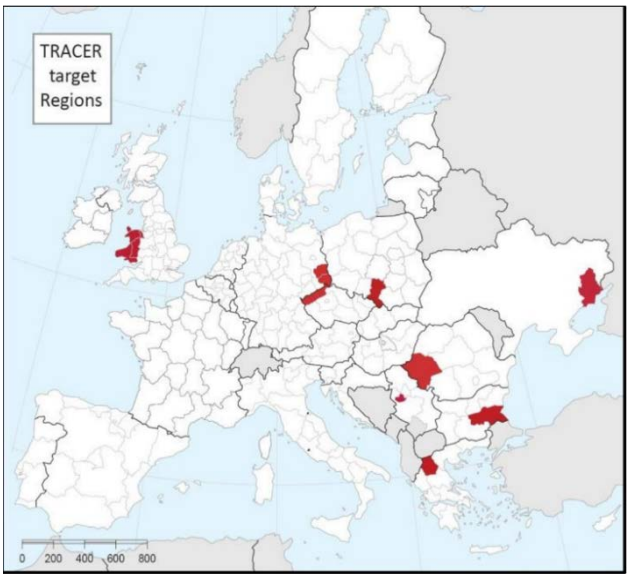
ADI-ITI Jiu Valley	Intercommunity Development Association - Integrated Territorial Investment
ADR	Vest West Regional Development Agency
ANPM	National Agency for Environmental Protection
ANRM	National Association for Mineral Resources
BEH	Bulgarian Energy Holding
BF-BOF	Blast Furnace/Basic Oxygen Furnace
BG	Bulgaria
BGN	Bulgarian currency (lev)
BRUA	Bulgaria-Romania-Hungary-Austria natural gas network corridor
CCC	UK Committee on Climate Change
CCS	Carbon Capture and Storage
CCU	Carbon Capture and Utilisation
CEH	Hunedoara Energy Holding
CEO	Chief executive officer
CHP/CHPP	Combined Heat & Power Plant
CNH	Hard Coal National Company
CSP	Concentrated solar power plant
CZ	Czech Republic
CZK	Czech currency (koruna)
DE	Germany
DHS	District Heating Systems
DN	National Road
DSO	Distribution Systems Operator
EAF	Electric Arc Furnace
EBRD	European Bank for Reconstruction and Development
ELSTAT	Hellenic Statistical Authority
ELV	Emission Limit Values
EMS	Environmental Management Systems
EPS	Electric Power Industry of Serbia
ERDF	European Regional Development Fund
ESF	European Social Fund
ESP	Electrostatic precipitator
ESR	Effort Sharing Regulation
ETP	Engineering and technical personnel
ETS	Emissions Trading System
EU	European Union
EUR	Euro
EVA	Economic value added
FDI	Foreign direct investment
FGD	Flue Gas Desulphurization
GD	Governmental Decision
GDP	Gross Domestic Product
GEO	Government Emergency Ordinance

GHG	Greenhouse gases
GR	Greece
GRP	Gross regional product
GUS	Statistics Poland
GVA	Gross Value Added
GW	Gigawatt
ha	Hectar
HCJ	County Council Decision
HHV	Higher heating value
HWB	Hot Water Boiler
ICT	Information and communication technology
IED	Industrial Emissions Directive
INS	Romanian National Statistics Institute
KIDSF	Kozloduy International Decommissioning Support Fund
LHV	Low heating value
LPA	Local Planning Authority
M200	Railway Network
m^3	Cubic meter
MB	Mining basin
Mm^3	Cubic megameter
MPA	Minerals Planning Authority
MPC	Maximum permitted concentration
Mt	Megatonne
MW	Megawatt
MWe	Megawatt electric
MWt	Megawatt thermal
NDF	National Development Framework
NECP	National Energy and Climate Plans
NERCU	National Commission for State Regulation of Energy and Utilities
NGO	Non-governmental organization
Nm^3	Normal cubic meter
NOx	Nitrogen oxides
NSI	National Statistical Institute (Bulgaria)
NUTS	Nomenclature of Territorial Units for Statistics
OECD	Organisation for Economic Co-operation and Development
OP	Operational Programme
OUG	Emergency Governmental Ordinance
PJ	Petajoule
PL	Poland
PLN	Polish currency (zloty)
PM	Fine particulates
PP	Power Plant
PPC	Public Power Corporation
PV	Photovoltaic
R&D	Research and development
RDC	Regional Development Councils
RDI	Research Development and Innovation

RES	Renewable Energy Sources
RO	Romania
RS	Serbia
RU	Regional Units
SCR	Selective catalytic reduction
SE	Southeast Region (Bulgaria)
SIF	Structural and Investment Funds
SME	Small and medium enterprise
SNH	National Hard Coal Society
SNIMVJ	Jiu Valley National Mines Closure Society
SO_2	Sulphur dioxide
SO_x	Sulphur oxides
t	tonne
TAP	Trans Adriatic Pipeline
TEN-T	Trans-European Transport Network
TPES	Total primary energy supply
TPP	Thermal power plant
TS	Thermal Station
TSO	Transmission Systems Operator
TWh	Terawatthour
UA	Ukraine
UAH	Ukrainian currency (hryvnia)
UES	United Energy System
UK	United Kingdom
VAT	Value Added Tax
WB	World Bank
WEFO	Welsh European Funding Office
WEMP	Wholesale electricity market price
WMLC	West Macedonia Lignite Center
WMR	Western Macedonia Region

1 Executive summary

This report describes the current situation and intentions in 9 European coal-intensive regions facing the challenge of transition towards low-carbon economy. It will serve as a basis for the development of solutions, guidelines, and strategies for the transition.



Coal mining and coal utilization for the production of electricity, heat, briquettes, etc. have a very different role across regions. The below table shows the coal production, installed electrical capacity, and electricity generation, according to the last available data. It demonstrates the large scale of coal business in the Polish and German regions and the small scale – in the Romanian and UK regions. These figures are linked with the social, economic, and environmental effects and transition challenges.

Region	Coal production (million tons per year)	Coal-based TPPs	
		Installed capacity (MW)	Electricity generation (TWh/year)
BG: Yugoiztochen	28	3,214	14
CZ: North-West Bohemia	38	above 2,850	36
DE: Lusatian Lignite District	171	6,717	49
GR: Western Macedonia	29	4,438 (3,775 since 2011)	25 (in 2014)
PL: Upper Silesia	53	31,300	79
RO: West Region / Jiu Valley	2	1,225	1
RS: Kolubara	29	3,411	18
UA: Donetsk	11	6,875	55
UK: Wales	1	2	no data

In most regions, the coal-related businesses take a serious share of the employment and gross value added (GVA), e.g. in the Greek and Serbian regions the sector accounts for up to a third of the regional GVA. In many regions, however, both the sectoral employment and GVA are going down. The most striking examples are Germany, where the direct jobs in coal mining decreased from 80,000 to 8,000 between 1990 and 2000, and Romania, where in the period 1990 – 2018 the employees in the same sector decreased from 55,000 to less than 5,000 and the contribution to the local budget – from 76% to 2%. In some countries, like Romania, this is due to the diminishing coal production and utilization, while in others, such as Germany, this was combined with increasing mechanization and rationalization.

The current employment consists predominantly of elderly people, especially in the mines approaching their end-of-life, and in some regions, such as the Polish and Ukrainian ones, elderly people represent a large share of the employees. The education level of the employees in the sector is low, with only a small share possessing a university degree. Nevertheless, as a general rule, the salaries of the persons employed in the coal mines and TPPs are much higher than the regional and country average. The male employees are typically 2 – 2.5 times higher in number than the female ones.

In the majority of the countries, the coal regions are more developed than the country average in terms of economic indicators and infrastructure. The German region is the most notable exception, but this is partly attributed to the remaining disparity between the east and west parts of the country.

Coal mining and burning cause serious environmental and health problems in all regions. In most cases, however, a positive trend can be observed in the last several years, either due to the reduction of coal activities, or due to the introduction of advanced pollution control technologies. Despite that general trend, the land damaged by coal mining increases in a couple of regions, due to untimely recovery.

Seven of the nine TRACER target countries are EU members and one – Serbia - is a candidate country committed to implement EU energy policy. Therefore, except for Ukraine, all target countries are obliged to contribute to the 2030 and 2050 EU targets for emission reduction, renewable energy, and energy efficiency. These obligations have already become part of the national energy strategies and / or National Energy and Climate Plans (NECPs) of all countries except Ukraine.

The nine countries have different visions and priorities regarding the coal sector, only some of which are in line with “green” declarations and commitments. Wales will close the last remaining coal-fired power station in 2020. Germany, Romania, Greece, and the Czech Republic have committed to substantially reduce and / or eliminate coal mining and use, although coal will continue to play an important role in the next decades. Germany, Romania, and Greece have already significantly decreased their coal volumes. Germany decided to phase-out coal until 2038. Romania plans to reduce its use so that by 2030 only 20.5% of its electricity originates from coal. According to its recent Planning for Energy & Climate (NECP), Greece plans to phase out lignite for power generation by 2028, while the Czech Republic intends to decommission the old coal-fired plants until 2025 and after that to continue the decrease of coal use until 2040.

In Bulgaria, Poland, Serbia, and Ukraine, on the other hand, coal mining and utilization remains a priority in the long-term perspective. In Bulgaria lignite mining and utilization is planned to continue at least until 2050, although the quantities will decrease over time. In Poland, in 2030, 60% of the electricity is expected to come from coal and there are no plans for its role after 2030. In Serbia and Ukraine, the indigenous coal resources will continue to be a pillar of the electricity system in the next decades.

In relation to their future intentions about coal production, some countries are much more advanced in planning the regional transition towards carbon-free economy - improvement of the local environment, re-skilling of the workforce, stimulation of new start-ups, etc. For example, in Wales and Germany there is much clarity what needs to be done, based on their past experience (lessons learned) and long-standing discussions. On the other hand, in Bulgaria, Serbia, and Ukraine no concrete plans to ensure sustainable transition have been reported. Most countries have indicated potential public financial sources to support some aspects of the regional transition, but the financing is still not arranged.

2 Introduction

TRACER project supports the transition of coal-intensive regions around Europe towards low-carbon economy. The focus is on some of the most coal-dependent **regions**:

1. Bulgaria, Yugoiztochen Region
2. Czech Republic, North-West Bohemia
3. Germany, Lusatian Lignite District/Economic Region Lusatia
4. Greece, Western Macedonia Region
5. Poland, Upper Silesia Region
6. Romania, West Region / Jiu Valley
7. Serbia, Kolubara region
8. Ukraine, Donetsk region
9. United Kingdom, Wales

Based on a strong collaboration with the key stakeholders, TRACER will agree on a shared vision and priorities for the transition, develop research and innovation strategies and industrial roadmaps, elaborate guidelines and decision support tools, etc.

To achieve these results, it is important to become well acquainted with the situation in the target regions. For that purpose, TRACER develops different reports. The current report provides a general overview of the regions, coal-related activities, coal-related policies, while other reports will focus on specific problems and solutions – technical, environmental, and social.

This report covers 3 topics for each of the 9 coal regions. The first one is a **description of the region**. It includes location, area, demographics, administrative and institutional structure. Additionally, it provides an overview of the social situation - employment, culture, education, poverty, and vulnerable groups. Furthermore, there is a summary of the regional economic development, including main economic activities (businesses), per capita income, infrastructure, and others. Finally, the environmental aspects, such as land use, concentration of pollutants and their effect on health and agriculture, are described.

The second topic is the **role of coal mining** in the region. An overview of the coal businesses and their key historical indicators is made. The coal-related social aspects, such as number and characteristics of the employees, are presented. The economic effect of coal, including gross value added, average monthly wages, arrangements for use of the territory, arrangements for ensuring land remediation, and others are summarized. In the next step the coal-related environmental aspects are described –the pollutants resulting from coal production and utilization, as well as the related impacts on humans, nature, etc.

The third topic is **coal-related policy**. It covers all relevant policies at national, regional, and local level, including experience with coal transition policies, current legislation, targets, priorities, strategies and plans in the field of energy and climate.

Finally, short **conclusions** are made. These outline similarities or differences among the countries and / or regions.

3 Bulgaria, Yugoiztochen Region

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3.1 Description of the region

3.1.1 Region overview

Location and area

In Bulgaria, TRACER studies the country's biggest coal-mining complex Maritsa East, situated on the territory of the South East (SE) planning region (Yugoiztochen region, BG34, NUTS 2 level), in the Southeastern part of the country, including 4 districts (NUTS 3 level): Burgas, Sliven, Yambol and Stara Zagora. To the North the region borders Central and Eastern Balkan Mountains, to the East – Black Sea, to the South – Turkey (via Strandzha and Sakar mountains), to the West - East Upper Thracian Plain and East Rhodope mountains.

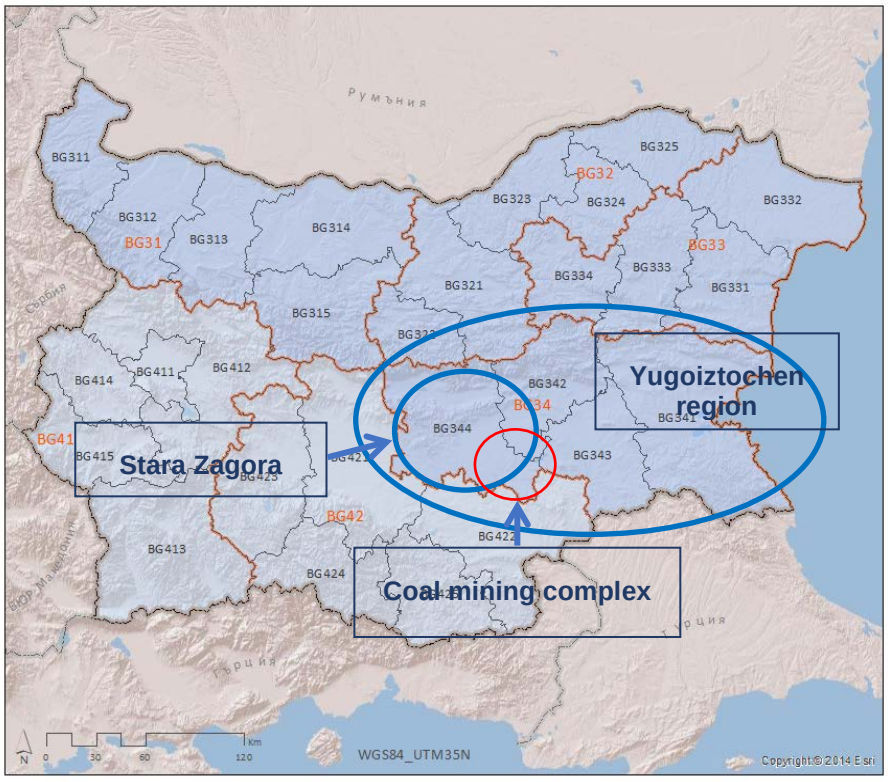

Figure 1: BG: Bulgarian NUTS and TRACER target region

Source: (NSI, 2016)

It is a medium-sized region with an area of 19,664 km^2 (about 18% of the territory of Bulgaria). Maritsa East complex is almost entirely located on the territory of Stara Zagora district (BG344, NUTS 3 level), situated in the central part of Southern Bulgaria, with a territory of 5,129 km^2

(approx. 26% of the territory of the SE Region). The history and development of the mining complex is closely related with and has major effect on two towns – Radnevo and Galabovo, situated in the south-eastern part of the district.

Demographics

The population of the SE region constitutes 14.7% of the country's total, ranking it third among the six planning regions. The number of the inhabitants in the region (1.032 mln. in 2018) has significantly decreased over the last 18 years - by 14% (Figure 2), following the common trend of population reduction and aging in the country. For Stara Zagora district the decrease is 17%.

The birth rate in the region is the highest in the country – 9.7‰, i.e. exceeding the country's average by 0.8‰. The natural growth rate in the region is -5.7‰, while the average for the country is -6.5‰.

By density, SE region is the second least populated – 52.9 persons/km^2, while the average for the country is 63.9 persons/km^2. Only Stara Zagora district approaches the average density in the country – 62.2 persons/km^2.

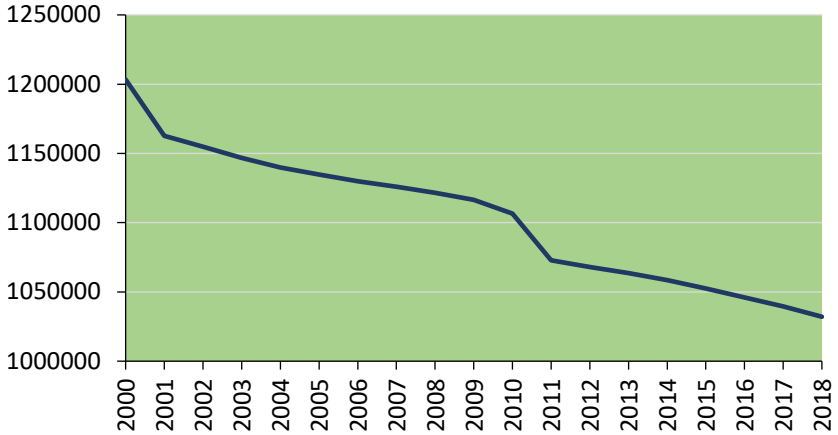

Figure 2: BG: Population decrease in SE region

The age distribution shows that 59% of the population is at working age, 17% under working age (for Stara Zagora – 16%), 24% over working age (26% for Stara Zagora).

Life expectancy in the region varies among the four districts but is close to the country's average (74.65 in the country and 74.05 in the SE region; 74.09 in Stara Zagora).

More than 70% of the population lives in the towns.

Administrative and institutional structure

SE region consists of 675 settlements, of which 41 towns and 634 villages. In Stara Zagora district there are 206 settlements, of them 11 towns and 195 villages.

NUTS 2 regions are not administrative and territorial units; they have no administrative structures and are not autonomous. Regional Development Councils (RDC) are set up for all 6 NUTS 2 regions, and chaired by a district governor, designated on rotation principle for 6 months. Their operational funds are allocated from the budgets of the relevant district administrations to cover the urgent needs of the council for its main functions – consulting, approval, coordination, monitoring and control of strategic planning of regional and spatial development at the NUTS 2 and 3 levels. At the national level RDCs monitor the operational programmes with an impact on the development of the region, co-financed from the EU funds. The NUTS 3 regions are administrative and territorial units and cover the territories of 28 individual districts. District Development Councils are established in each of them, chaired by the district governor and comprised of the mayors of all municipalities within the respective district, the representatives of the municipal councils, the organizations of employers and employees (AER, 2018).

Table 1: BG: Overview of the region

	Yugoiztochen Region (BG34)	Stara Zagora District	Source
Area	19,664.2 sq.km (~18% of the territory of Bulgaria)	5,129.4 sq.km (~26% of the territory of the Region)	NSI, 2019
Demographics (2017)			
Population (2018)	1,032,079 (500,730 males; 531,349 females) 749,727 (73%) living in towns; 282,352 (27%) in villages	316,356 (153,264 males; 163,092 females) 229,132 (72%) living in towns; 87,224 (28%) in villages	NSI, 2019a
Population density	52.9 persons/sq.km	62.2 persons/sq.km	
Under working age	173,792	50,148	
At working age	614,056	186,928	
Over working age	251,701	81,991	
Natural growth (2018)	-5,816 (-5.7‰)	-2,319 (-7.3‰)	NSI, 2019b
Birth rate (2018)	9.7‰	9.2‰	NSI, 2019c
Life expectancy (2016-2018)	Burgas: 75.16 (men – 71.75, women – 78.63) Stara Zagora: 74.09 (men – 70.63, women – 77.67) Yambol: 73.84 (men – 70.20, women – 88.84) Sliven: 73.12 (men – 69.35, women – 77.12)	74.09 (men – 70.63, women – 77.67)	NSI, 2019d
Administrative and institutional structure			
Settlements	675 (41 towns and 634 villages)	206 (11 towns and 195 villages)	NSI, 2019
Institutional structure	Ministry of Regional Development & Public Works (MRDPW) Regional Development Councils	District governor and administration Mayors and municipal administration	

3.1.2 Social situation

Employment

The national statistics show a positive downward trend in the **unemployment rate** in the country (from 15.6% at the beginning of 2003 to 5.0% for the first quarter of 2019) (NSI, 2019e). In 2018, SE region ranked third among the 6 statistical regions, with unemployment rate of 5.4% (5.2% country's average). There are significant differences within the region, where Stara Zagora district keeps the lowest level of unemployment (2.3%), while Sliven registered 9.7% in 2018. Stable decrease is observed in the region as a whole, and individually in Stara Zagora and Burgas districts, while for the other two there have been fluctuations during the last five-year period.

The **employment rate** in the country is increasing (from 42.4% in 2003 to 52.4% in 2018). Against this background, in 2018 the employment of the population above 15 years in the SE region was 51.7%, placing it third in the country. Within the region, the highest employment rate is for Stara Zagora district (53.8%).

By level of education, the employment rate in the SE region is distributed as follows: 24.6% higher education, 60.1% upper secondary, of which 66.4% secondary vocational, and 15.3% lower secondary or lower. For Stara Zagora district the figures are close, with a deviation of ~1%, only as regards secondary vocational education, the rate here is 74.7% of the upper secondary.

In 2017, the total **average income** per capita in the SE region was 5,147 BGN (country's average – 5,861 BGN). All Bulgarian regions have reported income growth in 2017 compared to 2016, the lowest being for the SE region (240 BGN against 457 BGN for the country). Within the region, Stara Zagora district had the highest total average income per household – 5,273 BGN. In comparison to 2008, the total average income per capita in Stara Zagora district has increased by 54.2%, while in Burgas, Sliven and Yambol the increase is respectively 24.7%, 11.9% and 16.3% (MRDPW, 2018).

Table 2: BG: Overview of the employment

	Yugoiztochen Region (BG34)	Stara Zagora District	Source
Employment (2018)			
Population aged 15 and over	870.1 thousands	269.6 thousands	NSI, 2019f
Labour force	475.9 thousands	148.5 thousands	
Activity rate	54.7%	55.1%	
Employed persons	450.1 thousand	145.0 thousands	
Employment rate	51.7%	53.8%	
Unemployed persons	25.8 thousands	3.4 thousands	
Unemployment rate	5.4% (7% in 2017)	2.3%	
Persons not in the labour force	394.2 thousands	121.1 thousands	
Employed persons by level of education:			
Higher	110.8 thousands	29.2 thousands	
Upper secondary	270.5 thousands	97.6 thousands	
(of which Secondary Vocational)	*159 thousands*	*63.9 thousands*	
Lower secondary or lower	68.7 thousands	18.3 thousands	

Poverty

In 2017, the population at risk of poverty or social exclusion in SE region amounted to 40%, compared to the national average of 38.9%. In terms of this indicator, the SE region ranks second in the country. Compared to 2015, the indicator for the region decreased by 2.3 percentage points and at the national level - by 1.5 percentage points. The at-risk-of-poverty population varies significantly within the districts in the region: Yambol (28.5%), Sliven (48.5%), Burgas (41.7%), and Stara Zagora (38.5%). A decreasing trend is observed (MRDPW, 2018).

Table 3: BG: Overview of the poverty

	Yugoiztochen Region (BG34)	Stara Zagora District	Source
Poverty			
Total income average per household	12,422 BGN	N/A	NSI, 2019
Total average income per capita	5,147 BGN	N/A	
Population in poverty or social exclusion risk		108.6 thousands (34% of the population)	MRDPW, 2018

Education & culture

The educational system in the region includes 3 universities and equivalent higher schools and 376 general and vocational schools. This represents 15.4% of the country's total educational institutions.

According to the National Statistical Institute (NSI, 2019g), during the 2017/2018 school year, the total number of students in general and vocational schools in Bulgaria was 730,576, of them 21,805 (3%) dropped out due to various reasons. The statistical data (NSI, 2019h) shows that from all 13,902 pupils from I to VII grade that dropped out from school in the country, SE region ranks second with 3,094 (22%) pupils, 27% of which from Stara Zagora district. In terms of university graduates, (NSI, 2018) SE region provides 5% of the total higher education graduates in the country, 38% of which from Stara Zagora district. By this indicator the region ranks second in the country (after North-West region).

The schools of arts and culture have a significant place in the educational system of the Southeast region. There are 6 such schools on the territory of the region. About 15% of the national cultural heritage sites are to be found there. Of great regional importance are the theatres in Burgas and the opera house in Stara Zagora. The community cultural centres are well-developed.

Table 4: BG: Overview of the education and culture

	Yugoiztochen Region (BG34)	Stara Zagora District	Source
Education (2017/2018)			
Kindergartens	262	75	NSI, 2019i
Educational institutions, of which:	379	123	
general schools	*312*	*100*	
art & sport	*9*	*3*	
vocational secondary schools & colleges	*55*	*19*	
universities	*3*	*1*	
Students 2017/2018			NSI, 2018
Students I-IV grade	43,705	12,779	
Students V-VII grade	31,643	9,351	
Graduated (V-VII grade)	15,577	4,391	
Students VIII-XII grade	18,583	5,449	
Graduated (VIII-XII grade)	3,603	1,028	
Culture			
Theatres	12	5	NSI, 2019
Cinemas	10	3	
Museums	32	10	
Community clubs	545	183	
Libraries	7	3	
Community cultural centres with operating libraries	506	168	
Radio & TV operators	12+11	1+5	

Vulnerable groups

The main risk factors that impede social integration and form the main risk groups are: the high rate of illiteracy and poor literacy among adolescents and working-age population, dropping out of school and formal transition from grade to grade, lack of orientation to education and qualification, which puts them at risk on the labour market; incomplete families and marriages of under-aged persons, which determines the tendency of neglecting children and their placement in institutions; persistent lack or insufficient own income, leading to a high rate of antisocial manifestations in children and adults; aging population and a steady increase in lonely elderly people unable to cope with their daily needs (UNICEF).

The identified vulnerable groups in Stara Zagora district are (RDC):

- Children raised outside their biological families
- Children raised by their biological parents, but with disabilities or coming from under-aged parents, multiple children families and single parent families; children dropped out of school; victims of violence and with problematic behaviour
- Adults with disabilities
- Elderly people (residing in institutions or in families)
- Disadvantaged and vulnerable groups: under-aged parents, unemployed, disadvantaged ethnic communities, poor families.

While disabilities and unemployment are not necessarily related to the ethnic composition of the population, the majority of the other cases are more or less connected with particular ethnic communities from the Roma minority. Information regarding the ethnic composition of the population is available from the last national census in 2011, according to which 82.7% of the population of SE region was of Bulgarian ethnics, 9.4% - Turkish, 6.7% - Roma. In Stara Zagora district, the Bulgarian ethnics was 86.2%, Turkish – 4.9% and Roma – 7.8% (Eurydice).

3.1.3 Economic development

Economic activities

In 2017, GDP at current prices in the region formed 13% of the national GDP. Region's contribution to the country's economic development is relatively high. Stara Zagora district has the highest share in the region's GDP – 43% and 6% in the national GDP, which assigns it the fourth place in the country. Regarding GDP per capita, the region takes the second place in the country. According to the GVA indicator, the SE region is ranked third in the country, with a relative share of almost 13%. In SE region, services have the highest share – 48%, followed by industry – 46% and agriculture – 5%. Within the region, there are significant disproportions of the contribution of the different districts to the forming of GVA. Stara Zagora district is leading in the industrial sector with a share of 66%, services - 31%, agriculture – 3%.

The Net Sales Revenue in Stara Zagora district is attributed mainly to companies working in the fields of energy, coal mining, fuel trading, food processing, construction and manufacturing of electrical appliances. The state-owned enterprises active in the field of energy, Maritsa East Mines EAD and TPP Maritsa East 2 EAD, provide the largest employment in the district. By direct foreign investments, the region takes the second place in the country with slightly more than 12%. Stara Zagora district goes second within the region with 30% of that amount. More than 93% of the enterprises in the region are micro businesses, SMEs make 7%, and large enterprises constitute 0.1%.

Table 5: BG: Overview of the economic activities

	Yugoiztochen Region (BG34)	Stara Zagora District	Source
Economic activities (2017)			
GDP per capita at current prices	12,538 BGN	17,550 BGN	NSI, 2019
GDP	13,075 mln. BGN	5,620 mln. BGN	
GVA	11,340 mln. BGN	4,874 mln. BGN	
Direct foreign investments	2,983 mln. €	905 mln. €	NSI, 2019
Enterprises	57,408	N/A	NSI, 2019
Micro	53,424	N/A	
SMEs	3,898	N/A	
Large	86	N/A	

Infrastructure

First-class domestic and international road transport links intersect the territory of the SE region and connect the northern and southern parts of Bulgaria. The traffic flows along the two railway lines connecting the western parts and the capital with the Black Sea ports of Burgas and Varna and with the south-eastern border with Turkey and Greece, are intense. According to NSI data, the total length of the constructed and functioning railway lines in the region as of the end of 2017 was 625 km, which makes up 16% of the country's railway network (4,030 km). Stara Zagora district takes the first place within the region with 261 km long railway lines.

Orient – East Med trans-European corridor passes through the region, connecting Sofia with Burgas (Thrace motorway). Another motorway – Maritsa connects Thrace motorway with the most intensive European border checkpoint connecting EU with Turkey. Motorways together with the first-class roads E80, E85 and E773 provide fast and efficient transport of goods for export to the EU or Central Asia and are a prerequisite for the development of services and the creation of small and medium-sized cargo and passenger services flow, information and cash flows.

Maritime transport in the SE region is well developed thanks to the international port of Burgas, through which most of Bulgarian import and export pass. Air transport is represented by the international airport of Burgas, 4 certified airfields and 2 helipads. There are plans to turn the airfield in Radnevo into a civilian airport, for which a reconstruction project has been developed and negotiations are ongoing.

The intensive traffic of goods, cars, people, capitals, information and services stimulates the construction of Free Economic Zones, transit warehouses, service activities, services, retail outlets, banks, exchanges, markets, internet centres.

Telecommunications on the territory of the region are well developed, providing quality telephone connections and high-speed internet communication.

The **electricity** network is relatively well developed and corresponds to the region’s needs. The electricity distribution grid (electric lines and electrical installations at low, medium, and parts of high voltage level) is operated by and services are provided by Elektrorazpredelenie Yug EAD.

The **gas** pipeline infrastructure is represented by part of the southern ring of the national gas pipeline network. As of 2012, the gas distribution pipeline on the territory of Stara Zagora district was of the total length of 129 km, 25 km of which supplying industrial zones and 104 km – residential areas in the city of Stara Zagora. All industrial sites and more than 30,000 households were gasified (NCRD).

Table 6: BG: Overview of the transport

	Yugoiztochen Region (BG34)	Stara Zagora District	Source
Transport (2017)			
Road network	3,307 km (16.7% of the country total)	907 km (27.4% of the region total)	NSI, 2019
Motorways	222 km (30.2% of the country total)	92 km (10.2% of the region total)	
Category I roads	600 km (18.1% of the country total)	167 km (18.4%~)	
Category II roads	753 km (22.8% of the country total)	215 km (23.7%~)	
Category III roads	1,732 km (52.4% of the country total)	433 km (47.7%~)	
Density of total road network per 1000 km^2	167 km (178.9 km of the country total)	174.4 km	
Length of railway lines	625 km (4,030 km country total)	261 km	
Ports	Burgas - Public port of national importance with 3 terminals	-	
Airports	1 international airport – Burgas and 4 certified airfields and 2 helipads	1 certified airfield in Radnevo	MTITC

3.1.4 Environmental situation

Land use

Biggest part of the land in the SE region is used for agriculture (57%), followed by forests (35%). Urbanized territories constitute 4%, waters – 2%, mining and transport – 1% each. For Stara Zagora district, the proportions are almost the same, with 1 or 2% difference. Mining lands here represent 3% of the total land use.

Table 7: BG: Overview of the land use

	Yugoiztochen Region (BG34)	Stara Zagora District	Source
Land use (2011, decares)			
Total	19,664,202	5,129,399	NSI, 2019
Agricultural	11,270,966 (57%)	2,869,937 (56%)	
Forest	6,920,144 (35%)	1,712,852 (33%)	
Urbanized	792,059 (4%)	247,091 (5%)	
Water flows and territories	394,855 (2%)	105,453 (2%)	
Mining and digging raw materials	172,018 (1%)	159,534 (3%)	
Transport & infrastructure	114,160 (1%)	34,532 (1%)	

Stara Zagora area is characterized by temperate climate, diverse and fertile soils, relatively good water resources and non-obstructive relief, which is a favourable factor for the overall development of the area. Climate and soils favour the development of agriculture - crop production, vegetable production, industrial crops, beekeeping and others. The fertile soils of cultivated lands are 2,908,794 decares (56.47% compared to 43.3% on average in the country). Forests cover 32,4% of the area.

Regional climate

The climate in the Upper Thracian Plain is transitional continental. The average January temperatures are around 0°C and the July temperatures are around 22 - 24°C.

The region of Stara Zagora is characterized by a maximum of 201 mm of rainfall in summer and a minimum of 134 mm in winter. The average relative humidity for the region is 67 ÷ 72%, with the lowest daily amplitude in winter - 8 ÷ 9% and the highest in summer - 17 ÷ 18%. The average annual wind speed for the area is 1.4 m/s.

According to an analysis of the Bulgarian Academy of Sciences, Bulgaria falls within the area of increased risk of heat waves and droughts. Climate models adapted to Bulgaria have been used to assess possible changes for the period up to 2050, and the estimates show a decrease in cases with extremely low temperatures and an increase in cases with extremely high temperatures.

Environmental impact

According to the National report on the state and protection of the environment (ExEA, 2019), Bulgaria is the only EU Member State to report **exceedances of sulphur dioxide levels**. Despite the considerable reductions during the last years, serious violations of the air quality with respect to the permissible number of exceedances of the hourly average rate and/or the daily average rate of air pollutants are still registered in Galabovo and Sliven. In recent years, there has been regular exceedance of the hourly average and daily average levels for sulphur dioxide in the town of Galabovo. The main sources for the exceedances of sulphur dioxide in the town of Galabovo are the thermal power plants of Maritsa East energy complex, and for the town of Sliven - local sources.

In 2018, in Galabovo were registered 72 hourly average exceedances of SO_2 limit values with maximum measured concentration of 1,383.68 µg/m^3, and in Sliven – 1 with concentration of 401.89 µg/m^3.

In 2014, exceedances of the SOF for SO_2 were registered in AIS "Galabovo" - 83 and in AIS "Sliven" - 25. As regards the daily average, there were 28 exceedances in Galabovo with maximum measured concentrations of SO_2 of 161 µg/m^3; in Sliven – 1 exceedance with 79 µg/m^3.

Exceedances of **fine particulates (PM)** are also being registered in Stara Zagora and Sliven. In 2018, there were 23 daily average exceedances in Sliven with maximum measured concentration of 114.41 µg/m^3, and 5 in Stara Zagora with maximum measured concentration of 61.71 µg/m^3. The mean annual concentration of PM2.5 in Stara Zagora in 2018 was 21.28 µg/m3 (maximum daily average 50.70 µg/m^3) (ExEA, 2019a).

Soils are in a good condition with respect to heavy metal, metalloid and persistent organic pollutants. Exceedances of copper have been registered in Sliven district.

Surface **waters** are in a poor condition. Sections of Sazliyka river passing through Stara Zagora district are in a very bad condition, related probably to pollution from untreated urban and industrial waters. In contrast, underground waters are in very good condition as a whole (NCRD; RIEW).

The continued pollution of the environment and the presence of contaminated territories call for allocation of more resources to waste management.

Compared to the previous years, there is a significant increase in the cost of wastewater removal and treatment, as well as a lasting tendency to increase the cost of improving the quality of the ambient air. Investment in waste facilities has remained high.

The most serious environmental problems in the SE region are concentrated in Burgas, (Gulf of Burgas) and in the municipalities of Galabovo and Radnevo. Air, soil and water are heavily polluted by the oil industry, energy, mining and transport sectors.

The analysis of the quality of ambient air shows that the population of Stara Zagora and Galabovo is exposed to the potential harmful effect of PM and SO_2 pollutants.

The total registered morbidity of the population in 2018 on the territory of Stara Zagora district was 390,353 cases, which is 1.23 cases per person. This includes 164,772 newly discovered cases. The newly discovered morbidity in children from 0 to 17 years was 0.85 cases per person, which is higher than of the population over 18 years – 0.45 cases per person. In the structure of general morbidity in Stara Zagora district, the highest relative share are diseases of the circulatory system (24%) and diseases of the respiratory system (24%) (RHI, 2019).

According to the Regional Health Inspectorate of Stara Zagora, however, acute upper respiratory infections should not be correlated with the quality of the air, but rather with other ethno-cultural, socio-economic factors, access to health system etc.

3.2 Role of coal mining in the region

3.2.1 Coal sector in the region

Since nearly 60 years, large-scale industrial coal mining with the related energy-intensive industry is an important economic pillar of the region (and especially of Stara Zagora district).

Maritsa East is the biggest lignite coalfield in Bulgaria with a productive area of nearly 240 km^2, spreading over the territories of the municipalities of Radnevo, Galabovo, Nova Zagora and Simeonovgrad, respectively – in Stara Zagora, Haskovo and Sliven districts.

The coal beds in the deposit lie at relatively small depths - from 6-10 m to 110-120 m below the surface of the terrain; coal is characterized as soft, brown, lignite type with average ash content

of 36% and calorific value of 1,560 kcal kg. The horizontal deposit of the coal beds determines the application of a classic technological scheme of open-cast processing. The industrial reserve of lignite in Maritsa East basin amounts to 1,200 Mt. With a yield of 30 Mt/year, the mine utilization horizon is 2057. The maximum capacity of the mines is 32 Mt/year from which could be generated up to 21.9 TWh of electricity. The minimum yield below which the mines will operate at a loss is about 18 Mt/year or the production of 11.3 TWh of electricity.

The concession of the production belongs to **"Mini Maritsa Iztok" EAD**, which is a 100% state-owned sole-proprietor joint-stock company with one-tier system of management. The company operates three opencast mines: Troyanovo-1, Troyanovo-North and Troyanovo-3, supplying three thermal power plants: Maritsa East 2 TPP EAD, ContourGlobal Maritsa East 3 TPP and AES Galabovo TPP for power generation and a briquette factory - Brikel EAD for production of briquettes along with electricity generation and heat water for district heating. Coal extraction and supply are established under the Claim Contract of August 2005 for a period of 35 years.

The construction of the first mine **– Troanovo-1** started in 1952. According to the project, the mine had 525 300 000 tonnes of coal reserves at an average stripping ratio of 2.44 m^3/t of coal. Since its commissioning until 31st July 2012, Troyanovo-1 mine produced 363.5 mil. t of coal and removed 1,051.7 mil.m^3 of overburden (MMI).

Troyanovo-North mine takes the northern part of the Maritsa Iztok basin, bordering Troyanovo-1 to the south. The construction started in 1960 and the extraction commenced in 1964. Since the commissioning until 31.07.2012, 343.7 mil. t of coal were extracted and 1,582.5 mil.m^3 of overburden excavated (MMI).

Troyanovo-3 mine is located in the southern part of the basin; its payable reserves are calculated at 336.2 mil. t. The coal layer is located at an average depth of 70-80 m. The construction started in 1964 and coal production - in 1969. Since its commissioning until 31.07.2012, 292.5 mil.t of coal were produced and 1,535.6 mil.m^3 of overburden removed (MMI).

The mines in the complex are developing according to the approved and proven technological scheme, with the extraction of 28 Mt of lignite and 84 Mm^3 of overburden on an average annual basis, with an average coefficient of overburden = 2.98 m^3/t. Under the Concession Agreement, conditions are created for the complete depletion of the reserves in the field of the Troyanovo-South mine (merger between the Troyanovo-1 and Troyanovo-3 mines) and the seizure of the reserves in the field of the Troyanovo-North mine to the level of economic efficiency. The distribution of open-air traffic flows and embankment activities in time and space, create conditions for balanced use of the storage capacity and the formation of good final landscape terrain forms and water areas at the end of the exploitation of the deposit.

Table 8: BG: Main indicators of mining in Maritsa East complex (Source: ME, 2019)

Indicator / Year	2015	2016	2017	2018
Coal production (mil. t)	32.3	27.8	30.3	28.0
Supply to clients (mil.t.):				
Maritsa East 2 TPP EAD	16.1 (48.78%)	14.0 (49.64)	14.6 (48.04%)	13.4 (47.93%)
ContourGlobal Maritsa East 3 TPP	8.0 (24.82%)	6.4 (23.13%)	7.6 (24.90%)	6.7 (23.96%)
AES Galabovo TPP	5.6 (17.96%)	4.8 (17.81%)	5.5 (17,98%)	5.2 (18.52%)
Brikel EAD (mil. t)	2.6 (8.44%)	2.5 (9.42%)	2.8 (9.08%)	2.7 (9.59%)
Overburden, 1000 m^3	75,556	85,785	83,294	82,622
Muck, 1000 m^3	102,129	108,593	108,231	105,607
Average calorific value, kcal/kg	1,586	1,590		
Average price, EUR/t coal equivalent	38.5	38,5		

The lignite from the mines is delivered to the power plants in the complex by the developed transport infrastructure, as follows:

- From the mine site of Troyanovo-North, coal is transported by rail and belt transport to AES Galabovo TPP.
- From the mine sites of Troyanovo-1 and Troyanovo-3, coal is transported by belt transport to the TPP Maritsa East 2 coal loading.
- From the mine site of Troyanovo-3, coal is transported by belt transport to the loading facility of the ContourGlobal Maritsa East 3 TPP.

Figure 3: BG: Plan of Maritsa East complex

Maritsa East 2 TPP is the largest renovated thermal power plant in Bulgaria. It is a basic condensing plant designed to operate in the main load schedule of the country's electricity system and is located on an area of 512 hectares in the East Maritsa basin, on the territory of Radnevo municipality, 60 km southeast of Stara Zagora. It is located outside the settlement territory. Distance from Radnevo - 28 km. The nearest settlement is Radetski village, about 3,5 km away.

In the immediate vicinity of the plant is Ovcharitsa Dam - a protected area inhabited by rare bird species (ExEA, 2019b).

The plant was commissioned in 1966 and consists of eight generating units with a total installed capacity of 1,620 MW. All units operate with built-in desulphurization installations with efficiency over 96%.

TPP Maritsa East 2 EAD is a joint stock company within the group of the Bulgarian Energy Holding (BEH), owned by the Bulgarian state.

TPP Maritsa East 2 holds a license for production of electricity from 2001 for a 20 years period, and a license for trade with electricity from 2018 for a period of 10 years. The modernization of the eight units during the period 2008-2016 extended their lifetime by 25 years in average.

AES Galabovo TPP is a thermal power plant with two units and a total installed capacity of 686 MW. It is located in vicinity of the town of Galabovo and produces electricity entirely from local Maritsa East lignite.

The plant is operated by AES 3C Maritsa East 1 EAD – a joint stock company owned by the US AES Corporation. With an estimated investment of nearly € 1.3 billion, TPP AES Galabovo represents the newest and most modern power plant in South East Europe. The plant became operational in 2011.

Annually, TPP AES Galabovo uses on average over 5 million tons lignite, which is between 23% and 27% of the annual production of Maritsa East Mines. This share also represents the percentage of the jobs supported by the TPP from the overall headcount of the mines and other raw material suppliers in contractual relations with the plant. These are about 1,900 jobs secured, or 3% of people employed in the Bulgarian mining sector as a whole.

According to the technical process no possibility for bypass of Flue Gas Desulphurization (FGD) system exists. The flue gas is discharged into the atmosphere only through the FGD system. Thus, if or when the desulphurization process fails, the production of electricity also interrupts automatically. This measure guarantees operation of the plant only with working FGDs, achieving 98% efficiency rate and ensures protection of the air from pollution with sulphur dioxide.

Waste water from all streams is treated with Reverse Osmosis and reused. The waste, formed in result of the combustion and desulphurization processes are bottom ash (slag), fly ash and gypsum. They are temporary stored in closed silos, equipped with dedusting systems. The wastes are disposed at a specially constructed waste disposal facility, 7 km away from the plant, where they are transported through a tube belt conveyor and by trucks (AES).

ContourGlobal Maritsa East 3 is a thermal power plant with four units and a net installed capacity of 908 MW. It is located approx. 60 km from the city of Stara Zagora, 10 km from Galabovo, 1-2 km from the village of Mednikarovo and 3 km from the village of Iskritsa. Mednikarovo is the closest residential area in the vicinity of the plant.

The majority share (73%) is owned by ContourGlobal, the minority shareholder (27%) is the Bulgarian National Electric Company.

The complex consists of a power plant and a waste heap. The waste heap is located about 5 km from the southeast of the power plant.

The installation was commissioned from 1978 to 1981, and each year one unit had been put into operation - four units in total.

From November 2003 to March 2009, rehabilitation and modernization of the power plant was carried out, and after completion the capacity of each power unit was increased to 227 MW and a large-scale investment program was implemented to comply with the applicable environmental legislation.

The Complex Permit includes also an installation for the production of hydrogen. It is located in the western part of the site. The hydrogen produced is stored in 6 receivers.

The annual power production in 2018 – 4,41 TWh.

The annual production of hydrogen production installation – 110,242 Nm^3.

Brikel TPP is an industrial and district heating power plant, located next to AES Galabovo TPP, approx. 5 km from Galabovo and 45 km from Stara Zagora on an area of 327 ha. The plant was constructed during the period 1959-1963, currently having total installed capacity of 200 MWe electrical power and 500 MWt heat power. Originally, it uses energy and briquetting lignite from the Maritsa East basin. A part of the produced heat is supplied to the town of Galabovo for residential district heating and the rest is used for drying of coal and production of briquettes for own consumption, as well as for TPP Maritsa 3 (Dimitrovgrad), Bobov dol TPP and Sliven TPP.

In order to continue its operation, further measures and introduction of high-efficiency equipment are required to reduce nitrogen and sulphur oxides.

Brikel EAD is a joint stock company, owned by Kalista 2004 EOOD.

The other small TPP from the same group of ownership as Brikel is TPP Maritsa 3 near Dimitrovgrag. The plant is operating one condensing turbine of 120 MWe and is using primary dried coal from Brikel. TPP is working only at free market and the annual load is according to the concluded trade contracts.

Table 9: BG: Installed capacity and power generation by the plants using Maritsa East lignites

TPP	Installed capacity, MW		Electricity, TWh				Coal, Mt		Participation in the regulation of the power system, MW	
	Gross	Net	Nominal		Maximal		Nominal	Maximal	Primary	Secondary
AES Galabovo	686	575	3,350	2,874	5,025	4,680	4,788	7,820	±33.5	344.9
Maritsa East 2	1,620	1,387	8,100	6,935	12,150	10,403	12,988	20,333	±55.5	395.3
ContourGlobal Maritsa East 3	908	808	4,540	4,040	6,810	6,060	7,042	10,563	±34.7	262.4
Brikel, electrical	200		550		800		2,500	3,500*	no	no
Brikel thermal	500		2,000		3,000					
Maritsa 3	120		400		500		600	900	yes	yes
Total	3,198	2,770	15,490	13,849	25,985	21,144	24,818	38,078	±123.7	1,002.6

**Including coal for briquettes for heating needs*

3.2.2 Social aspects

At the national level, employment in the fields of coal mining and production, power transmission, distribution and trade shows a clear downward trend. From 81,431 people in 2003, the average annual number of employees decreased to 38,123 people in 2015. This decrease is the result of a decrease in production, changes in capacity structure and an increase in labour productivity. In the field of coal mining at the national level, the number of employees was reduced from 18,099 people in 2003 to 11,986 in 2015, mainly due to the closure of underground coal mining sites. The outsourcing of many of the service activities also contributes to the reduction of employees in the sector.

Maritsa East complex

Six major mining and energy production companies operate on the territory of the complex. The dynamics of the personnel of these companies is shown in Table 10.

Table 10: BG: Annual average number of employees in the entities of Maritsa East complex

Entity	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mini Maritsa Iztok	7,477	7,425	7,238	7,189	7,034	6,975	7,222	7,294	7,525
AES Galabovo	112	225	394	446	474	479	461	451	440
Maritsa East 2	2,205	2,530	2,544	2,450	2,507	2,481	2,466	2,464	2,445
ContourGlobal Maritsa East 3	788	659	562	509	502	490	475	465	462
Brikel EAD	1,337	1,340	1,308	1,261	1,257	1,228	1,223	1,273	1,294
Maritsa 3 TPP	219	251	349	347	348	298	241	230	184
Total	12,138	12,430	12,395	12,202	12,122	11,951	12,088	12,177	12,350

Source: Register of employed persons of NSI

The average age of the employees of the individual companies in the Maritsa East complex is as follows: Maritsa East Mines - 48 years (32.8% over 50 years); TPP Maritsa East 2 - 46 years (and over 50 years are 28.9%); AES Galabovo TPP - 40 years (and over 50 years are 17.3%); ContourGlobal Maritsa East 3 TPP - 45 years (27.4% over 50 years).

The complex has an extremely positive impact on the labor market in the districts of Stara Zagora and Haskovo, and especially in the municipalities of Radnevo, Galabovo and Dimitrovgrad and the peripheral settlements in other neighbouring municipalities. The complex generates not only direct but also indirect and induced employment, thanks to which the average annual unemployment rate in the respective municipalities in 2016 was as follows: Dimitrovgrad – 7,8%, Radnevo - 8%, Galabovo – 9,6%, Opan – 11,9 %. At the same time, in similarly sized municipalities of the same two districts, unemployment is two or more times higher.

Table 11: BG: Personnel of "Mini Maritsa Iztok" as of 01.01

Year	2016	2017
Number of personnel, incl:	7,294	7,308
Production	5,790	n/a
Administrative	1,172	n/a
Operating	279	n/a

Table 12: BG: Education levels in the main companies in the Maritsa East complex, 2016

Year	"TPP Maritsa East 2"	"Mini Maritsa Iztok"
Number of personnel, incl.:	2,419	7,294
Higher education	704	1,458
Secondary	814	5,520
Primary	901	316

Source: Mini Maritsa Iztok EAD

Table 13: BG: Number of persons employed in electricity generation and coal production in the Maritsa East region (2016)

Company	Direct employment	Indirect employment	Incl. indirect employment in mining	Induced employment	Total employed
ContourGlobal Maritsa East 3	462	1441	527	28	1,931
AES Galabovo	440	1,373	502	26	1,839
Maritsa East 2	2,445	7,628	2,787	147	10,220
Brikel	1,150	3,588	1,311	69	4,807
TPP Maritsa 3	184	574	210	11	769
Mini Maritsa Iztok	7,525	4,741	-	226	12,492
Total	12,206	19,345	5,337	507	32,058

Sources: NSI and Financial reports of the entities

In summary, the number of jobs related directly and indirectly to all TPPs and the mines in the Maritsa East complex is 32,058, including 12,256 direct, 19,345 indirect and 507 induced jobs.

3.2.3 Economic effect

General economic performance of the region

The Stara Zagora region has a diversified and well-balanced regional economy, which has been able to substantially counteract the undesirable effects of the global crisis. Good performance is mainly due to energy, but there are weak positions in the areas of high technology, innovation, quality and sufficient human resources.

The municipality of Stara Zagora, together with Kazanlak and the Radnevo - Galabovo energy complex, account for almost 94% of the district's revenues.

Unlike most districts with an absolutely dominant economic centre, Stara Zagora has two balancing secondary centres - the Radnevo-Galabovo energy complex and Kazanlak. Nevertheless, all constituent municipalities show a steady trend of significant demographic outflows. For the last 10 years the district has lost over 10% of its population. This is a sign of a lack of effective regional policy, a sign of a non-competitive living environment in the area as a whole. The city of Stara Zagora is a regional centre and an "engine" of development, but in order to achieve balance in the regional space, a strategy must be launched to outsource functions and resources to strengthen peripheral regions, to retain outbound migration by creating a competitive environment and living conditions in them.

Importance of the mining and generation sector

The highly mechanized and rationalised mining and energy industry are one of the most important pillars of the regional economy (information of District administration of Stara Zagora). The annual incomes from sales of the two municipalities with predominant mining and energy production is 28% from the total value in the Stara Zagora district. The hourly gross wage is above the average as compared to average in Bulgaria as a whole.

The average working salary in Bulgaria for 2019 is 1,260 BGN (1 EUR = 1.95583 BGN) with dominant contribution of the capital city Sofia with 1,729 BGN (NSI). Among other regions those with large power production sectors, such as Vratza (NPP Kozloduy) and Stara Zagora (Maritsa East coal complex) maintain close to the average levels of the average salaries, 1,183 BGN and 1,164 BGN, respectively. The average monthly income in the coal mining company “Mini Maritsa Iztok” is 1,886 BGN and in the State owned TPP Maritsa East 2 it is 2,528 BGN, whereas the average salaries for workers in the power plants in Bulgaria is 1,990 BGN (BAS).

The mining and generation sector in Bulgaria is bound to collective bargaining agreements negotiated between the employers and the relevant trade union.

In the region significant number of companies and service providers - first of all SME - rely on the mining and generation sector. The annual investment and maintenance programs associated with lignite mining and power generation amounts to 200 million BGN. Unfortunately, the early termination of coal production from the Maritsa East field would produce the following negative results (BAS):

- will deprive the State Budget of concession fees amounting to BGN 20.7 – 26.5 million annually;
- will reduce the gross domestic product by about BGN 1.2 – 1.4 billion annually;
- the funds for the immediate and final leaving of the concession area in the amount of BGN 335 million should be at the expense of the State budget;
- mining activities will end with extremely unfavourable landscapes and environmental consequences for the environment; more than BGN 1.2 billion of working fixed assets in coal mining and EUR 3.5 - 4.5 billion in electricity production will be disbursed
- the electricity system will be deprived of services for 1,140 MW secondary regulation, ± 110 MW primary regulation and tertiary reserve;
- the basic requirements for the security of the electricity system will be violated if there are no alternative options in preparation or no “transition strategy”. There is a need to start thinking beyond coal now in order to avoid the collapse later;
- power generation from local energy sources (coal) will be reduced; more than 12,000 people directly involved in various coal mining and power generation will lose their jobs.

Mining licences and land reclamation

Pursuant to Decision No. 655 / 13.07.2005 of the Council of Ministers, “Mini Maritsa Iztok” EAD was granted a concession for the extraction of underground resources in the East Maritsa coal basin. The concession is for a period of 35 years, as of 2008, in accordance with the amendment of the Law on Privatization and Post-privatization Control and expires in 2043. The concession fee for the period 2011-2016 was 5.24% of the value of annual sales of coal by the Concessionaire, excluding VAT (BAS).

The concession area includes terrains necessary for the overall activity of “Mini Maritsa Iztok” EAD, amounting to 474 km^2.

It is currently estimated that the total reclaimed land at the end of the concession period shall be 65 km^2, of which 51 km^2 - technically reclaimed and 15 km^2 – biologically reclaimed lands. The cost of the reclamation activities is estimated to 215 million BGN (110 million EUR).

3.2.4 Environmental effect

Bulgaria is one of the leading lignite producers in Europe. Coal accounts for 46% of the national electricity production (equal to over 50% of the electricity demand, due to exports). Other major electricity sources are nuclear (34% of generation) and renewables (15% of generation) (NSI, 2019j). From its 30 million tons mined coal for energy use in 2017, 95% falls upon the Maritsa East Lignite Complex (ME, 2019a). Despite far-reaching structural changes, coal energy industry remains the economic lifeline of the region. Starting with the industrialisation of lignite mining in the mid-20th century large-scale and opencast pits have turned the Maritsa East landscape in part upside down, from a pre-industrial rural area in a large-scale technogenic space.

Actually, the removed surface by mining comprises 200,000 decares which takes more than 90% of the nationwide area claimed by coal mining. Up to now 48,000 decares are restored and released from mining supervision.

Like any technogenic intervention, coal mining, especially through open-source mining, has a negative impact on the environment - the temporary use of arable land, pastures and forest plantations are changing, settlements are shifting, riverbeds are being modified, roadways and other communications are changing, the composition of the ambient air and water sources, etc. is changing. Organized environmental actions have the task of reducing to a reasonable extent this impact with technically sound solutions, at a reasonable cost. The last stage is the restoration and reclamation of the areas affected by the activity of the mines.

From the currently redeemed or expropriated 200 km^2 of mining land in Maritsa East mines as of December 31, 2016, about 46-48 km^2 were reclaimed, of which 37 km^2 for agricultural use and 9 km^2 - for forestry fund (BAS). Technical reclamation is carried out annually, according to projects agreed with the respective institutions and municipalities.

However, the Stara Zagora district has a very high proportion of the affected areas. As of 2012, they occupy 2,6% of the regional territory (133 km^2), compared to the national average of 0.3%.

Maritsa East lignite is of low quality due to their low calorific value and high ash, moisture and sulphur content. The low temperature and the degree of organization of the combustion air are the reason for the low level of nitrogen oxides emissions into the atmosphere. The sulphur oxides are captured by wet limestone desulfurization.

Dust emissions into the atmosphere are limited by dewatering mining and mining jobs, limiting mining activities at wind speeds over 5-6 m/s, limiting / minimizing drilling and blasting operations in adverse weather conditions, preventing self-ignition of coal seams or rapid elimination of occurrence of outbreaks, construction of enclosed structures at overloading / filling points, etc.

At a nominal electricity production of 15,5 TWh per year by the TPPs, the emissions of harmful substances into the atmosphere are: carbon dioxide – 17,402,294 t, nitrogen oxides – 10,532 t and sulphur dioxide – 27,705 t.

AES Galabovo TPP was put in operation in 2011, with highly efficient technology and low level of atmospheric emissions. Over the past decade, the condensing power plants – Maritsa East 2 and ContourGlobal Maritsa East 3 have been rehabilitated, modernized and brought into line with the current environmental protection requirements for the levels of emissions of the harmful gases. Successful rehabilitations, including the replacement of basic equipment (turbines, generators, switchgear, etc.), have led to a significant increase in the duration of their use.

A modern and reliable system for monitoring and control of the environment has been established in the district - automatic measuring stations, satellite monitoring and an early warning system related to the functioning of the Maritsa East energy complex.

3.3 Coal mining and coal utilization policies

3.3.1 National policy

National energy strategy affecting coal mining activities

According to the Energy Strategy of the Republic of Bulgaria till 2020 of the Ministry of Energy (ME, 2011), the efficient utilization of the indigenous energy resources is a priority. An emphasis in the national energy strategy from the viewpoint of security and sustainability is preservation and development of the coal industry with strict observation of the environmental protection standards. In relation to that, the existing coal potential of Bulgaria will be utilized to the maximum. The state will support the coal-fired power plants, rendering support for full compliance with all environmental requirements, including the restrictions for admissible limits of noxious emissions (sulphur, nitrogen oxides and dust); it will perform monitoring and will seek international support for projects for construction of new and/or replacing capacities, operated on the basis of indigenous coal, using necessarily up-to-date highly efficient and low-emission carbon capture and storage

technologies. With a view to ecologically sound development of the national energy sector and in conformity with the Bulgarian and European legislation, a time schedule for modernization or closing down of heavily polluting generating capacities will be prepared in the coming years, and their owners will be obligated to comply with the adopted environmental standards.

The Energy Strategy points on the significance of the indigenous coal for energy security are indisputable. The Bulgarian energy policy will follow the technological development with respect to generation efficiency and clean coal technologies and will apply the technological achievements in conformity with the European requirements and the economic capabilities of the country. In order that the indigenous coal can perform a stabilizing role in the future national electricity generation, up-to-date technological, highly efficient and low emission solutions will be applied in the construction of new and rehabilitation of the existing power plants.

The Energy Strategy acknowledges that the transition to low-carbon energy will inevitably result in growth of the energy costs. The adequacy and timeliness of the political decisions and measures will determine the price that the Bulgarian business and citizens will have to pay for the transition to low-carbon energy.

For maintaining generation of energy by local sources but in the same time to comply with increased requirements for reduction of greenhouse gas emissions, the following policies were foreseen:

- Use of less energy, i.e. improvement of energy efficiency in energy generation and consumption;
- Use of cleaner energy, i.e. improvement of the energy mix through increase of the share of low-emission energy, mainly renewables
- Fast technological progress, including introduction of new energy (clean coal) technologies.

With a view to the stabilizing effect of indigenous coal as a resource for power generation, the state will support, financially and institutionally, the construction of power plants with facilities for capture and storage of carbon dioxide by the schemes and mechanisms adopted at an European level, and in accordance with a balanced policy between environmental legislation and promotion of the indigenous energy resources.

For achievement of sustainable development without painful economic consequences for the country, however, the following more important steps shall be followed in the short and medium term:

(1) Some additional revenue will enter the budget of the country from sale of allowances by bidding. At least 50% of this revenue shall be invested in environmental projects for reduction of greenhouse gas emissions, such as development of renewable energy sources, energy efficiency and introduction of „smart grids“, measures for prevention of deforestation and increase of afforestation and reforestation, environmentally safe capture and storage of CO_2 in geological formations, promotion of low-emission freight and public transport vehicles, and others.

(2) With a view to full exercise of the trading rights given to Bulgaria, the country will make the required efforts to draft and create in a timely manner working mechanisms, including through participation in a common European platform for conducting of bids for emission allowances, so that the revenue can be used in the exercise of rights granted to the state.

(3) Along with the revenue raised at national level by bids for allowances, up to 300 mln. emission allowances with estimated value between 6 and 9 billion Euro have been allocated at European level for financing of clean technologies – demonstration projects for carbon capture and storage technologies and innovative projects for renewable energy.

The Reference scenario from the Energy Strategy highlighted introduction of Carbon Capture & Storage (CCS) technologies. It was considered that by 2030 the generation through CCS shall be 19.4% of total electricity generation in the country, and that captured and stored CO_2 emissions shall be 9.2 Mt of CO_2.

Due to high costs of CCS technologies, as well as due to high spending of incomes from the trading of allowed national emission quotas for maintain low electricity prices in Bulgaria, currently no advancement in application of those policies can be noted.

By 2012, in Bulgaria totally 12 coal mines had been in operation with production of 36 Mt lignite and brown coal (hard coal insignificant) in open and underground casts – 3 of them were the lignite mines in Maritsa East complex. The coal from local mining was used in 7 TPPs and for direct heating needs – 5 of them were using lignite coal from Maritsa East complex.

Currently the underground mining is in process of closure but coal TPPs are still working and use of coal for domestic heating is still available. In 2018 the working coal mines were 8 in open cast mines (including the three lignite mines in Maritsa East complex) with production of 30 Mt mainly lignite coal (95%). The coal from local mining is still used in 7 TPPs and for direct heating needs but with decreased intensity with 15% less in comparison to 2012.

The national actions plans in the fields of RES and energy efficiency are assuming measures for decrease of the emissions of CO_2 but the use of coal for generation of electricity remains a priority.

The National Climate and Energy Plan of Bulgaria, prepared in the beginning of 2019, follows the medium European climate protection targets: there are no set up targets for 2050 and by the year 2030 a reduction of 40% is intended for the greenhouse gas emissions as compared to the baseline situation of 1990. At the same time the portion of renewables in gross internal energy consumption should increase from 19% (2020) to 25 - 27% (2030). In addition, the energy efficiency will increase, leading to a reduction of the primary and final energy consumption by 32,2%% as compared to 2008. For the Stara Zagora region it means a stepwise reduction of coal production and power generation after 2030 coming from actual 30 million tons to zero maybe by 2050. In the end of the process all remaining 3 active opencast mines and three large-scale power plants will be closed. Therefore, the approved mining planning should be revised in near future.

Actually, lignite fired power plants contribute to 42% of the national electricity production and about 35% of the climate-damaging CO_2 emissions. According to the current step-by-step plan for the decarbonisation, the installed net electrical capacity should fall from 4.2 GW (2017) to 3.0 GW (2035) and finally zero around 2050. For a better understanding of the challenge: on an average day Bulgaria uses about 4.5 to 5.5 GW electricity capacities, but in the winter the consumption can require work of around 8.0 GW. In such periods the capacities of coal fired power plants are critically needed to cover the demand, because no other option is available at the moment.

A plan for compensation of the upcoming socio-economic risks in the biggest Bulgarian coal region, Maritsa East is still under discussion.

According to the Integrated Climate and Energy Plan, the Bulgarian state makes maximum use of the existing potential of local coals in the country while respecting environmental requirements, providing them with a resource for electricity production for the next 60 years. The use of local coal reserves has a future as a stabilizing source of energy. Local coal plants provide for about 48% of the electricity production and are a guarantee for Bulgaria's energy security and the competitiveness of the Bulgarian economy. These power plants are the main basic power generating capacities for the Bulgarian electricity system and are the main provider of system balancing services, which is why they are a major factor for the country's electricity security. This defines the role of local coal as a strategic energy resource in terms of the country's energy and national security.

Smart specialisation strategies

In the assessment of JRC (JRC, 2018) regarding the availability factors, provided in EU coal regions: opportunities and challenges ahead, 2018, shows that the solar resource potential is high both for BG34 and BG41 coal regions – 15%.

Investigating the potential role of innovative technology solutions such as Carbon Capture and Storage (CCS) and/or Carbon Capture and Utilisation (CCU) can be an option during the transition of coal regions, as it offers the possibility to use coal for power generation, while capturing and permanently storing the CO_2 formed during the power generation process. Clean coal technologies have already been identified by some European regions as a Smart Specialisation priority in their strategies. The study of JRC indicates that Bulgaria has low potential for "CO_2 capture ready" but coal-bed methane production could be reasonable alternative in support of the transition to a low carbon future.

The successful structural-economic transition also needs proactive adaptive measures and not passively waiting for irreversible structural breaks.

Financing

In Bulgaria, the main public funding for environmental activities in coal mining comes from Kozloduy International Decommissioning Support Fund (KIDSF). The fund is administered by the European Bank for Reconstruction and Development (EBRD). It supports the necessary restructuring, upgrading and modernisation of the energy sector.

For Bulgaria, about 350 million euros are allocated (the concrete amount depends of the price of the emission quotas) in a modernization fund after 2021 (Capital). The fund will be used for the modernization of the national energy system. Although investments in coal sector are not eligible, there is one exception – the funds can be used for the restructuring of the labour market in the coal-intensive regions.

The EU Structural and Investment Funds (SIF) 2014-2020 generally provide no support projects for the transition of the Bulgarian coal regions. An exception is Operational Programme (OP) Human Resources Development, which finances pre-qualification of the workforce. On the other hand, in the next programming period, the EU SIF (e.g. OP Environment, OP Regional Development, OP Competitiveness) can be used to support relevant investments, in line with the current practices of other EU Member States.

3.3.2 Regional and local policy

Subsurface resources are exclusively state property. The extraction is carried out on the basis of granted concessions by the Council of Ministers upon proposal of the Minister responsible for energy. “The Council of Ministers determines the state policy for management of the subsurface resources aimed at sustainable development of the country, the national security and the attraction of investors and adopts the National Mining Industry Development Strategy” (Ministry of Economy). So, regional and local policy can only follow the state policy in the field and envisage local development in line with the national directions.

The region of Stara Zagora is one of the four European coal regions along with those in Poland and Czech Republic, presenting above 10,000 jobs each. Many of these jobs will become redundant in the next decade, both in direct and indirect coal activities. These perspectives are under discussion and development of strategies for diversification of activities at local level.

The national objectives for increasing the flexibility of the national energy system are based on keeping the key role of local energy resources (coal) and using them in existing production capacities, in accordance with the requirements of environmental legislation. To achieve these goals, measures are envisaged to improve production efficiency in existing coal-fired power plants by increasing energy efficiency and by replacing coal with natural gas.

The Regional Plan for the Development of South East Region of NUTS 2 during the period 2014-2020 from 2013 (MRDPW, 2013) sets as a specific goal the improvement of air quality through reduction of the total annual CO_2 emissions, development and implementation of municipal programmes for air quality management in problematic areas, increase and promotion of production of clean fuels. A key priority in this respect is the wider utilization of renewable sources (wind energy in the eastern parts, solar energy in southern).

The vision for the development of Stara Zagora district during the period 2014-2020 is set in the Development Strategy (NCRD), and stipulates for sustainable development, balanced economy based on knowledge and high standard of living achieved through the wise utilization of available resources and the development of human potential.

Strategy's specific objective 2.3 calls for the improvement of the energy system. The measures identified to achieve this aim are:

- Improving the quality of electricity supply to small towns and villages;
- Replacement of depreciated power transmission and distribution networks;
- Development of gas distribution networks;
- Thermal renovation of large public buildings;
- Municipal housing renewal programs (including energy efficiency);
- Introduction of geothermal systems for public buildings;
- Introduction of alternative energy sources in public transport;
- Stimulating the use of RES;
- Encouraging the creation of public-private partnerships for energy efficiency and RES.

With reference to mining, specific objective 4.2 – implementation of measures for environmental protection in mining industry and localization of renewable energy installations - is the major measure for which there is a strict control over the implementation of reclamation plans.

The main strategic directions of the development of the three most affected by the Maritsa East complex municipalities in Stara Zagora district during the period 2014-2020 as concerns energy sector, are presented shortly below.

The Municipal Plan for Development of Stara Zagora till 2020 (Municipality of Stara Zagora) puts as a priority the utilization of renewable energy sources for production of electricity, considering the solar energy potential on its territory, including for public lighting. The other RES that could be exploited are forest biomass for heating and geothermal energy in areas with thermal springs.

In accordance with the Clean Ambient Air Act, Stara Zagora is included in the list of regions for assessment and management of air quality as a territorial unit with exceedance of PM10 levels. In this regard, Stara Zagora Municipality has developed and implements a "Pollution reduction program and reaching the established norms for hazardous substances in the ambient air and an Action Plan 2011-2015". The monitoring station registers the pollution from residential sector.

In its current Municipal Development Plan 2014-2020 (Municipality of Radnevo), the **municipality of Radnevo** underlines that mining and energy are fundamental sectors, defining the industrial profile of the region. The indicative projects foreseen during the period 2014-2020 relating to mining include:

- Maintaining and restoration of ecological balance and limitation of water and air pollution
- Reclamation of areas affected by coal mining and energy production

For the **municipality of Galabovo**, lignite is in the core of the leading economic sectors – mining and power generation. Most of the enterprises in the municipality have emerged and operate as servicing or supporting these two sectors and hence, they provide the highest share of employment. Thus, the Municipal Development Plan till 2020 (Municipality of Galabovo, 2014)

sets as a first priority the development of the local economy by exploiting local potential through support for the established businesses. Apart from that, the Municipality considers the utilization of local renewable resources (Municipality of Galabovo, 2017) – particularly of solar energy and biogas production.

According to the national and EU legislation, the municipality of Galabovo is included in an area for assessment and management of Air Quality with code BG0006, and is indicated as an area / territorial unit with exceedance of SO_2 and PM10 levels. In line with the Clean Ambient Air Act, the Municipality of Galabovo develops program and action plan for environmental protection, as well as regular reports on the implementation of the short-, medium- and long-term measures, outlined in the programme.

Therefore, Stara Zagora district can be an experimental field for peripheral regions by developing industrial hotspots/clusters based on existing infrastructure and regional business networks.

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4 Czech Republic, North-west Bohemia

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4.1 Description of the district

In the Czech Republic, all active lignite mines are located in the NUTS 2 North-west Bohemia district (CZ04), which covers an area of 8 649 km2. The NUTS 2 is so called cohesion district and mostly serves as a unit for EU statistics and financing, it does not have its own administration or decision power. Administratively CZ04 consists of two different districts (NUTS 3), which represent local authority: Karlovy Vary district (CZ041) and Ústí district (CZ042). Both of these districts have been described in detail thanks to the initial analysis (Re:Start 2019) of the strategic restructuring plan. Substantial majority of Czech statistical data are available separately for these two NUTS3, therefore statistical data on these two districts are described separately below. However, many similarities exist between districts, therefore if patters are similar they are discussed together.

4.1.1 District overview

The **Ústí District** is located in the Northwest of the Czech Republic on the border with the German Land of Saxony. The border with Germany is made up of the Ore Mountains, in the interior there is the Central Bohemian Mountains, the rest of the district is predominantly flat. The area of district is 5 335 km². By the end of 2016, the Ústí District had 821,337 inhabitants, making it fifth in the Czech Republic. Population density (154 inhabitants/km^2) is higher than the national average. The characteristic feature of the district is a relatively young population; the average age is 41.6 years. The Ústí nad Labem District is ranked fourth in the number of live births per 1 000 inhabitants (10.0), but there is the highest mortality rate in the Czech Republic (11.0 per 1 000 inhabitants) (ČSÚ 2019).

The **Karlovy Vary District** is located in the westernmost part of the Czech Republic, adjacent to the Plzeň and Ústecký Districts, as well as Bavaria and Saxony. The relief of the district is characteristic of the lowlands, where the headquarters of the district are situated - Karlovy Vary, Sokolov and Cheb, where the population and economic activity are concentrated. Karlovy Vary district is famous for its spa. In terms of population, the Karlovy Vary District is the smallest district in the Czech Republic, with approximately 295,000 inhabitants. Population density is around 90 inhabitant/km^2, the highest density is in Sokolov (120 inhabitants/ km^2), where operating coal mines are located. Infant mortality rate of 5.2 is the 3rd highest in the Czech Republic, the national average is 4.1. The relative number of live births is also high, ranking second in the Ústí nad Labem District, while the lowest in the Czech Republic is mortality (6.6% lower than the Czech average) (ČSÚ 2019).

The population and the structure of the district's settlement are still bearing signs of significant changes after 1945. The displacement of the German population and the subsequent resettlement especially for the needs of the heavy industry changed considerably the population of the district - the municipalities in the peripheral parts of the district were either extinct or marginalized areas.

Specific labour requirements resulting from decades of artificially supported industrial specialization have had and have implications for the socio-professional structure and education of the population. At the same time, environmental impacts are evident, although in the long run the situation is improving and in some respects is among the best in the Czech Republic. However, there are still many local environmental burdens and brownfields in the district.

4.1.2 Social situation

The Usti district is traditionally an industrial area with a strong orientation of the economy to the heavy industry. Historically, the district specializes in mining, especially brown coal. Other industries (e.g. engineering, energy) are linked to these sectors. After the German population was relocated after the Second World War, the area of the district was resettled by the population from other territories of then Czechoslovakia, which represented a significant labour force of workers' professions that could be used for the developing heavy industry. For this reason, there is a high concentration of population in the Usti district and this area is one of the most urbanized areas of the Czech Republic. A number of industries (chemistry - the district is represented by refining of crude oil, production of plastics, resins, artificial sapphires and production of products for agriculture and food industry textiles and clothing, mechanical engineering, mining, power engineering) underwent a dampening in the 1990s. Because of the decline of the mentioned industries, there are many unused industrial facilities in the Ústí District (Re:Start 2019).

A common problem of the Karlovy Vary and Ústí districts is the low rate of economic growth and the lag behind other districts of the Czech Republic. Typically, there is low attractiveness of the districts for the life of the population, a smaller offer of prospective job and career prospects and job conditions not only for young and qualified professionals. This is negatively affecting the inhabitants of the district as well as the attraction of people from outside the district. In the end there is a low attractiveness for business. An important factor of insufficient quality of workforce (Table 14) is the high concentration of socially disadvantaged groups in the Ústí district and a large number of socially excluded localities, which are associated with a relatively high incidence of socio-pathological phenomena and a high level of unemployment.

Table 14: CZ: Percentage of local citizen in individual districts of the Czech Republic, older than 15 years of age that reach certain level of education

District	Abbreviation	Basic	Secondary[1]	Secondary with leaving exam[2]	University
Praha - capital	PHA	7.6	17.9	38.8	35.6
Středočeský district	STC	13.0	35.5	34.4	16.9
Jihočeský district	JHC	14.1	35.9	35.2	14.6
Plzeňský district	PLK	13.6	36.4	34.1	15.8
Karlovarský district	KVK	19.8	36.5	31.9	11.4
Ústecký district	ÚLK	19.3	37.2	31.7	11.7
Liberecký district	LBK	15.3	38.2	31.4	15.0
Královéhradecký district	HKK	13.8	36.2	34.3	15.4
Pardubický district	PAK	13.8	36.8	33.7	15.5
Vysočina district	VYS	14.7	40.3	30.8	14.1
Jihomoravský district	JHM	11.5	31.6	33.0	23.7
Olomoucký district	OLK	14.3	37.4	32.9	15.1
Zlínský district	ZLK	14.4	37.9	32.1	15.3
Moravskoslezský district	MSK	16.3	35.7	31.7	16.2

[1] Secondary education without state leaving exam
[2] With state leaving exam

The table is based on population census in 2011 (data from Czech statistical office). The target districts are marked in grey, for comparison light grey is another mining district in transition, Moravskoslezský district (ČSÚ 2019). The decline in coal mining, the restructuring of enterprises, the decline in production and agriculture, mean that the highest proportion of unemployed people is in the Ústí nad Labem District (7.79% in the Czech Republic was 5.19% at 31.12.2016). The share of the unemployed aged from 15 to 64 years was equal to 5.45% in the Karlovy Vary District.

The economy of the Karlovy Vary District is also specialized in mining and power engineering. In the district, there is a significant mining capacity for brown coal mining, but its reserves are gradually diminishing and the mining industry in the district will therefore be forced to terminate its activity in the period of about 10-15 years. In particular, traditional industries are linked to the activities of engineering firms, and the chemical industry has a role to play. Similarly as in Usti district there is a low proportion of people with higher education (Table 14) and high unemployment rate (see 4.1.3 and Table 15).

In Northern Bohemia some activities supporting the development of mining districts are already beginning to emerge, especially in the effort to promote productivity growth and the performance of private enterprises, to facilitate the change in the structure of the economy and the transformation of individual enterprises. A number of successful private enterprises in domestic and especially in foreign markets is increasing. The landscape is in transformation as well (Re:Start 2019).

Both districts have a higher unemployment rate (Table 15) than the rest of the Czech Republic although it should be mentioned that situation is getting better in last years. The only district with similar unemployment rate is Moravskosleský district - another coal mining district where mostly black coal is mined.

Table 15: CZ: Unemployed rate in target district (dark grey) in comparison with other district in the Czech Republic, light grey is another coal transition district Moravskoslezký district (ČSÚ 2019)

	2012	2013	2014	2015	2016	2017	2018
Praha - capital	3.1	3.1	2.5	2.8	2.2	1.7	1.3
Středočeský district	4.6	5.2	5.1	3.5	3.1	2.1	2.0
Jihočeský district	5.7	5.2	5.9	4.0	2.8	2.2	1.4
Plzeňský district	4.8	5.2	5.1	3.8	3.4	1.9	1.5
Karlovarský district	10.5	10.2	9.0	6.7	5.4	3.3	2.9
Ústecký district	10.8	9.4	8.5	7.6	5.1	3.5	3.6
Liberecký district	9.3	8.3	6.5	5.5	4.4	3.7	1.9
Královéhradecký district	7.1	8.2	6.2	5.6	4.1	2.2	2.3
Pardubický district	7.7	8.4	6.4	4.6	3.7	2.7	1.7
district Vysočina	6.4	6.7	5.6	4.7	3.2	2.7	1.7
Jihomoravský district	8.1	6.8	6.1	5.0	3.9	3.3	2.6
Olomoucký district	7.7	9.2	7.7	5.9	3.7	3.1	2.6
Zlínský district	7.4	6.8	6.1	4.7	4.0	3.6	1.8
Moravskoslezský district	9.5	9.9	8.6	8.1	6.9	4.7	3.7

62% of the population of socially excluded localities in the Czech Republic live in the Ústí nad Labem, Moravian-Silesian and Karlovy Vary districts.

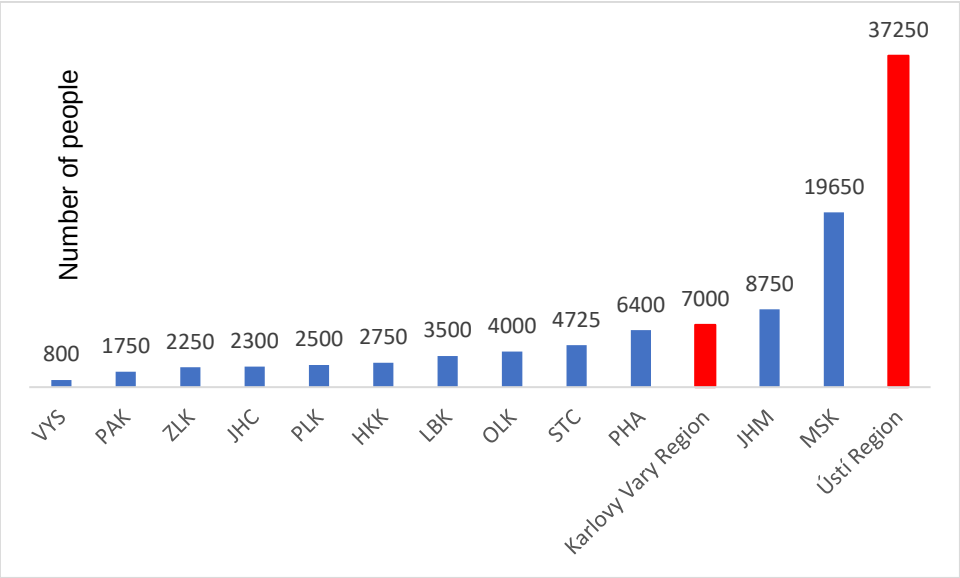

Figure 4: CZ: Number of people living in socially excluded localities in individual districts of the Czech Republic

Coal mining district in red KVK is Karlovarský district and ULK is Ustecky district (Source: GAC spol. s.r.o., 2015)

Another unfavourable factor is the educational structure with a high proportion of low-skilled people or even people without basic education. This has its origin in the orientation to heavy industry, which historically created a large proportion of job opportunities, especially in blue-collar professions. Moreover, there is a low representation of universities in the monitored district (in the Ústí nad Labem district only one university seat and in the Karlovy Vary district only a detached university workplace). The vast majority of those interested in higher education leave the district for education and their return is minimal. It is also necessary to take into account the fact that the educational status is often transferred between generations.

The population structure, educational level and economic situation are a common denominator of the enormous indebtedness of the population in the monitored area. The Ústí nad Labem District has the highest proportion of persons in the distraint within the Czech Republic, while the Karlovy Vary District ranks second.

Table 16: CZ: Education structure – rate of inhabitant in age higher than 15 years (ČSÚ 2019)

District	basic	secondary	Secondary with leaving exam	university
Czech Republic	13.8	33.9	33.7	18.5
Karlovy Vary Region	19.8	36.5	31.9	11.4
Ústí Region	19.3	37.2	31.7	11.7

Table 17: CZ: Execution in both mining districts (ČSÚ2019)

Parameter	Ústí District	Karlovy Vary District
Share of persons in execution	18.08%	17.45%
Year-on-year change in number of persons under execution	8.8%	10.3%
Average number of executions per person	5.2	4.8
Average principal per person	199 503 CZK	219 618 CZK

Parameter	Ústí District	Karlovy Vary District
Median principal per person	81 305 CZK	94 864 CZK
Number of persons older than 15 years	692 613	253 446
Number of persons under execution	125 241	44 215
Total seizures	652 338	211 655
Total amount recovered (in CZK)	24 985 955 223	9 710 409 870

4.1.3 Economic development

In 2016, the Ústí district contributed 5.7% to the gross domestic product in the Czech Republic. In terms of per capita, it reaches 73.8% of the national average, and is among the districts at thirteenth position (ČSÚ 2019). The most important employers of the Ústí District include two mining companies (Sev.en Energy and Severočeské doly) and chemical plants. A substantial part of the district's economy is built on a smaller number of large companies. Also, due to the above reasons, the district faces other socio-economic problems that are characteristic of economic transformation, such as high unemployment, declining property prices, inappropriate educational structure, underdeveloped civil society. In the district, there is a very low share of the university-educated population. The Karlovy Vary district is the last in comparison. In addition to the gradual decline in mining, another important sector of the district, the spa industry, is currently undergoing stagnation. Coal mining and processing dominates in the Sokolov district. The most important employer is Sokolovská uhelná, a.s.

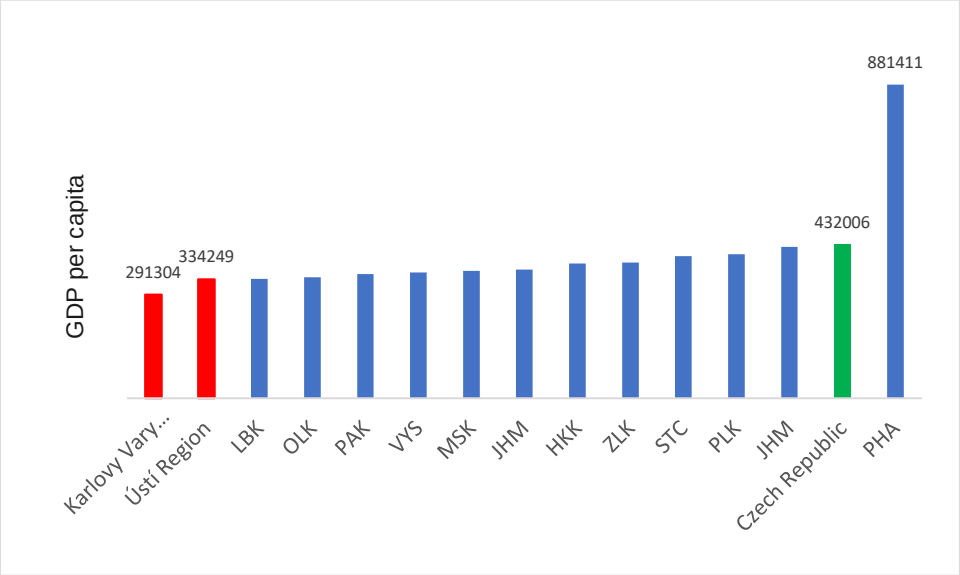

Figure 5: CZ: Comparison of GDP per capita by districts in the Czech Republic (ČSÚ 2017)

The Ústí nad Labem District has an important location in terms of transport connections to European Union countries. Road transport uses 14 border crossings. International transport corridors are very important: E 55 road connecting North and South Europe, D8 motorway Prague - Usti nad Labem – Dresden, R7 Prague - Louny - Chomutov - Chemnitz highway, Prague - Usti nad Labem - Dresden high-speed railway corridor. In Ústí region, there are also waterways - Elbe River with connections to German intercontinental waterways. The distances to the airport from the regional capital Ústí nad Labem to Prague International Airport is 93 km (1:14 h), to Dresden International Airport it is 85 km (1:12 h). More details about transport situation in Ústí region is described in regional transport service plans (e.g. TSP 2019). The Karlovy Vary Region is also very well connected by highway II class D6, Cheb - Sokolov - Karlovy Vary. The motorway is

connected to Germany (via the Schirding road crossing) by road I / 6 from Cheb and from Karlovy Vary the motorway is connected again by road I / 6 with Prague. Other important roads in the region are I / 13 (Karlovy Vary - Most - Teplice - Decin - Liberec - Frydlant - Poland), I / 20 (Karlovy Vary - Plzen - Ceske Budejovice), I / 21 (Germany / Plavno - Cheb) - Mariánské Lázně - motorway D5), I / 25 (Karlovy Vary - Ostrov –SRN / Chemnitz) and I / 64 (Cheb - Aš - Germany / Selb). All important and larger towns of the region are also connected by a dense network of II roads and III class (owned by the Karlovy Vary Region), while the most important ones have undergone or are currently undergoing major reconstruction and modernization. International airport is located directly in Karlovy Vary, to Prague airport it is 123 km (1:32 h).

Two transit gas pipelines go through Ústí District and two border transfer stations are located in Brandov and Hora sv. Kateřiny.

4.1.4 Environmental situation

Industrial activity from the past has had and still has a negative impact on the quality of the environment. Strongly developed surface mining has greatly damaged the natural face of the landscape, which is gradually being restored with very expensive reclamation. Beside problem with areas affected directly by coal mining activities, there are problems with the emission situation in the district. In the second half of previous century the large amount of sulphur dioxide was produced in the air, which was causing the so-called acidic rain. Just two power plants (Tušimice and Prunéřov) produced in 1986 593,000 t of SO_2 per year. This was caused by burning of high sulphur content coal and the technology used in the power plants. The situation was made even worse by accumulation of emissions coming not only from local sources, but also from Eastern part of Germany and Poland. This caused a massive dieback of forest in the district surrounding coalmine areas, which affected 75,000 ha of the forest. In mid 90s of past century legal steps were taken to avoid burning of high sulphur coal and desulphurization units were installed in major power plants. There has been a significant improvement in the last decade, which can be documented by decreasing emissions, but the district is still perceived as the area with the most damaged environment. Locally acid mine drainage produced by pyrite oxidation has been problem as well.

Damage on environment effect also the health of local citizens (Sram 2007). Since 1972, an increase in the incidence of congenital developmental defects has been observed in the Ústí nad Labem district and later in other parts of the district. When analysing the number of children with a birth weight less than 2500 g in the period 1982 - 1986, the number of such children in the Teplice and Ústí nad Labem districts was almost twice as high as the national average. An increase in the number of pathological findings in the examination of humoral immunity in the North Bohemian population was reported. Concentrations of polycyclic aromatic hydrocarbons in some parts of the Teplice district reached 300 - 800 ng/m^3 at the recommended NPK 1 ng/m^3. In the Teplice district in 1988, the average survival rate for men over 65 years was three years shorter than the national average, for women two years. Increased mortality from cancer and cardiovascular disease contributed significantly to these changes.

Experimental work was published in the 1980s, suggesting that even air pollutants such as SO_2 or NOx when exposed to pregnancy may affect some characteristics of children's behaviour. It was also assumed that significant air pollution in northern Bohemia could adversely affect the school performance of children from the areas. Neuropsychological damage to children has been associated with increased exposure from transport (petrol additives), arsenic and mercury from brown coal combustion. When analysing the morbidity of children in the districts, 2.90 cases per 100 children versus 0.54 in the Czech Republic were reported for airway diseases, 2.93 versus 1.70 for allergies, 1.29 versus 0.65 for skin diseases. In children aged 7-15 years, the increase in respiratory disease was 1.40 versus 0.45, mental illnesses 4.09 versus 2.0, skin lesions 1.09 versus 0.73. These data have become a starting point indicating the severity of air pollution in the basin areas of northern Bohemia to the morbidity rate of the paediatric population in particular.

During 1992 and 1993 a pilot study investigated respiratory function in children, 235 children. Vital capacity was significantly reduced in Teplice area for children from all years. When analysing the occurrence of symptoms of respiratory-tract diseases (cough, phlegm, dyspnoea, wheezing), a higher prevalence of all symptoms was found in children from the polluted area, in children from smoking families and in children whose mother smoked before pregnancy. Higher incidence of allergic diseases and chronic bronchitis were also found in children from the Teplice area. Decrease in respiratory function in children from a polluted area has been attributed to chronic exposure to increased concentrations of respirable dust particles and SO_2, parent smoking, and early smoking. They assume that all three factors will affect the likelihood of early onset of chronic lung diseases. The average age of deaths in target district was 3-4 years lower for both sexes. The development of life expectancy at birth is similar in all areas. The life expectancy in the target district of both sexes is still 2 to 3 years shorter than in the Czech Republic as a whole.

4.2 Role of coal mining in the district

4.2.1 Coal sector in the district

In the North Bohemia, we focused on two mining districts (Figure 6) – Sokolov and North Bohemian Brown Coal Basin (= Most and Chomutov basins), which include majority of lignite deposits.

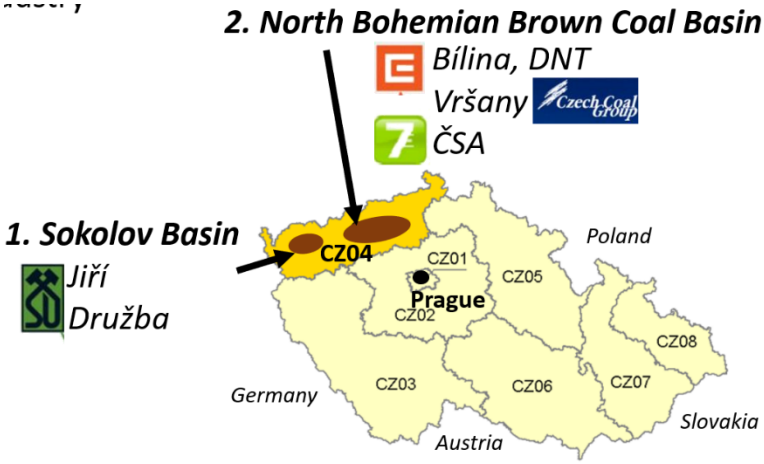

Figure 6: CZ: Coal mining areas and mining companies in the Czech Republic

In the Czech Republic, there are 55 known deposits of lignite out of which nine are mined, most of them are of Miocene age. Total known geological reserves of lignite are 9,055 mil t. Not all of that coal is however technically mineable and mining of part of the mineable resources is banned by limits set by government decision no 444 from 1991. Consequently, total mineable reserves in this district are 783.8 mil t. Majority of that reserves occur in Most district (654.8 mil t) and smaller part in Sokolovsky district (129.0 mil t). Share of individual companies and mines in mineable reserves (as reported by 1.1. 2015) is indicated in Table 18.

Table 18: CZ: Mineable reserves of individual mines, mining companies and districts by 1.1.2015 based on Raw material policy of the Czech Republic (MPO 2019)

Region in parenthesis	Company	Mine	Mineable resources (mil. t)
Ústí region "Severočeská	Vršanská uhelná a.s. (VU)	Vršany	266
		Slatinice	12
		Vršany + Slatinice	278

Region in parenthesis	Company	Mine	Mineable resources (mil. t)
Hnědouhelná"	Severní energetická a.s. (SE)	ČSA	28
		Centrum	1
		ČSA + Centrum	29
	Severočeské doly a.s. (SD)	Libouš	210
		Bílina	136
		Total SD	346
"Sokolovská pánev"	Sokolovská uhelná a.s. (SU)	Total SU	131
Total CR			784

Heat capacity of the coal varies from 10-11GJ t-1 in most districts to 12-13 GJ t-1 in some parts of Sokolov district (see Table 18 for average data in individual years). Except of one mine opencast surface mining does all mining. The depth of mines in many cases exceed 100 m (the deepest mine Bílina is over 200 m deep) which means that large amount of overburden cannot be stored in mining pit for stability reasons and around the mines there are large areas occupied by external heaps where overburden is stored. In 2014, 38.18 million tons of lignite were harvested. However, these amounts are just fraction of amount in the peak of production in 80s of previous century when annual production exceed 90 million tons. Lignite production in 2015-2017 is shown in Table 19 where North-west Bohemia basically produces all lignite in the Czech Republic. Therefore, coal production indicated in Table 19 actually shows the production of the target district. In addition, black coal is produced in other districts of the Czech Republic, but the amount is much smaller in terms of mass and energy (Table 19).

Table 19: CZ: Production of coal in Czech Republic, based on Czech statistical office data, 2018 based on Ministry of industry data

		2015	2016	2017	2018
brown coal	thousand t	38,105	38,528	39,306	39,191
	PJ	480.995	481.826	491.128	
	GJ t-1	12.623	12.506	12.495	
black coal for	thousand t	4,088	3,384	2,913	2,240
coke	PJ	117.166	95.998	83.24	
	GJ t-1	12.623	12.506	12.495	
energy black coal	thousand t	4,148	3,401	2,503	2,230
	PJ	107.024	93.989	60.548	
	GJ t-1	12.623	12.506	12.495	

Lignite production means production in target district, Northwest Bohemia (ČSÚ 2019).

Brown coal is the major source of energy as one can see it from decent data in Table 19. However, proportion of coal in electric supply is gradually decreasing. In 2005, lignite generated 43.1 TWh of electricity, which represented 52.2% of the total gross electricity production of 82.6 TWh. In 2013, lignite produced 35.9 TWh of electricity which represented 41.2% of the total gross electricity production of 87.1 TWh. For eight years (2005-2013) the total electricity production increased by 4.5 TWh and lignite electricity production decreased by 7.2 TWh. The average annual decrease in electricity production from lignite was 0.9 TWh (2.1%). The production of lignite electricity has been displaced mainly by growing production in nuclear power plants and renewable energy sources. In 2005, lignite was centrally produced, and the total output was 139.2 PJ of which 58 PJ were dedicated to heat production. In 2013, central heat production declined to 122.2 PJ and

delivered 53.4 PJ. In eight years (2005-2013) total heat production decreased by 18 PJ. Heat production of lignite fell by 4.5 PJ, but the share of lignite in total heat production increased from 41.6% to 44.1%. Lignite is mainly used for the production of electricity and heat in a wide range of power plants when particularly large energy companies with consumption above 50 MWt are of decisive importance. These are in total 47 companies. The most important heat and energy producer is semi-governmental Czech energetic company CEZ (four heating plants and nine power plants). Among the biggest we can name Prunéřov II (1,050 MW, lignite consumption of 2 442,0 thousand t y-1) Počerady a.s. (1,000 MW, using 5,417 thousand t lignite y-1), Tušimice II (800 MW, 4,577.0 thousand t y-1). Large amount of energy is produced by cogeneration during heat production and by company power stations. In 2014, 98.2% was sold in national market mostly for energy production and 1.8% was exported. Similar proportions will remain also in the next years (Table 20).

Table 20: CZ: Use of lignite in Czech Republic based on Czech statistics office data (ČSÚ 2019)

	2015	2016	2017	2015	2016	2017
Unit	**PJ**			**thousand t (recalculated)**		
001 Primary production	481.0	481.8	491.1	38,105.0	38,528.0	39,306.0
003 Imports	11.0	1.9	2.9	872.1	153.5	229.0
004 Exports	15.2	15.2	16.8	1,205.8	1,216.2	1,340.9
005 Change in stock	-6.7	6.5	1.3	-528.8	522.7	105.8
006 Gross available energy	470.1	475.1	478.6	37,242.5	37,988.0	38,299.9
008 Gross inland consumption	470.1	475.1	478.6	37,242.5	37,988.0	38,299.9
010 Total energy supply	470.1	475.1	478.6	37,242.5	37,988.0	38,299.9
011 Transformation input	431.7	435.8	415.0	34,197.7	34,848.8	33,210.3
012 Electricity & heat generation	406.5	410.0	392.7	32,199.3	32,781.2	31,426.9
013 Main activity producer electricity only	86.8	90.2	75.6	6,873.6	7,214.5	6,054.2
014 Main activity producer CHP	282.3	279.9	284.5	22,367.6	22,378.6	22,769.6
015 Main activity producer heat only	1.8	1.7	1.2	141.9	139.6	96.9
017 Autoproducer CHP	35.4	38.0	30.9	2,802.8	3,036.9	2,473.3
018 Autoproducer heat only	0.2	0.1	0.4	13.5	11.6	33.0
025 Gas works	22.0	22.6	19.1	1,740.2	1,809.5	1,527.4
034 BKB & PB plants	3.3	3.2	3.2	258.3	258.1	256.0

4.2.2 Social aspects

In North West Bohemia district (NUTS2) about 10,000 people are employed by mining companies (Table 21), which is about 3% of all employees in target district. However, one cannot really say that this is a number of people directly involved in coal mining as many companies now diversify their business in other activities such as coal processing, energy production, but also recreational activities and other. On the other hand, coal mining companies hire other companies for specific task, therefore a large amount of people may depend on mining companies indirectly. As already mentioned, target district has a higher unemployment rate in comparison with other districts of the Czech Republic.

Table 21: CZ: Number of employees in coal mining companies in the Czech Republic based on annual reports of individual companies

Company	2015	2016	2017
Sokolovská uhelná právní nástupce a.s.	-	3,561	3,676
Vršanská uhelná a.s.	706	687	700

Company	2015	2016	2017
Severní energetická a.s.	-	796	813
Severočeské doly a.s.	4,901	4,888	4,868

Average monthly salary in 2017, based on public annual report of the mining companies was 30,910 CZK for Vršanaká Uhelná a.s., 30,914 CZK for Severní energetická a.s. and 33,716 CZK for Sokolovská uhelná a.s. This is more than an average salary in the Czech Republic which was 29,638 CZK in 2017. It is more than the average salary in two districts of the target district Ústecký kraj (27,073 CZK) and Karlovarský kraj (25,995 CZK). Interestingly, both districts which form target coal mining district show lower salary than country average, while salary in mining companies is slightly above average. This is consistent with fact that nationwide average monthly income of people working in mining and quarrying (33,483 CZK) was also higher than country average.

4.2.3 Economic effect

In Czech Republic, mining and quarrying in total contribute to about 0.7 GDP in 2017 (0.7 in 2016, and 0.9 in 2015). Some other global values for all mining and quarrying sector are given in Table 22. The negative value of economic value added (EVA) as pointed out by analysis of ministry of industry: the negative values correspond with difficult situation in coal mining.

Table 22: CZ: Selected economic indicator of whole mining and quarrying industry in the Czech Republic (MPO 2018)

Parameter	2015	2016	2017
EVA billions of CZK	-7.37	-2.37	-0.27
Work productivity CZK per person	1,068,114	991,562	1,259,315
Sales mil CZK	74,209	67,959	85,413

GDP per capita in Northwest Bohemian District is 12,991 EUR (slightly higher than national value), share of industry on GDP (MPO 2017) is 38.6%. Mining companies manage the economy by employing a large number of people and other services linked to mining. For the surrounding municipalities, money from the miners is essential and irreplaceable in terms of municipal budgets. There are compulsory levies indicated in the Mining Act: 1.5% of extracted coal from the market price of coal should be given to the state and municipalities. In addition, the mining company pays fees to the Mining Authority for the occupation of 1 ha of land by mining (CZK 100 - 1,000, depending on the degree of nature protection in the given area). The amendment to the Mining Act brings a fixed amount calculated as ton x rate x net calorific value for the extraction from the mining area. E.g. In 2013, the mining company Severní energetická paid CZK 8.7 million for every million tonnes of coal. Of this amount, 75% goes to the state and 25% to municipalities. For the municipalities voluntary sponsorship donations of mining organizations (it is tens of millions of Euros per year) are also important. Czech brown coal mining companies also voluntarily cooperate with district authorities and are actively approaching the development of the area in their surroundings. Interesting figures are brought by the Hnutí Duha (non-governmental organization) (Rovenský and Ceman 2019), which summarized data on the development of brown coal mining companies in the period 2009 - 2016.

In 2009 - 2016 four companies producing brown coal in the Czech Republic:

- sold brown coal (owned by the state) for less than CZK 158 billion
- the above-mentioned companies reported EBITDA of over CZK 81 billion
- the above-mentioned companies posted a profit after tax of over CZK 35 billion
- their shareholders paid dividends of over 40 billion CZK
- over 36 billion CZK were reported on personnel costs (wages + levies)

- the state received 1.7 billion CZK for this coal in the form of a remuneration from the extracted mineral

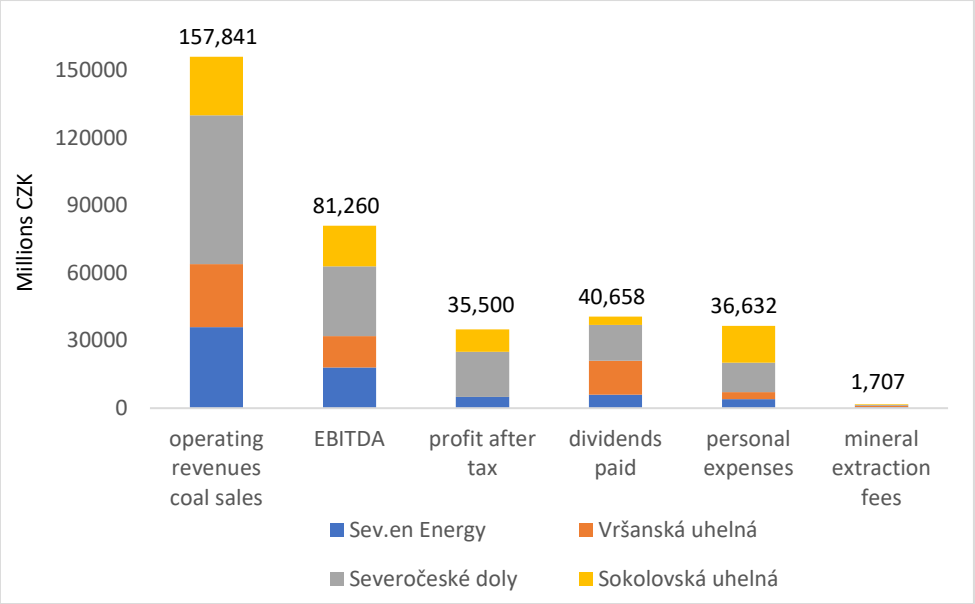

Figure 7: CZ: Economy of Czech coal mining companies 2009 – 2016 (total) (Rovenský and Ceman 2019)

The ratio of the reimbursement of the extracted mineral (i.e. what the mining should cost) to the dividends paid by all Czech lignite mining organizations (i.e. what the mining owners had) was even 4% for the state to 96% for business owners during the period.

Table 23: CZ: The overall economy of brown coal mining companies overview for 2009-2017 (mil. CZK) (Rovenský and Ceman 2019)

Mining company	Coal sales	EBITDA	Profit	Dividends	Personal costs	Extraction fees
Sev.en Energy	34,337	15,203	7598	7,000	4,198	402.7
Vršanská uhelná	27,797	14,146	-729	14,750	2,968	384.6
Sevročeské doly	88,146	40,054.5	22,476	18,105	14,587	1,149.4
Sokolovská uhlená	24,096	19,815	9,022	2,760	18,997	347.4
Total	174,376	89,218.5	38,367	42,615	40,750	2,284.1

The overall overview for 2009-2017 shows that even after the increase in brown coal recovery rates, the unequal distribution of wealth between mining companies and the brown coal-owned state still persists.

Hnutí Duha (NGO) proposal includes increasing the remuneration from the extracted mineral to 10% of the market price of brown coal without correcting the cost of mining (from the level of 1.5% valid until 2016 or about 3.5% in 2017). Hnutí Duha does not specify the method of calculation in this proposal and it is not considered whether the method of calculation will be based on the coal sales price or as a fixed rate on the coal extracted. The aim of this proposal is to share the profit fairly between the state and mining companies. The mining companies claim that the increase in the fee would make them redundant. It is therefore somewhat confusing: in fact, brown coal mining would remain a highly lucrative business even after the increase in fees and would only reduce their current astronomical profit. The ratio of dividends and profits for the whole lignite sector to their personnel costs (wage costs and salaries) is also interesting - it shows that the amount of dividends and profits is comparable to the personnel costs of all their employees (for the group Pavel Tykač's dividends for the three owners of the company were even three times higher than

the personnel costs of approximately 1,600 of their employees). Thus, to maintain existing employment, these companies generate enough money, but there is no willingness to share the profit with their employees. The negative profit of Vršanská uhelná is offset by almost twice the positive profit of Severní energetická of the same owner. It was Vršanská uhelná that served as the largest source of dividends in recent years. The threats of Sokolovská uhelná or Severní energetická that they would be forced to reduce the financial support of the districts in which they operate are not convincing. As a result of the increase in the fee, the municipalities concerned would receive significantly more than the current year, even if the individual mining companies reduced their financial support to zero. For example, the Tykač Group provided donations of CZK 182 million in the district, according to its annual reports in 2009-2016, but the difference in payments from the extracted mineral at the 10% rate is 4.8 billion, i.e. 25 times more. Increases in mineral extraction revenues could be used to more effectively transform coal districts (Rovenský and Ceman 2019).

However, according to the current redistribution model, only municipalities located in the immediate vicinity of mining sites benefit. The district as a whole is not included among the beneficiaries, district social partners call for this type of change in order to carry out transformation activities of district importance.

4.2.4 Environmental effect

The land directly affected by mining or dumps reaches an area of over 270 km^2. In affected areas existing ecosystems are completely erased, either excavated or covered by large layer of overburden. Overburden in most places of the target district is formed mainly by Miocene clays which have neutral or alkaline pH and are quite suitable for restoration, locally however pyritic material which is difficult to revegetate occurs and, besides difficult reclamation, it produces problems with acid mine drainage. Half of this degraded area (over 140 km^2) has already been reclaimed and another 52 km^2 of reclamation work is underway. Most common way of reclamation is afforestation followed by agriculture and hydric reclamation. Areas and proportions of individual reclamation types are given in Table 24.

Table 24: CZ: Areas and proportion of individual form of post mining land reclamation in Karlovarský and Ústecký district (MPO 2018, Frouz et al 2007)

Form of	Karlovarský district		Ústecký district	
reclamation	ha	%	ha	%
Agriculture	1,095.0	35.6	3,504	29.3
Forest	1,793.6	58.3	5,670	47.4
Waterbodies	77.7	2.5	320	2.7
other	109.6	3.6	2,472	20.7
total	3,075.9	100.0	11,966	100.0

However, indirect effects, alternation of watercourses, dust and effect of coal combustion affect much larger area. Some of the environmental effects mentioned above are internalized by various measures. A typical example is company obligation to restore post mining land for agriculture, forestry or other use etc. However, some part of the environmental cost is not internalized, we speak about so called externalities. Those include damage on people health, environment, buildings, etc. These costs are not part of any accounting and typically get paid by whole community or by next generation, by higher public spending and are even seldom considered. In Ústecký district we have available unique study of these externalities which were prepared for government decision about future coal mining (MPO 2015). These externalities originate not only from mining itself, but namely from using coal. It leads to air pollution, that effects human health, ecosystems, infrastructure, etc. Table 25 summarize some physical effects of different scenarios on human health.

Table 25: CZ: Some effect of coal mining in Ustecky district and use of that coal on citizens of the Czech Republic, based on present scenario on human health in period 2015-2050 (MPO 2015)

Parameter	Limit of mining based on government decision no 444 from 1991	Limits based on corrections made based on government decision 827/2015 (Recent situation)	Limits for scenario we will completely abandon limits set by decision no 444 from 1991
Years of lost lives	18,321	30,009	50,075
Chronic bronchitis no of hospitalization	68	117	183
Children bronchitis no of hospitalization	361	595	921
Cardiovascular disease no of hospitalization	453	802	1,339
Respiratory disease no of hospitalization	47	87	143
Sick leave days	35,361	59,246	91,250

By transfer of value, we can estimate also economic effect of these externalities. There are certain small differences between individual scenarios, but if we consider only effect on citizen of the Czech Republic these externalities are about 3.3 € per t of coal. However, air pollution crosses country border so if we consider citizen of EU these externalities will reach 323 € per t of coal. Beside health effect the burned coal will also promote global warming which increases externalities on 403 € per t of coal. As already mentioned, the fact that we mention these external costs only in Ustercký district does not mean they are unique for this district only. These externalities are likely occure because of mining and coal use anywhere but are seldom studied and discussed.

4.3 Coal mining and coal utilization policies

4.3.1 National policy

As already mentioned, one of the most important steps on the national level are the territorial limits of brown coal mining in Northern Bohemia adopted by binding resolution of the Czech government lead by Petr Pithart, No. 444 of 30 October 1991. It defines the lines for which mining in individual North Bohemian mines is not allowed. These limits were with some corrections respected by next governments. In 2008, the government lead by Mirek Topolánek, confirmed the limits by resolution no. 1176/2008, modifying the line of the Bílina mine. Further adjustments were made to the limits at the Bílina mine in 2015 by Government Resolution 827/2015, when the lines were mostly further shifted in favour of future mining. However, in some places, namely near the village of Braňany the mining space was reduced.

Another key document on national level 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 economy and 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 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 26: CZ: Expected development of primary energy sources of the Czech Republic based on SEC, positive value in electricity export import field means import, negative values means export (MPO 2015)

		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	1,854.3	1,852.3	1,825.8	1,771.2	1,756.6	1,796.6	1,746.3

Conception defines the decommissioning of old coal-fired power plants (from 2016 to 2025), commencing operation of new nuclear units and replacing decommissioned units of the Dukovany nuclear power plant with new nuclear units (between 2033 and 2037). The main changes in the balance of electricity production are a gradual decrease in production from lignite power plants and an increase in production from nuclear power plants. It is also planned to reduce the electricity surplus which is now realized as export of electricity.

In terms of coal important are plants in area of electricity and heat production, which are often coupled in the Czech Republic. In the field of electricity generation and supply, it is essential to transform by 2040 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 sector of coal energy, it is important to provide conditions for the reconstruction of existing large condensation coal sources exclusively for high efficiency sources according to best available technical standards. Possible new coal sources should be oriented to high-efficiency or cogeneration production 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 important 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. Major expected sources of renewables are summarized in Table 27.

Table 27: CZ: Expected development of renewables contribution to electricity production in the Czech Republic according State energy conception (SEC 2014)

Energy source		2010	2015	2020	2025	2030	2035	2040
Biomass	GWh	1,492.0	1,878.9	2,331.0	2,540.6	3,243.4	3,946.1	4,648.8
Biogas	GWh	634.6	2,754.0	3,121.2	3,416.0	3,696.0	3,976.0	4,256.0
Biologically degradable communal waste	GWh	35.6	91.2	138.1	310.0	425.2	425.2	425.2
Hydropower	GWh	2,789.5	2,475.6	2,522.7	2,524.5	2,526.2	2,528.0	2,529.7
Wind	GWh	335	647.2	1,013.8	1,328.4	1,598.4	1,945.8	2,291.4
Solar	GWh	615.7	2,275.5	2,403.6	3,567.4	3,567.4	4,725.7	5,883.9
Geothermal	GWh	0.0	0.0	18.4	55.2	69.0	92.0	138.0

Energy source		2010	2015	2020	2025	2030	2035	2040
Renewables total		5,902.4	10,122.4	11,548.8	13,742.1	15,125.6	17,638.8	20,173

In area of heat production SEC (State Energy Conception) expects that domestic coal will continue to form their critical fuel base together with natural gas, renewables, secondary sources and waste. In terms of energy, SEC supports using brown coal for heat supply from cogeneration. Creation of legislative and administrative environment, including economic instruments for the preferential use of this coal is necessary. Favouring efficient sources and penalizing low-efficiency sources condensing electricity production is promoted. Finally, SEC encourages the transition, in particular, of medium and smaller heat supply systems to multi-fuel systems using locally available biomass, natural gas, eventually another fuel where mainly natural gas will fulfil the role of stabilization and supplemental fuel.

In terms of local heating there is an important operational programme “Environment”, which is administered by the Ministry of Environment. In the frame of this programme the ministry supports the replacement of old sources for local heating by new sources fitting to best available technical standard. In the first call of this programme, replacing old heating sources by some advanced coal sources was possible. However, in recently proposed call coal was completely abandoned among subsidized sources. In addition, this support is targeted in the districts concerned.

Another key national policy is National policy on raw materials, government resolution 441/2017 which however basically copy the limits set by mining limits and energy policy mentioned above.

The draft National Energy and Climate Plans (NECP) of the Czech Republic (NECP 2018) was prepared on the basis of the requirement of the Regulation of the European Parliament and the Council on energy union governance and climate action and contains objectives and policies in all five dimensions of the energy union. The key part of the draft national plan consists of setting the Czech Republic's contribution to the so-called European climate and energy objectives of the EU in the area of reducing emissions, increasing the share of renewable energy sources and increasing energy efficiency. The draft national plan is based on two initial strategic documents: The State Energy Policy of the Czech Republic approved in 2015 and the Climate Protection Policy in the Czech Republic approved in 2017. National policy documents respect the above-mentioned regulation. In the area of GHG reduction, the EU-wide target is set at a level of 43% greenhouse gas reduction compared to 2005 in the EU ETS and 30% in the non-EU ETS sectors. The Czech Republic's target is to reduce total greenhouse gas emissions by 30% by 2030 compared to 2005, which corresponds to a reduction of 44 million tonnes of CO_2eq emissions. The draft national plan also contains long-term indicative targets up to 2050, based on the agreed Climate Protection Policy. According to emission projections, the implementation of the policies and measures contained in the National Plan will lead to a 34% reduction in greenhouse gas emissions (compared to 2005). The emission projections have been updated for the preparation of the National Plan Draft and are consistent with the above-mentioned energy outlooks. These projections are prepared on a two-year basis.

Renewable energy sources are also part of the decarbonisation dimension. The EU-wide target of 32% by 2030, expressed as the share of renewables in gross final energy consumption, was agreed here. Furthermore, the recast directive on the promotion of the use of energy from renewable sources contains requirements for sub-targets in the heating and cooling sector and the transport sector. The Czech Republic proposes a contribution to the European target of 20.8% by 2030, an increase of 7.8 percentage points compared to the Czech Republic's national target of 13.0% for 2020. Proposed average annual growth in the share of RES in the sector heating and cooling then corresponds to 0.8%. In the field of transport, the target is set at 14% for all Member States. The main policies for fulfilling the proposed contribution include those enshrined in the draft amendment to Act No. 165/2012 Coll., On Supported Energy Sources, which sets up a new support scheme after 2020. However, this proposal has not yet passed the complete legislative

process. Other policies beyond the scope of the draft amendment will also be important for fulfilling the proposed contribution in the field of renewable resources.

Within the energy efficiency dimension for the period 2021-2030, there are three objectives: (i) an indicative target for the size of primary energy sources, final consumption and energy intensity; (ii) a binding target for energy savings in public sector buildings; (iii) a binding annual rate of final consumption savings. These objectives correspond to Articles 3, 5 and 7 of the Energy Efficiency Directive. The Czech Republic's goal in 2030 is to achieve primary energy sources at the level of 1,727 PJ, final consumption at 990 PJ and energy intensity of GDP at the level of 0.157 MJ / CZK. Based on the assumption of the energy performance of the buildings of the central institutions in 2020, the Czech Republic has set a commitment to achieve energy savings in the inefficient buildings of these institutions in the amount of 124 TJ in accordance with the rules of the Energy Efficiency Directive. In addition, in accordance with Article 7, based on the available EUROSTAT data and consumption forecasts for 2018 and 2019, the cumulative energy savings obligation was set at 462 PJ. The commitment at the level of Articles 5 and 7 is preliminary and will be recalculated on the basis of current data available in 2020. The Czech Republic will continue to use economic measures, including state aid, to meet its energy efficiency targets and commitments; legislative and education and counselling measures.

4.3.2 District and local policy

Most of the problems of future development of target district are described above. In the past mining attracted a large amount of less qualified workers to the district. Social situation and lower quality of environment force the part of more adaptable and more educated portion of citizens the leave the district. This contributes that the target districts have the lowest proportion of university educated people in population in the Czech Republic. Moreover, the fact that most of the people come here after WWII caused that there is very few people which would have family roots in the district. The latter was caused not only by mining, but also complex development of the district before and after WWII. Reduction of mining during the last decade of previous century largely increased the unemployment rate. Moreover, the most affected were people with lower education and less socially adaptable people. This resulted in formation of socially excluded locations, increase of criminality and other unfavourable social effects, which make district even less attractive for developers and people starting new businesses. This was enhanced by infrastructure, which was generally outdated by the end of the last century and specialized on the needs of mining industry. Mining companies were able to build its own infrastructure if needed. All this creates very complex conditions for future development.

There have been several targeted attempts at district level to improve the situation, some of them coming from national level. Based on government decision No 952 from 11th December of 2013 a government commissioner for coal district in transition namely for Moravskoslezký and Ústecký district was established. Later on from 1st November of 2015 the jurisdiction of commissioner was enlarged and included also Karlovarský district. Priority topics of the government commissioner were the following: employment and entrepreneurship, technical education, science, research and innovation, energy and environment, building infrastructure. The Ústí, Moravskoslezský and Karlovy Vary Districts, through the Office of the Government, applied for financial and systemic support for specific measures that will help to restart the economy of these districts. The Office of the Government Plenipotentiary proposed the creation of an Economic Restructuring Strategy in which the government and the district would work together. By its Resolution No. 826 of 19 October 2015, the Government decided on the economic restructuring of the Ústí, Moravskoslezský and Karlovy Vary Districts. The government has indicated that it is aware of the problems in these structurally affected areas and has committed itself to halting their backwardness and to starting their prosperity. The Ministry for District Development commissioned an input analysis which assessed in detail the current situation, the most serious problems and the development potential of the districts concerned. This important document was based not only

on extensive macroeconomic analysis, but also on collection of impulses and experience, which took place directly in individual districts (Re:Start 2019).

Based on the input analysis, a **strategic framework** (Action plan 2019) was created. This important document did not contain a proposal for concrete measures but identified their basic principles common to all districts. The Strategic Framework expresses the government's long-term strategy to support, facilitate and accelerate the restructuring of the economy in structurally affected districts. According to this, the districts concerned, in cooperation with government, take action in all key areas. The strategic framework is structured into several levels. At the highest level, they are divided into thematic pillars, which include desirable changes in individual thematic areas. Each thematic pillar has several strategic objectives. The strategic objectives are designed in such a way that their fulfilment will lead to the realization of the key changes described both in the individual thematic pillars and for each strategic objective separately. For each strategic objective, several types of measures/activities are proposed that describe in more detail the possible interventions through which changes can be made and the strategic objectives can be achieved. Typical measures/activities are mainly illustrative in nature and are intended to show that there are tools to achieve the proposed changes. In the introductory part of each pillar of the Strategic Framework for Economic Restructuring, the content of the thematic pillar is briefly presented. The Strategic Framework also describes and explains the concept of implementation mechanisms and rules, the institutional framework of implementation and also deals with the principles for future financing of the implementation of the Economic Restructuring Strategy, respecting measures in the action plan.

Strategy is approaching this issue in a very complex way and points out all-major issues, which can be separated in the following major categories: enterprise and innovation, direct foreign investment, research and development, human resources, environment, social stabilization and infrastructure and public administration.

Enterprise and innovation. The basis for economic restructuring is successful business or enterprises in the district, when enterprises grow, employ people, invest, generate and realize profit, they at the same time form basic condition for improving the quality of life in districts. Target districts are more dependent on one large traditional (mining) companies. That is why the uncertain future of large traditional enterprises has a negative impact on the whole economy. In addition, the target district has the lowest intensity of entrepreneurial activity and low dynamics of start-ups of new enterprises of all districts in the Czech Republic. This strengthens the trend of leaving younger, more educated people. In addition, remote, areas of a rural nature still exist in the target district, which are among the least developed. During the preparation of the smart specialization strategy, the target districts identified key sectors that represent a balanced mix between traditional industries (energy, metallurgy, engineering) and new ones (information technology, biotechnology, renewable energy use, reclamation), existing farm structure and change it completely.

Direct foreign investment is another topic that may help to increase economic growth or target district substantially, however the creation of suitable environment for investment is connected to offering suitable spaces, infrastructure and stable economic environment.

Research and development. Major target here is to support research with direct effect on enterprises, promotion of partnership among research and development companies with business, but also supporting academic start-ups.

Human resources. Human resources are key to successful development of the district. They were negatively affected in the past as described above which generate self-enhancing interactions between low economy growth, low salaries and low offer of highly qualified jobs, low quality of work force. Solution closely corresponds with research and development enterprises and foreign investment.

Environment. Investments in the revitalization and regeneration of territories and settlements alone will not contribute to the restructuring of the economy, but they are a precondition for carrying out activities supporting the development and growth of enterprises (brownfields regeneration, business premises), foreign investments (brownfields, industrial zones and lands) human resources development, social stabilization and research and development. It is important to reconstruct unused areas and territories for the purpose of implementing significant investment activities with higher added value in connection with services for investors and entrepreneurs. The following points are important: (1) revitalize and regenerate areas in districts heavily affected by mining and industrial activities, in particular with a view to enabling new activities to be located and given new functions and (2) regenerate development in deprived or peripheral areas in settlements with a high population concentration in order to achieve substantial complex changes with a significant impact on the life of the whole city, which will also manifest themselves in improving the image of districts externally; it will have an impact on stabilizing the population and improving the social stability of the territory. As was mentioned above, environment was one of the factors that enhance migration of people out for target district.

Social stabilization. Social instability is one of the factors resulting from the slow economic development of target districts and is a factor that complicates this development. On average, the lower quality of human resources and the greater number of socially disadvantaged and excluded people limit the development of local businesses, create local social problems and negatively affect the image of districts. The human dimension of social stabilization is aimed at motivating the population in the districts concerned to increase their own activities. In this context, three different groups must be supported in somewhat different ways: (1) to encourage naturally active citizens who are already contributing to the development of districts and who will be permanent leaders and natural authority for the rest of the population and will contribute to the transformation of districts; (2) increase the motivation of passive individuals, who have a relatively high development potential and can form a critical mass of long-term active residents in the district.

Infrastructure and public administration. Investing in infrastructure and quality of public administration creates the conditions for more efficient or successful interventions in other areas. These investments alone will not lead to the restructuring of the economy; however, they are important supportive measures for investment in other areas, especially business and foreign investment, such as key transport infrastructure connections or offering efficient public administration services.

The basic and interconnecting element of all the above-mentioned pillars to change the structure of the economy, accelerate economic growth and stop districts lagging behind is the implementation pillar including multi-level cooperation of public administration, use of existing programs and financial resources, supplemented, if necessary, by new ones, professional implementation management and responsibility for results. All pillars should lead to strengthening the identity, belonging and increasing the self-confidence of local people, improving the image of the district among investors, tourists, talents.

All the above mentioned principles serve as the base for project RE:START (Re:Start 2019). The RE:START program is an open and publicly discussed process of restructuring the three districts concerned with the involvement of hundreds of actors. It is managed at government level and is subject to regular evaluation and updating flexibly responding to socio-economic developments in the districts concerned. As a result, governments and districts 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 district 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 system 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 Districts 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 was transferred to the Ministry for District Development, within which the National Executive Team RE: START was established. At the same time, in accordance with the principle of subsidiarity, the involvement of individual districts was strengthened through the District Permanent Conferences. The aim of the new implementation structure is to maintain a centrally coordinated approach, but to maximize the absorption capacity in the territory and strengthen the individual approach to individual districts. These new implementation policies have been valid for the following years of RE: START since their approval.

Since 2017, the Strategy of Economic Restructuring of MSK, ÚK and KVK (RE: START) has been implemented through a set of concrete measures, which are approved annually by the Government of the Czech Republic in a document entitled Comprehensive Action Plan for Economic Restructuring (hereinafter the Action Plan). Each of the Action Plans is the result of district and government consensus. The implementation of the RE: START program is also continually evaluated by the districts and the government and specified and supplemented in individual Action Plans. Three Action Plans were gradually adopted by the government. They contain both systemic and financial measures. Financial measures are implemented in the form of subsidy titles and are paid from the state budget or through ESIF. In terms of district focus, there are differentiated supra-district measures (common to all three districts concerned) and specific ones (covering only one of the districts).

The first Action Plan contained 65 measures with anticipated implementation by 2030 of approximately CZK 62 billion: 54 supra-district, 9 district-specific for the Ústí and Karlovy Vary districts and 2 district-specific for the Moravian-Silesian district.

The second Action Plan contained 27 measures with anticipated implementation by 2030 in the amount of CZK 20 billion: 21 supra-district, 5 district-specific for the Ústí and Karlovy Vary districts and 1 district-specific for the Moravian-Silesian district.

The third updated Action Plan (MMR 2016) is approved based on the principles defined by the Strategic Framework for Economic Restructuring of the Ústí, Moravian-Silesian and Karlovy Vary Districts. It is a set of concrete measures that the government requires the relevant ministers to implement. Measures are in the form of financial support or systemic changes. Funds are allocated through individual grant programs/ministries/managing bodies of operational programs. The proposed measures will be implemented in the years 2019 - 2030.

Several previous actions have already been revised under the Third Action Plan. A further 24 measures were met during 2017-2019. Now RE: START has a total of 71 active measures that need to be moved to the next phase of implementation. So far (as of July 30, 2019), programs worth approximately CZK 16 billion have been made available, of which approximately CZK 3.8 billion have been released into the districts (83% EU, 17% national finance) - NUTS II Northwest - EUR 60,158,760.

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5 Germany, Lusatian Lignite District/Economic Region Lusatia

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5.1 Description of the region

5.1.1 Region overview

Location & area

The TRACER target region *Lusatian Lignite District* is congruent with *Economic Region Lusatia* representing the NUTS-2 territorial units Brandenburg (DE40) and Dresden (DED2). It lies in North-East Germany and covers 11,582 km^2 ground surface within the borders of the Federal States of Brandenburg and Saxony (Figure 8).

Neighbouring federal states are Saxony-Anhalt in the west and the capitol city *Berlin* in the northwest. In the south Lusatia borders to the Saxonian counties *Meißen* and *Sächsische Schweiz* and the district-free city *Dresden*. The eastern boundary to the Polish voivodeship *Lower Silesia* and *Lubsz Republic* is marked by the river *Neiße*. At its southeast edge there is a small border to the Czech Republic, the so-called border triangle at *Zittau* close to *Görlitz*.

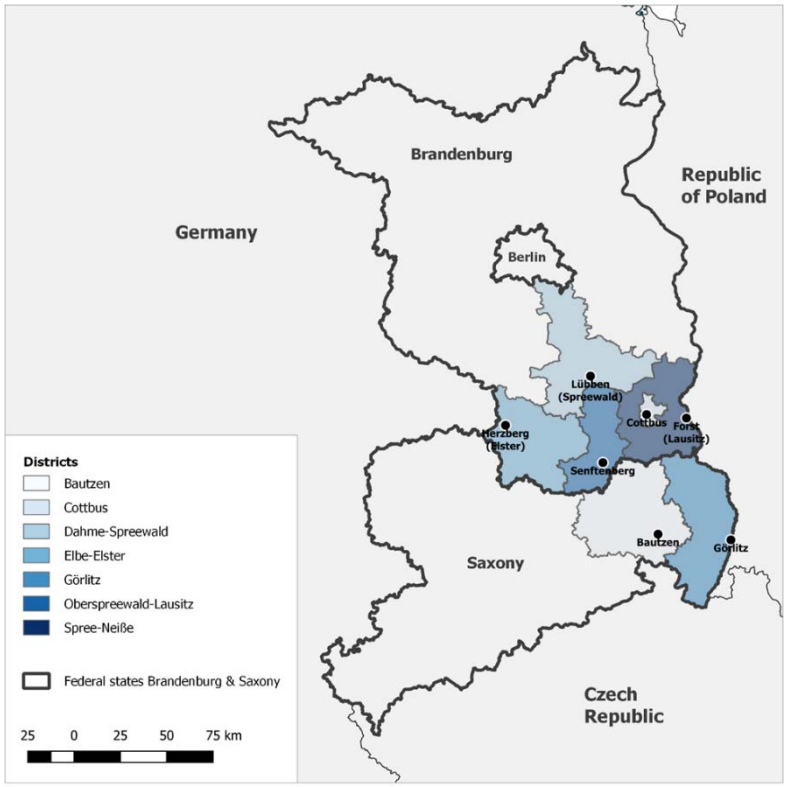

Figure 8: DE: Administrative structure of the *Economic Region Lusatia* within the Federal States of Brandenburg and Saxony - regional counties with the municipal city *Cottbus*

Administrative and institutional structure

There are 6 NUTS-3 regions, all self-administrated: the independent town and medium centre *Cottbus* (DE402) and the more rural and small-town counties/districts *Elbe-Elster* (DE407), *Lausitz Dahme-Spreewald* (DE406), *Elbe-Elster* (DE407), *Oberspreewald-Lausitz* (DE40B), *Spree-Neiße* (DE40G), *Bautzen* (DED2C) and *Görlitz* (DED2D).

In total, the region includes 235 communities, from which nearly half of them relates to the more densely populated Saxonian Upper Lusatian counties *Bautzen* and *Görlitz* in the southeast close to the metropolitan area *Dresden*. Alone the district towns *Bautzen* and *Görlitz* count 39,429 plus 56,391 inhabitants (Table 28 and Table 29)

Table 28: DE: Area, political structure and local self-government of the *Economic Region Lusatia* as defined by the federal *Braunkohle-Strukturkommission/Commission for Growth, Structural Change and Employment* (WSB) set up in 2018 (Part I)

County	Elbe-Elster DE407	Dahme-Spreewald DE406	Oberspreewald-Lausitz DE40B	Spree-Neiße DE40G
Federal state	Brandenburg	Brandenburg	Brandenburg	Brandenburg
Sub region	Lower Lusatia	Lower Lusatia	Lower Lusatia	Lower Lusatia
Surface area (km^2)	1,900	2,274	1,223	1,657
Population	103,455	167,319	111,122	115,456
Inhabitants/km^2	54	74	91	70
Municipalities (in total)	33	37	25	29
Cities	11	5	7	5
Municipalities/100 km^2	1.74	1.63	2.04	1.75

All data as at December 31, 2017, data source: Wikipedia

Table 29: DE: Area, political structure and local self-government of the *Economic Region Lusatia* as defined by the federal *Braunkohle-Strukturkommission/Commission for Growth, Structural Change and Employment* (WSB) set up in 2018 (Part II)

County	City Cottbus DE402	Bautzen DED2C	Görlitz DED2D	Germany
Federal state	Brandenburg	Saxony	Saxony	16 Federal states
Sub region	Lower Lusatia	Upper Lusatia	Upper Lusatia	-
Surface area (km^2)	165	2,396	2,111	357,386
Population	101,036	302,634	256,587	82,790,000
Inhabitants/km^2	612	126	122	231
Municipalities (in total)	19 city districts	57	53	11,014
Cities	1	15	14	2,056
Municipalities/100 km^2	-	2.38	2.51	3.08

All data as at December 31, 2017, data source: Wikipedia

Demographics

The population of the region amounts to 1,162,703 inhabitants in 2017 which are about 100 people per square kilometre. However, the population distribution is uneven: whereas the both Upper Lusatian counties in Saxony *Bautzen* and *Görlitz* have about 120 inhabitants/km^2, there are only 54 to 91 in the more provincial areas in Lower Lusatia like *Elbe-Elster* or *Oberspreewald-Lausitz* situated between the metropolitan areas *Berlin* (3.72 million inhabitants) and *Dresden* (595,000 inhabitants) - with an exception of the independent town Cottbus, just

above the 100,000 residents threshold for the category of *large cities* in Germany (Table 28 and Table 29). This means that only 9% of the inhabitants are living in a big city, whereas in Germany about one third of the total population.

Overall, Lusatia shows an ageing population as compared with other regions in Germany - the emigration of well-educated young professionals, especially women is a serious problem for economic development. The mean age is about 50 years, while the national average counts 44 years. On the other side, life expectancy for newborns is high in the international comparison, for example, it varies in the Federal States Brandenburg and Saxony between 77 years (men) and 83 years (women).

Having a closer look at Germany as a whole, there is a remarkable north-south gradient of 1.8 years (women) and 3.2 years (men) with Baden-Württemberg having the highest life expectancy. Saxony and Brandenburg are in the last third of all Federal States taking rank 10 and 11 (STATISTISCHE ÄMTER DES BUNDES UND DER LÄNDER 2019).

Landscape - natural physiographic

The landscape zone is part of the *Northeast German Lowlands* in transition to the *Saxonian Hill and Mountainous Country* (Table 30) about 100 kilometres southeast of *Berlin* close to state border to the Republic of Poland. It was mainly formed during the *Lusatia*n/*Saale glacial period*. Quaternary glacial and fluvial sands, dune sands, gravel and loam are covering the lignite bearing *Miocene* loose rocks in a thickness of 10 to 150 metres. With exception to foothills of the *Saxonian Hill and Mountainous Country* with its prevailing granite and sandstone soils in the southeast, the region shows the typical landscape forming elements of the glacial period: ground and terminal (end) moraines, sand dunes, drifts and basins.

Table 30: DE: A brief landscape characterisation: Geomorphology - soil cover & forest vegetation

Main landscape / Natural region	- in general 55 to 200 m a.s.l. (Lower Lusatia), up to 792 m a.s.l. in the Saxonian Mountainous Country close to the Czech border (upper Lusatia) - in transition of the Northeast German Lowland and Saxonian Hill and Mountainous Country in the south, the core heart of the Lusatian Lignite District (Lower Lusatia) is located between the rivers *Schwarze Elster*, *Spree* and *Neiße* - landscape-formative (predominant): sediments of the *Lusatian/Saale glacial period*: *Saale II* and *Saale III* (304,000 to 127,000 yr AC), subordinated loose rocks of the *Weichselian ice age* (115,000 to 9,700 yr AC) - covering lignite and pyrite bearing marine-brackish Tertiary strata of the *Upper* and *Middle Miocene* (23 to 2.580 mio. yr ago)
Site conditions	- in general, Quaternary glacial and fluvial sands, dune sands, gravel and loam with a low to medium yield potential, soil value 20-50 points with 100 points maximum soil level in Germany - forming sandy brown earths, sandy podzols, hydromorphic soils
Potential natural vegetation	- Scots pine-sessile/common oak forests - pure, mono-structured Scots pine plantations with common birch - mixed oak-lime-beech forests with other valuable broadleaved trees - alder-ash swamp forests - some mountain mixed woodlands with beech, valuable hardwoods, spruce and larch in the southern parts

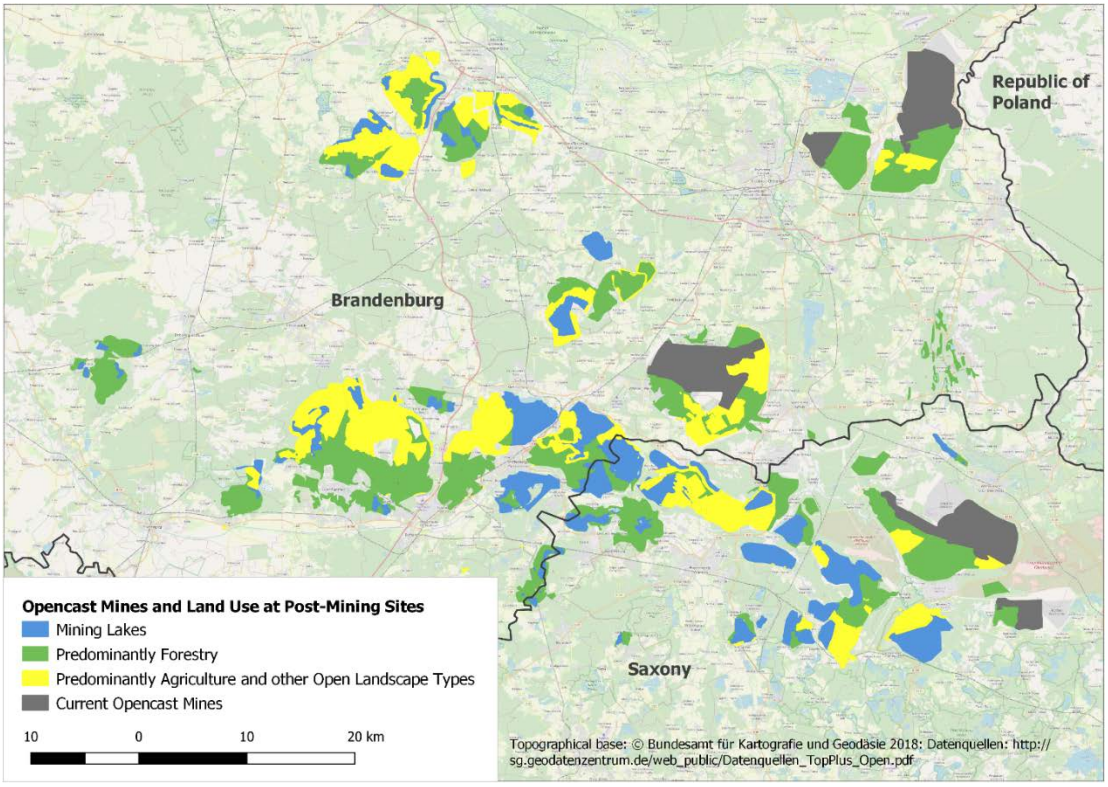

Figure 9: DE: Physiographic situation of the region, therein the opencast mines in operation and post-mining landscape

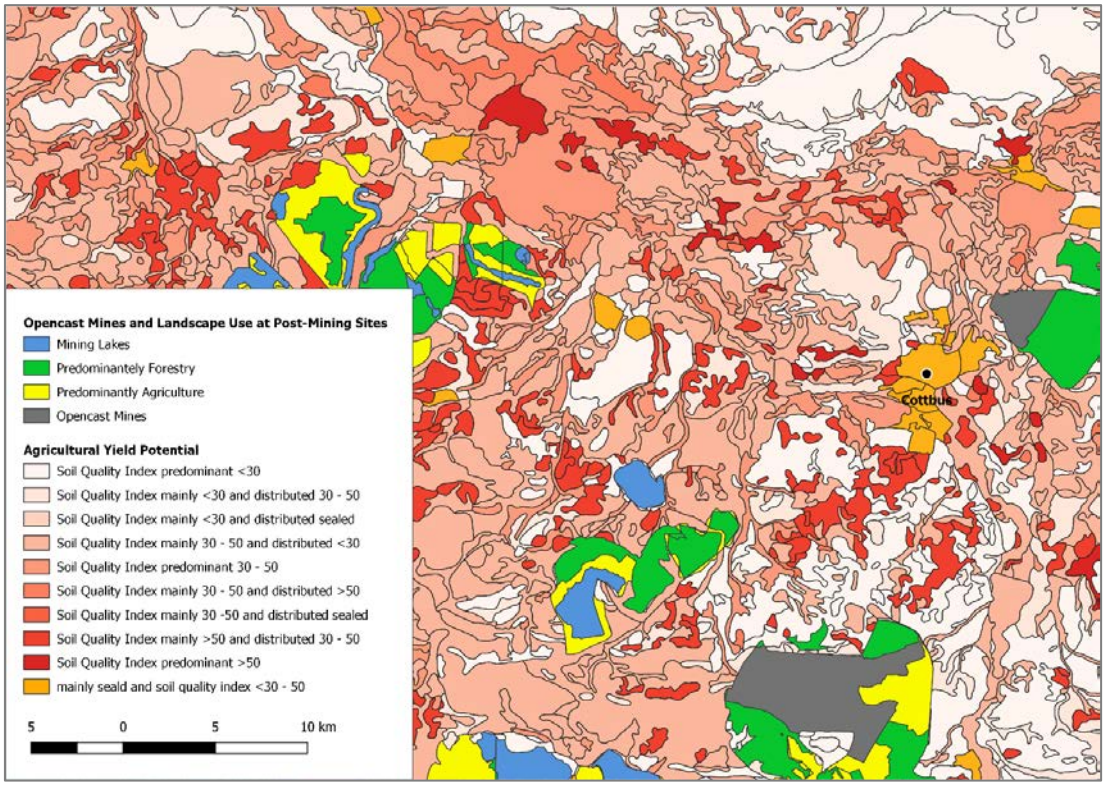

Figure 10: DE: Agricultural yielding potential (German Soil-Quality rating Index/Bodenwertzahl), data source: LANDESAMT FÜR BERGBAU, GEOLOGIE UND ROHSTOFFE BRANDENBURG (2019)

5.1.2 Social situation

Below the line, Lusatia is a quite heterogeneous political construction - historically seen quite fragile. That's why the region - spreading out over 250 kilometres from *Berlin* in the north to Czech border and about 140 kilometres from west to east - is not showing a real regional identity and solidarity. Looking at the economic impact of mining and generation there is a focus around the mining pits and power generation plants located in the counties *Spree-Neiße*, *Oberspreewald Lausitz* and *Bautzen* (ZUNDEL 2019). But the social consequences of the decided coal phase-out in 2038 are affecting the whole target region because the residential areas of the workers are distributed all over the Lusatian region.

Considering the painful experiences of the hard structural break in the 1990s and the obvious income and economic gap between Eastern and Western Germany (respectively the urban agglomerations in the south-west), there is a widespread sense that the political elites do not understand the problems of the people, and even more are looking down on them. In essence, this opinion is based on the experience of large-scale unemployment in the course of the German reunification when more than two thirds of all employed persons have lost their former job.

Especially the strong decline of the working force in mining and generation has left marks - also in the self-esteem of people: many professionals feel that their life's work is not adequately appreciated by politicians and other decision-makers. The diffuse atmosphere and noticeable dissatisfaction with the current living conditions are reflected by the electoral successes of anti-democratic and nationalist, anti-European, populist parties in the region. They received up to 33% of the votes on county level at the European election in 2019 (German average: 11%).

At the moment, Lusatia is one of the fastest shrinking regions in Germany since the reunification in 1990. Whereas the population in 1995 was 1,432,730 million people, there are 1,157,609 inhabitants in December 2017 (-19.2%). In the same period the population group of 15 to 65-year-old people relevant to the labour market decreased by 255,945 persons (-26.1%) (SEIBERT et al. 2018).

Between 1995 and 2017 some sub regions have lost more than 25% of the population. But this is not only a result of the political change in 1989/1990. RÖSEL (2019) emphases, that a different development of the population between the western part and the eastern part of Germany already started at the founding of the *German Democratic Republic* (GDR) in 1949. This trend still increased in the two decades after 1990.

Data from STATISTISCHES BUNDESAMT (2019) in Figure 11 furthermore show, that while rural regions in Brandenburg and Saxony (e.g. the districts *Elbe-Elster*, *Oberspreewald-Lausitz*, *Spree-Neiße*) have lost inhabitants their number in the district *Dahme-Spree*, in the neighbourhood of the capital city *Berlin* increased for more than 15% from 1995-2017.

The situation is alarming because the negative demographic trend has not stopped yet; there remains a negative migration balance and considerable birth deficit: all long-term forecasts are predicting a further decline of potential employees in the region, up to 200,000 to the year 2030 (-17%). The skills shortage (academic and non-academic, technical/commercial) is one of the most serious barriers for regional economic development, already today many training places remain vacant and dropout rates higher than 50% are not unusual. In the worst-case scenario, the labour force will decline by further 30% while the average age increases from 48 to over 53 years - the *brain drain*: an ageing society losing their creative minds (MARKWARDT & ZUNDEL 2017).

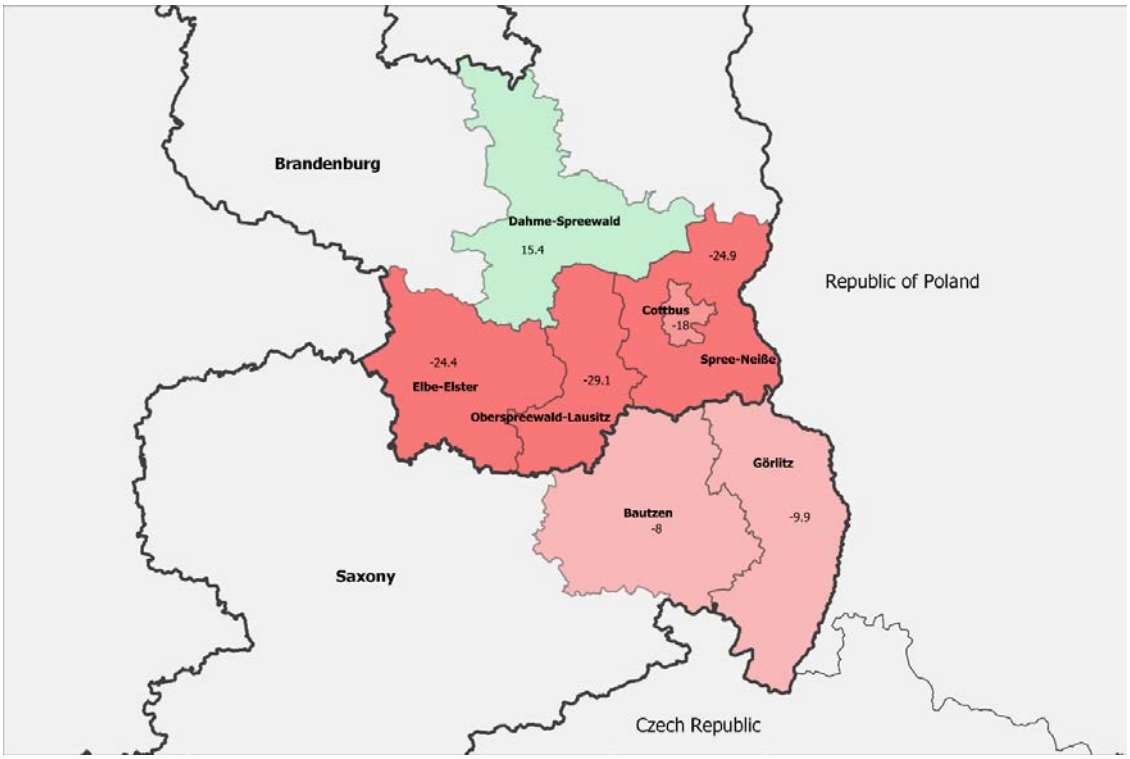

Figure 11: DE: Demographic development in the region between 1995 and 2017 (in % decline of inhabitants, *Bautzen* and *Görlitz* between 2008-2017

Data source: STATISTISCHE ÄMTER DES BUNDES UND DER LÄNDER (2019)

5.1.3 Economic development

Overall, Lusatia is an economically weak region as compared to the German average (Table 31). Actually, the GDP per employed person is about 53,003 EUR (2016) whereas in the national average 72,048 EUR (2016) (STATISTISCHE ÄMTER DES BUNDES UND DER LÄNDER 2019). That indicates a productivity gap of 26% which is comparable to the situation in the year 2000 with 53,022 EUR versus 38,553 EUR.

Table 31: DE: Socio-economic baseline situation (2017/2018)

Category	Economic region Lusatia	Germany
Population	1,162,703	81,198,000
GDP per capita	26,307 EUR	36,211 EUR
Share of production industry on the gross value added	30%	26%
Employees	413,666	44,716,583
Unemployment rate	10.1 % (20.0% in 2004)	3.4%

Data source: PROGNOS AG (2017), WEHNERT et al. (2018), STATISTISCHE ÄMTER DES BUNDES UND DER LÄNDER (2019)

However, the economic area of Lusatia is a huge area and shows a considerable structural and economic differentiation on the sub regional (county) level (SEIBERT et al. 2018). The productive and economically above average performing sub regions *Dahme-Spreewald* and *Görlitz* are linked to the metropolitan area *Berlin* and the surroundings of *Dresden*. In light of these heterogeneous trends within the region, there is missing a joint regional economic development strategy beyond the federal state boundaries and administrative bodies. In contrast, the both involved federal states Brandenburg and Saxony are still having a clear focus on strengthening the developing

metropolitan areas (so-called *lighthouse policy*). The more peripheral regions in between lose out - they don't get as much public subsidies at the moment (ZUNDEL 2019).

Infrastructure

An overview about the most important traffic routes in Lusatia is given in Figure 12. Even the railway station in the medium centre *Cottbus* has no ICE link, which makes connections out of the region difficult. In *Cottbus* there is just once per day an IC train leaving to the Polish *Wroclaw*. The next freight centres are located in *Frankfurt (Oder)*, *Berlin* and *Dresden*, which offer a good connection for freight traffic in the Lower Lusatia and in the county of *Bautzen* (KLUGE et al. 2014). The big gaps of the infrastructure in this rural and peripheral area are causing long travel distances to important transport links and main centres within Lusatia (Table 32). The development of the digital infrastructure, indicated by households with an Internet connection with at least 50 Mbit/s, is in Lusatia (except *Cottbus*) below-average (Table 33).

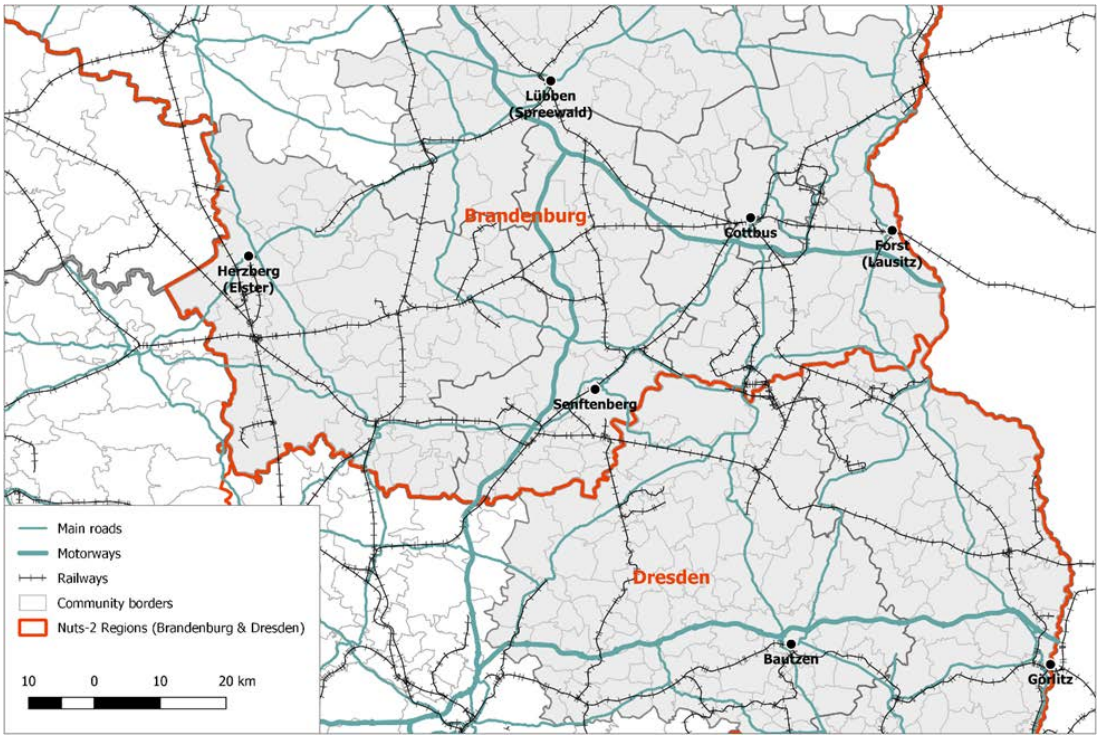

Figure 12: DE: Overview of the *Lusatian Lignite District* infrastructure - communities and traffic routes

Table 32: DE: Transport links within Lusatia

	travel time (in min.) with a car to the next:			
County	**slip road**	**airport**	**ICE/IC train station**	**main centre of the region**
Elbe-Elster DE407	37	66	44	72
Oberspreewald- Lausitz DE40B	8	43	27	34
Spree-Neiße DE40G	19	78	26	25
City Cottbus DE402	10	68	01)	0
Dahme-Spreewald DE406	16	40	24	44
Bautzen DED2C	17	40	43	18
Görlitz DED2D	24	68	62	31
Eastern Germany including Berlin	21	-	-	-
Western Germany	16	-	-	-

1) There is once a day an IC (no ICE) going from this station. Otherwise travel times to train stations with ICE/IC connection would be much more. Data source: modified after GREIB et al. (2019)

Table 33: DE: Percentage of households with an Internet connection with at least 50 Mbit/s

County	**Share of internet connection with at least 50 Mbit/s (%)**
Elbe-Elster DE407	26
Oberspreewald- Lausitz DE40B	67
Spree-Neiße DE40G	49
City Cottbus DE402	95
Dahme-Spreewald DE406	62
Bautzen DED2C	41
Görlitz DED2D	47
Germany	75

Data source: modified after GREIB et al. (2019)

5.1.4 Environmental situation

Land use

As quite typical for the Northeast German Lowlands the *Lusatian Lignite District* (core region) is a rural cultivated landscape. On mostly sandy, rather low-yielding soils the forest land use is dominant, with 80% of the woodland stocked with little structured Scots pine pure stands, in most cases in private ownership. Facing climate change impact, the boreal pine turns out to be quite heat sensitive - although it is very undemanding with respect to nutrients and draft tolerant. However, and below the line, non-natural pure stands show a high vulnerability to insect pests and infestation by secondary parasites. The main silvicultural objective - ecological but also economically justified - is *forest restructuring*, which describes the stepwise transformation of instable forests into self-sustaining and self-regenerating mixed hardwood forests - close to the potential natural vegetation forms of the region (Table 34).

Table 34: DE: A short characterisation of the land use

Potential natural vegetation	- Scots pine-sessile/common oak forests - pure, mono-structured Scots pine plantations with common birch - mixed oak-lime-beech forests with other valuable broadleaved trees - alder-ash swamp forests
Land use distribution	- before mining: 59% forestry, 31% agriculture, 9% settlements & infrastructure, 1% waters - post-mining landscape (reclaimed land): 55% forestry, 18% agriculture, 14% waters (residual lakes), 13% others, in particular nature reserves
Site conditions	- *Quaternary* glacial and fluvial sands and loamy arable lands with a moderate yield potential, less than 20% of the arable land are of better quality sandy loam and sandy loess soils - sandy-loamy brown earths (*Dystric Cambisols*) and sandy podzols, hydromorphic soils
Forestry	actually, 80% of the woodland is stocked with Scots pine, naturally it covers less than 40%
Agriculture	- arable cropping, dry-land farming for catering production and conventional feedstock - forage cropping - pasture farming

One third of the Lusatian landscape relates to agriculture, in most cases managed as arable land in large, highly mechanised enterprises with up to 2,000 ha farmland and more under cultivation. Approximately 75% of the cultivated farmland is leased. Crop production is wide-ranging and depends on the site conditions, first of all the plant available water storage capacity of the mainly light soils.

The main agricultural crops grown in the region are rye, maize, wheat, barley, winter oilseed, rape and triticale. In addition, sweet lupines, oat, sunflowers, peas, potatoes and sugar beets are cultivated in a smaller proportion (Figure 13). Several farms produce fruits and vegetables like asparagus, cucumbers and strawberries. They usually use irrigation and foil covers to ensure the plant yield and optimise their economic income. Several hundred hectares of short rotation coppices, mainly with hybrid poplar, are used for bioenergy production (heat and electricity).

Typical crop rotations include rye and maize, sometimes combined by *Sorghum*, wheat, winter oilseed rape and barley mark the agricultural system at more productive site conditions.

Several farmers use overhead irrigation with drums and enter pivots to ensure the water supply of their arable crops in periods of drought. Irrigated crops are mainly potatoes, cereals, maize and sugar beets.

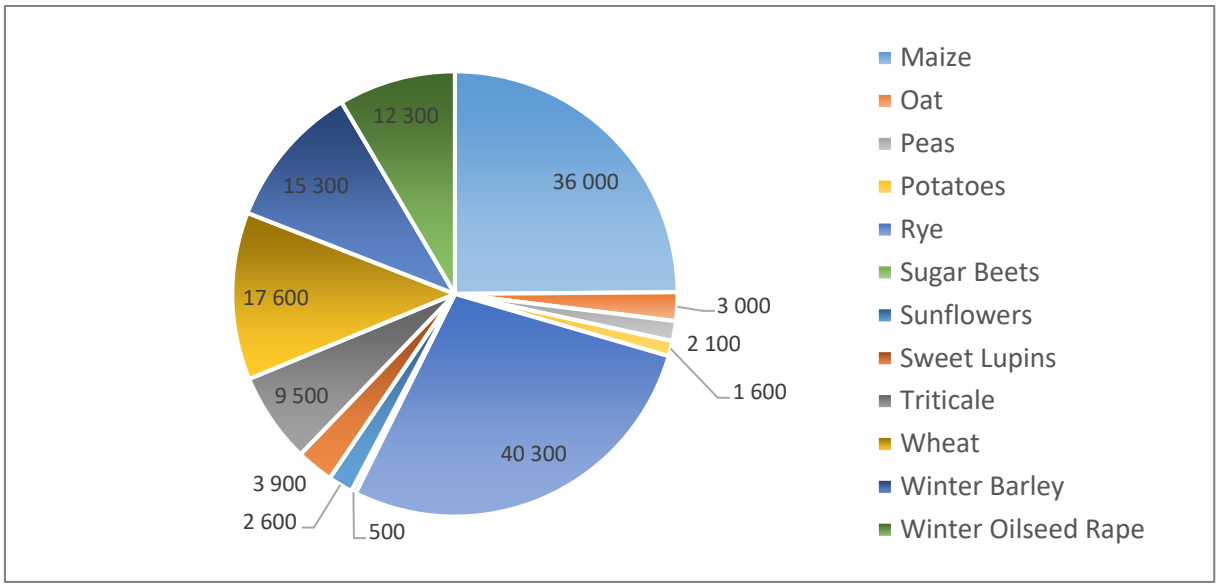

Figure 13: DE: Sum of the area (ha) of the typically grown crops within the districts *Dahme-Spreewald*, *Elbe-Elster*, *Oberspreewald-Lausitz* and *Spree-Neiße* of Brandenburg, data from 2014, 2016 and 2017

AMT FÜR STATISTIK BERLIN-BRANDENBURG 2015, 2017 and 2018

Regional climate

The Lusatian mining core area has a moderate temperate, summer dry continental minted climate (Table 35). Annual mean temperature is between 8.0 to 9.0°C, the rainfall about 550-650 mm in the long-term average, with 50% in the vegetation period from April to September (KOPP & SCHWANECKE 1994). The climatic water balance in the summer half-year is strongly negative: -150 to 250 mm (Figure 14). Thus, water availability becomes the limiting resource for cropping, especially on sorption-poor and groundwater unaffected soils of the plateaus. In other words: on 90% of the agricultural land there is an average water requirement in the vegetation period of about 4 mm per day while precipitation supplies only 2 mm. Even a single water deficiency event in early summer leads to a serious decline in vitality, yield depression and final quality loss of the harvest products. Dry summers, like 2003, 2006, 2015, 2018 and 2019 cause a yield reduction of 30 to 40% compared to the long-time average.

Table 35: DE: Quick data and facts to the regional climate of the *Lusatian Lignite District* (core region, Lower Lusatia)

Regional climate normal period (1971-2000)	- sub-continental temperate lowland climate, summer-dry - mean annual temperature: 8.0 to 8.5 °C - average precipitation: 550 to 650 mm yr^{-1}, with half of rainfall in the vegetation period from April to September - climatic water balance during the growth period < -150 to -250 mm

The target region is one of the most climate sensitive regions in Germany, with amplified responses to climate change impact (LINKE et al. 2010). Already compared to the 1960s there is a significant increase of the annual average temperature by 1° C. Across all regionalised climate scenarios showing the prognostic uncertainties (*Wettreg*, *Cosmo-CLM*, *Remo*) the annual average temperature will increase by 2.0 to 3.0 degrees Celsius by the end of this century, compared to climate normal period 1971-2000 (KNOCHE et al. 2012).

In addition, the growth-limiting water availability in the vegetation season will further decrease and in the worst-case scenario the already low annual rainfall will fall by one third in a normal year. Long rainless and hot early summer periods occur more frequently and intensive calling for modifications in the cultivation planning and management. 2018 was the driest period since

weather records began, with only 380 mm precipitation at some climate stations leading to yield depressions in agriculture up to 30 to 40% depending on the site conditions, established cropping system and cultivated plants.

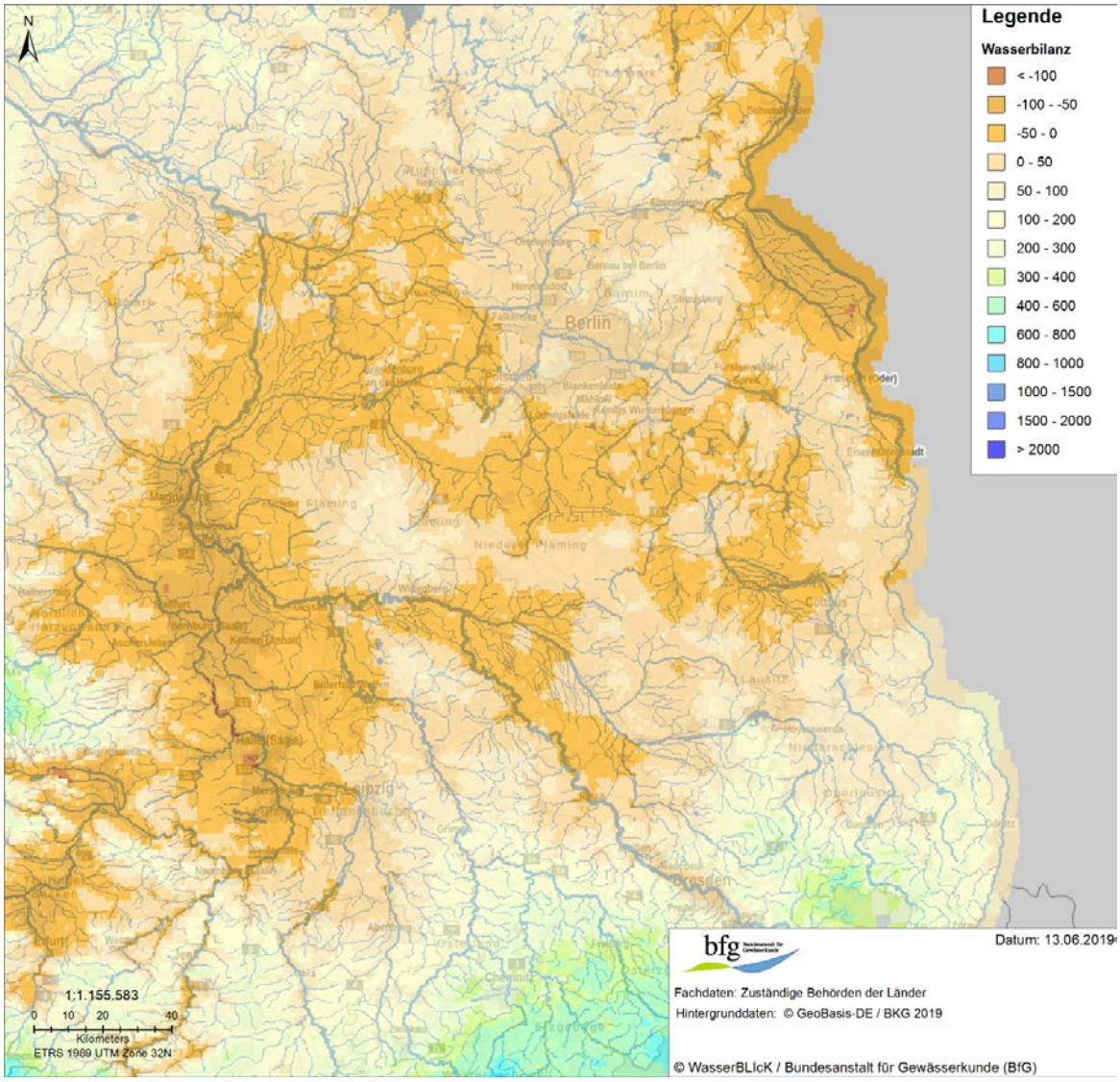

Figure 14: DE: Climatic water balance (mm per year)

Data source: BUNDESANSTALT FÜR GEWÄSSERKUNDE (2019)

Mining impact

Germany is still and by far the leading lignite producer worldwide - and on the other side claiming a lead role in renewables and climate protection. From its 170 million tons mined in 2017, one third falls upon the *Lusatian Lignite District* (DEBRIV 2019). Despite far-reaching structural changes, coal energy industry remains the economic lifeline of the region. Starting with the industrialisation of lignite mining in the late 19th century, large-scale and deep opencast pits have turned the Lusatian landscape in part upside down, from a pre-industrial rural area in a large-scale technogenic living space.

Actually, the removed surface by mining comprises 900 km^2 which takes half of the nationwide area claimed by lignite mining. Up to now 550 km^2 are restored and released from mining supervision. Thereby, the *Lusatian Lignite District* turns out the largest artificial landscape in

Europe. And still there are 32,000 hectares under management of the mining companies LEAG (active mining) and LMBV (rehabilitation of former state-owned mining areas), with 6,800 ha fresh dumped raw soils currently under early reclamation.

5.2 Role of coal mining in the region

5.2.1 Coal sector in the region

Since hardly 150 years' large-scale industrial coal mining with the related energy-intensive industry is an important economic pillar of the region. It has always been a crucial point and driving force for the prosperity and development of the region. In the former GDR lignite emerged to the major energy source of the country. In 1989 there were 15 state-owned opencast mines in operation with a production of 188 million tons. After the German reunification there was a radical structural adjustment of the energy and coal processing industry. Due to lack of competitiveness under market conditions and because of obvious ecological risks most mines and over 60 processing briquette factories were closed within a few years. Between 1990 and 2000 the number of direct jobs in coal mining (without generation) decreased from 80,000 to 8,000 - indeed, a hard structural break in a short time and long lasting economic decline with manifold long-term social consequences, even for the near and far future (MARKWARDT & ZUNDEL 2017, WEHNERT et al. 2018).

Actually, there are 4 lignite mines left (*Jänschwalde*, *Nochten*, *Welzow-Süd* and *Reichwalde*) with a stable annual coal production of about 60 million tons up to now (60.7 million tons in 2018, LEAG 2019, which is one third of the German lignite extracted. About 94% of the lignite are used for electricity generation in 3 large-scale lignite power plants close to the operating mines: *Jänschwalde* (Block A-F: 2,790 MW), *Schwarze Pumpe* (Block A+B: 1,500 MW), *Boxberg* (Block N, P, Q, R: 2,427 MW). In addition, there is a cogeneration plant situated in the city *Cottbus* fired with pulverised coal (74 MW). That means: every 10th kWh electricity generated in Germany at the moment comes from Lusatian power plants (LEAG 2019) - an important contribution to the national energy security. Finally, there are also 3.7 million tons of lignite processed each year to pulverised lignite, briquettes and fluidised-bed lignite (Table 36).

However, the EU climate and clean energy policy and decided coal-phase out in Germany for the year 2038 are already affecting the lignite mine planning and calling for a reorganisation of the regional energy system. For example, the block F (465 MW) of the power plant *Jänschwalde* north of *Cottbus* was closed at 1. October 2018 and is now in a temporary reserve (the so-called *Stillstandsreserve*) to buffer unforeseeable energy shortage events. In the second half of 2019 block E (465 MW) follows. At the same time the lifetime of the opencast mine *Jänschwalde* is shortened, despite of a longer approved running time. The planning for the opencast mines *Welzow-Süd* and *Nochten* are currently in revision.

Besides other factors the consequent development of renewable energies in Germany puts the lignite industry under heavy pressure - the cost recovery level is hardly to achieve for this business model in the future. By the middle of the century renewable energy should make up at least 80% of the national power generation. But it remains unclear, whether the mining region itself can benefit from the proposed development of renewable energies and break-through technologies (e.g. increasing efficiency and storage, power system management).

Since 2016 all lignite opencast mines, the 3 large-scale power plants and the only one lignite upgrading facility left (briquette factory, lignite finishing) in *Schwarze Pumpe* are held by the LEAG company - with their headquarters in *Cottbus* and a conference centre in *Lübbenau*.

Table 36: DE: Key figures of the coal mining industry in the *Lusatian Lignite District* as compared to the German lignite sector

Reference year	2015	2016	2017	Germany (2017)
Coal mines production (million tons)	62.452	62.292	61.211	171.286
Employees mining & generation	8,316	8,7651)	8,639	20,891
Coal mines productivity (tons per employee / mining & generation)	7,510	7,107	7,086	8,199
Coal supply to local power plants (million tons)	58.820 (94.2 %)	58.630 (94.1 %)	57.453 (93.9 %)	155.707 (90.9 %)
Coal supply to local briquette factory(s) / Processing / Upgrading (million tons)	3.575	3.663	3.762	14.737
Others (million tons)	0.006	0.000	0.002	0.789
Change in inventory (million tons)	+0.052	-0.001	+0.006	+0.054
Power plant capacity (MW, net)	6,717	6,717	6,717	6,717
Electricity generation (billion kWh)	50.2	-	48.7 49.0 (2018)	-

Data source: DEBRIV (2019), STATISTIK DER KOHLENWIRTSCHAFT E.V. (2019)

1) data not comparable with the year before because of an enterprise change and internal restructuring

5.2.2 Social aspects

Right now, around 8,600 people are employed in the regional coal businesses (full-time jobs, full-time equivalents). Thereof coal mining counts for circa 5,500 employees and energy generation about 3,100 workers (LEAG 2019, SEIBERT et al. 2018). In addition, about 12,000 people are working in the related industry and as service providers, together corresponding to about 5% of the regular employments in the region. Although within the last ten years about 12.5% jobs were lost in the mining and generation sector, it is still an important factor for the vocational training and professional development in the region. The 600 LEAG trainees are qualified as miners, power plant engineers, specialists for environmental protection, industry mechanic, administrative employees and merchants (LEAG 2019). In comparison: The *Economic Region Lusatia* provides overall 413,666 employments, from that in the manufacturing industry sector approx. 70,500.

Unfortunately, there are no generally available statistical data about age structure or qualification/position, etc. of the people employed in the regional coal businesses and related coal processing industry. Also, official statistics do not separately record the related businesses in and outside the region.

5.2.3 Economic effect

General economic performance of the region

The gross domestic product (GDP) per capita is about 26,300 EUR which is only 73% of the national average - thirty years after the German reunification. Although the share of industry on the gross value-added amounts to 30% (26% national average), the commercial tax revenue is about one third lower as compared to Western Germany.

Overall, the Lusatian region is quite structurally poor in a national comparison, although there are considerable differences on sub regional level (ZUNDEL 2019). A good indicator for the overall socio-economic performance of the region is the nationwide ranking of German districts by 2018, having a closer look to economic facts (GDP, economy, investments, unemployed persons, etc.), ecological criteria, living quality and demography (age structure, population development). Thereby, from 375 listed counties and cities with actual data available, the 4 considered regional districts in this report occupy the lower ranks: *Elbe-Elster* 355, *Oberspreewald-Lausitz* 300, *Spree-Neiße* 311, *Dahme-Spreewald* 204. According to competence field analysis of the PROGNOS AG (2013, 2017), especially the regional innovation potential is very low as compared to the German average (Table 37). The portion of employees in R&D is only 1.5% in Lusatia whereas about 2% nationwide.

Table 37: DE: Innovation potential of the *Economic Region Lusatia* (2017)

Category	Economic Region Lusatia	Germany
Business start-ups at county level	58.5 - 95.8	100 (index)
Patents per 100,000 inhabitants at county level	5.2 - 75.2 (134.1)	111.4

Data source: Prognos AG (2017), Statistische Ämter des Bundes und der Länder (2019)

Importance of the mining and generation sector

The highly mechanised and rationalised mining and energy industry are the most important pillars of the regional economy (ÖKO-INSTITUT 2018). The annual added value by lignite mining and processing also considering all upstream and downstream effects is about 1.3 billion EUR in 2018. That is about 5% of the regional GDP. From economical point of view Lusatia is no mono-structured energy region anymore as it was in the early 1990s (ZUNDEL 2019). However, when looking at the foreseeable end of coal-fired power production in Germany and the stepwise replacement by renewables, it is clear that the economic risks of the mining and generation sector will increase in the next years. In general, the capacity utilisation of coal fired power plants decreases as it is closely correlated with their position in the merit order. To say it in other words: because the marginal costs of renewable energies are close to zero, their market entry enhances the pressure on coal, corresponding to a falling value added.

At present about 3,300 partner companies and service providers - first of all SME - rely on the mining and generation sector (LEAG 2019). The annual volume of orders associated with lignite mining and power generation amounts to 510 million EUR. Unfortunately, there is a high dependency of coal-mining related suppliers on one single mining and energy company - which is besides the largest taxpayer of the region.

Mining licences and land reclamation

In Germany, the Federal Mining Act (BBergG 1980) with its implementation rules like RegBkPlG (2002) has replaced a confusing mass of former state mining regulations by a single unified, albeit not definitive, public regulatory regime. The national mining law is licensing all mining operations and at the same time bringing together the general environmental laws relevant for the environmental impact assessment. Thereby, other regulations of the general legislation that stand opposed to mining should be applied only to the extent that any deleterious impact on exploration and extraction can be kept to a minimum. That means: the mining regulations are overriding to speed up and simplify the complex planning process “insofar prevailing public interests do not stand against”. In doing so, the approved mining operating plans under mining law concretise the general targets and measures of the general *Lignite Plan* which is part of regional spatial development planning. The superior regional plans describe not only infrastructure demands, but also key environmental goals and protection measures in the region - it has a legislative character.

Any mine operation planning within the framework of the mining law has fit in the higher-ranking regional spatial and infrastructure plans.

The so-called *general operating mining plans* define the framework and describe that key environmental goals and protection measures are the essential precondition for the whole operational management and thus also final rehabilitation, in particular, the assignment of surface design, land use types, aspects of substrate quality, minimum requirements of restoration, soil target values and a binding time schedule for minimising the time lag between impact and restoration. They have to be confirmed by the responsible mining authorities - in Brandenburg (DE40), for example, the *State Office for Mining, Geology and Raw Materials* (LBGR). Therein all measures of environmental protection, rehabilitation and post-mining redevelopment are linked to the public interest already before and during active mining. However, concerning lignite mine reclamation in detail the demands of the general legal provisions are relevant, i.e. soil protection, water legislation (WHG), waste regulations (KrWG), nature conservation (BNatSchG), forest (BWaldG) and other environmental regulations (USchadG, etc.) They "will be applicable insofar the BBergG and derived ordinances do not regulate impacts in detail" - which is actually in most cases. The release from mining supervision by law is linked to the implementation of the final operating plan with its reclamation requirements at all points.

The mining and generation sector in Germany is bound to collective bargaining agreements negotiated between the employers and the relevant trade union (*IG Bergbau, Chemie, Energie*). There are various scale groups according to qualification, job characteristics and years in the wage group (*Vergütungsgruppen/Entgeltgruppen*). The following basic gross tariff payments in the mining and generation sector of the LEAG company may provide some guidance, as related to the starting salary in the relevant wage group (since 2019) without additional payments like holiday pay or Christmas bonus: 14.54 EUR/h (housekeeper, janitor), 15.17 EUR/h (kitchen assistant, factory security), 16.55 EUR/h (machine and crane operator), 18.79 EUR/h (locksmith, equipment operator), 21.39 EUR/h (mining engineer, surveying technician, instructor), 24.29 EUR/h (team leader, mechanical and electrical engineering), 32.91 EUR/h (division manager and operation manager mining). That corresponds to monthly gross wages between 2,528 EUR to 5,246 EUR - starting salary without extra payments. As comparison: the monthly average gross wages in the target region are about 2,212 EUR (*Elbe-Elster*), 2,402 (*Oberspreewald-Lausitz*) 2,438 EUR (*Spree-Neiße*), 2,621 EUR (*Dahme-Spreewald*) up to 2,724 EUR (city of *Cottbus*).

The hourly gross wage is above the average as compared to Eastern Germany as a whole which are actually about 17 EUR/h. Moreover, other employment relationships not bound by collective arrangements with lower qualification, especially in the regional service sector are very often remunerated with the statutory minimum wage of actually 9.19 EUR/h (9.35 EUR/h as of 2020).

5.2.4 Environmental effect

In the *Lusatian Lignite District* mostly sandy overburden material is dumped in a loose layering and small-scale alternation of Quaternary and Tertiary substrates. Under this geomechanical presetting raising post-mining groundwater and heavy precipitation events can trigger a sudden liquefaction (*quicksand*, VOGT et al. 2014, TRIANTAFYLLIDIS 2015). During the last decade several unforeseeable hydraulic failures led to a large-scale blocking of already returned reclamation sites - even of areas which have been released from mine supervision. As already mentioned, preventive emergency response affects 20,600 ha in total with 4,500 ha agricultural land or 25 farms. Thereof, 2,800 ha are set with temporary use restrictions and the remaining 1,700 ha *off-limits*.

Moreover, the Lusatian area suffers from hydro-chemical problems, triggered by sulphide mineral oxidation (pyrite, marcasite) of overburden material and acid-induced silicate weathering in contact with rainwater. Combined *Acid Mine Drainage* (AMD) and *Metal Leaching* (ML) are one of the most serious off-site environmental challenges posed by coal but also sulphide-containing

ores lasting for decades or even hundreds of years. In fact, both the restoration of groundwater quality in the post-mining landscape and the reestablishment of a self-sustaining water balance are a century-long tasks. Without additional reclamation measures tailored to the acid formation, especially an ongoing liming of acidic mining lakes and a long-term treatment of the affected out-flowing water, it is hardly possible to achieve a good (near-natural) water quality according to the *EU Water Framework Directive 2000/60/EC* (BENTHAUS & TOTSCHE 2018).

Finally, there are hundreds of post-industrial hazardous sites, contaminated and suspected areas in the mining region, concerning waste products of lignite processing (lignite pyrolysis, distillation, gasification, briquetting, etc.), e.g. the tar disposal sites *Terpe* and *Zerre* (760,000 tons waste) or industrial park and former power station *Schwarze Pumpe*. In addition, there are manifold residuals of lignite-relating and energy intensive industry (refineries, aluminium smelting, galvanisation, mechanical engineering, etc.) and other mixed municipal and industrial landfills. These hazardous sites are under public environmental monitoring, safeguarded or in still ongoing remediation.

5.3 Coal mining and coal utilisation policies

5.3.1 National policy

National energy strategy affecting coal mining activities

Following the national *Climate Protection Plan* (*Klimaschutzplan*, BMU 216) Germany has quite ambitious climate protection targets: amongst others, up to 2050 the greenhouse gas emissions should be reduced by around 85% (-80 to -95%) as compared to the baseline situation of 1990. Already by the year 2030 a reduction of 55% is intended, whereas at EU level by 40%. At the same time the portion of renewables in gross internal energy consumption should increase from 18% (2020) to 30% (2030) and 60% (2050). In addition, the energy efficiency will increase, leading to a reduction of the primary and final energy consumption by 50% as compared to 2008. For the Lusatian region it means a stepwise reduction of coal production and power generation coming from actual 60 million tons to zero. At the end of the process all remaining 4 active opencast mines and three large-scale power plants will be closed. Therefore, the approved mining planning is at the moment under revision. That makes the runtime of the operational facilities unclear - regardless of the existing operating plans with the set end of operations, which are: opencast mines *Jänschwalde* (2023), *Welzow-Süd* (2040), *Nochten* and *Reichwalde* (2045).

For transforming the energy industry, the decided coal phase-out in December 2018 by the end of 2038 is an essential and no more negotiable pillar. Actually, lignite and hard coal fired power plant contribute to 40% of the national electricity production but count for 80% of the climate-damaging CO_2 emissions. According to the current step-by-step plan for the decarbonisation, the installed net electrical capacity should fall from 42.6 GW (2017) to 30.0 GW (2022), 17.0 GW (2030) and finally zero in 2038. For a better understanding of the challenge: on an average day Germany spends about 65 to 70 GW electricity, in the winter season the consumption can reach around 80 GW.

To compensate the upcoming socio-economic risks in the three German coal regions, *Rhineland*, *Middle German Lignite District* and *Lusatian Lignite District* 40 billion EUR public incentives are planned for the next 20 years. Alone the Lusatian area should receive 17 billion EUR - although the co-financing for the regional restructuring is not yet ensured. Even more there is no detailed timeline for the regional and national phase-out at the moment. The complex modalities are part of a political and societal negotiation process getting involved many stakeholders in the next years (MARKWARDT & ZUNDEL 2017).

However, a first *ad-hoc* step to conversion: in April 2019 the federal government and the affected federal states have agreed to a so-called emergency programme by providing 260 million EUR for

100 already decided structural adjustment projects and measures (e.g. technology development, business parks, test areas for 5G mobile communication, etc.) in the coal mining regions. However, this could only be a first drop in the bucket: the *German Chamber of Industry and Commerce* (DIHK) estimates the real economic costs of the coal phase-out up to 170 billion EUR by considering the effects on the energy prices.

In addition, there is a further and quite considerable support of landscape restoration and engineering of 1.23 billion EUR up to the year 2022. But here the focus lies on well-established technologies, thereforeit makes only a very little contribution to self-supporting structural-economic transition and innovation in the future.

Smart specialisation strategies

According to MARKWARDT et al. (2016) and ZUNDEL (2019) most proposals for managing structural change in the region are based on conventional political steering instruments: (1) the large-scale new industrial settlement, e.g. battery factory, (2) establishment of R&D facilities (e.g. competence centre in energy-intensive industries, (3) infrastructure expansion by digitalisation (5G), expansion of railway connections and motor highways within the region and to the surrounding urban agglomerations *Berlin*, *Dresden* and *Leipzig/Halle*, (4) creation of investment-friendly framework conditions, e.g. by shortened approval times, tax concessions, etc., (5) speeding-up planning procedures for industrial and commercial settlements.

Successful structural-economic transition also needs proactive adaptive measures and not waiting passively for irreversible structural breaks (FRANKE et al. 2017). In this context smart specialisation makes sense, based on the already existing economic priorities in the region: energy industry, metal, chemicals, logistics, vehicle suppliers, agricultural and food industry (ZUNDEL 2019). More financial resources are essential, especially in the early stage and there is a strong need to maintain EU funds, applicable for cohesion in coal regions in transition (FREYTAG & WOITEK 2018)

5.3.2 Regional and local policy

Promoting economic clusters

A deeper going economic analysis of the *industrial landscape* of the region shows that there are some promising clusters on sub regional level having an economic performance and employment impact above the average. Such economical clusters focus on the SME potential of the region and link economic activities by using production synergies and already established business relationships. Regional medium centres together can be an anchor for the development of value chains together with the surrounding, more agricultural and less populated spaces in between. One sounding example represents the so-called (1) *Regionaler Wachstumskern* (RWK, regional growth core) *Westlausitz* around the cities *Finsterwalde*, *Lauchammer*, *Großräschen*, *Senftenber*g and *Schwarzheide* (*inter alia* BASF company). The subarea has a smart local know how on metal industry, mechanical engineering, electrical industry, biotechnologies, automotive industry (suppliers), life science, renewables industry (solar cells, wind turbines, plastics and biochemicals), but also the joint tourism marketing. Other city associations/alliances with a definable specialisation profile are: (2) *Lübben/Lübbenau* (tourism, food industry, electrical engineering, agricultural and wood industry), (3) *Cottbus* (research and science, education, services, health technologies, insurances, building materials industry, information technologies), (4) *Hoyerswerda/Spremberg* with the industrial and business park *Schwarze Pumpe* (generation, paper processing, energy technologies, etc.), (5) *Bautzen/Löbau* (mechanical industry, logistics, plastic, automation, furniture manufactures, etc.) and (6) *Görlitz* (mechanical and traffic engineering, energy technologies).

Fostering smart specialisation

Facing the challenges of the on-going and imminent structural economic change and regarding the climate change objectives, the following fields of action were identified in line with the SET plan: (1) providing a more rational energy use, (2) promotion of renewable energies, decentralisation of the energy system, (3) intelligent transmission, distribution and storage of energy (smart grid), (4) efficient increase of conventional energy power plants, thereby reducing CO_2-intensity, (5) substitution / conversion of lignite-fired power stations by smart gas power plants, using in all topics mentioned the regional key competences and decade-long experience in energy production. Therefore, Lusatia can be an experimental field for peripheral regions by developing industrial hotspots/clusters based on existing infrastructure and regional business networks.

According to a recently published potential analysis of mining and generation competences the region provides a broad but still unused innovation potential. About 80% of the interviewed companies have already ideas to market special products and skills proven in the lignite industry in other economic sectors, especially concerning building, structural engineering, mobility, metal industry, renewable energies, recycling, remediation and environmental technologies. Moreover, a further internationalisation of the operative business appears promising; that means first of all a know-how and blueprint transfer in other mining regions with ongoing or upcoming structural change. Some important target markets identified for Lusatian enterprises involved into the mining and generation sector are: *Australia*, *Bulgaria*, *Bosnia-Herzegovina*, *Brazil*, *China*, *Serbia*, *Russia*, *Poland*, *Romania*, *Canada*, *India* and *Greece*. However, there is a considerable weakness in regional R&I and very limited investment in forward-looking technologies, products and value chains - despite the high level of qualification and know-how which calls for a stimulation of the regional innovation system (DMT 2017, MARKWARDT et al. 2016).

Lessons learnt from the past

In Germany, regional planning and development are based on the amended *Spatial Planning Law* (*Raumordnungsgesetz*, ROG) from 2008. But already the basic constitutional law (*Grundgesetz*) dating back to 1949 targets at a strengthening of the regions and providing equal living standards across the nation. That means not a uniform development of regions but having same development chances for all people by mitigation of structural disparities. Thereby, in the past regional planning activities were frequently seen from the national and federal perspective (top to bottom) leaving little scope for regional and local decision making and economic actions.

When looking closer at the German reunion process and its socio-economic marks left in Lusatia, regional planning had a strong focus on basic infrastructure development, supporting a few major regional centres, more densely populated agglomerations and large-scale investment projects. However, in retrospect it turns out questionable to spend public incentives for infrastructure without any sounding business concept and only following good will or political intentions. For example, many of the established industrial and commercial parks in the region - even in small villages, without any economic connecting point - are still underutilised and unproductive. Funding large projects without having a common vision or development target for the region and structural subareas are in most cases not sustainable. Such serious failures/flops of a misleading and somehow rather amorphous economic policy are for example: (1) *Eurospeedway Lausitz* (planned as formula 1 race track, opened in 2000, funded with 123 million EUR, intended 1.500 working places, now converted into an automobile test centre with approx. 50 full-time jobs), (2) *Cargo-Lifter* project (established in 1996, funded with 40 million EUR, insolvent in 2002, now adventure park *Tropical Islands*), or (3) the semiconductor plant in *Frankfurt Oder* (announced 1,500 new jobs, after 2003 transformed into a factory for solar cells, finally closed in 2013).

Nowadays, there is a paradigm shift to meet the challenges of structural transition under pressure of the demographic development and economic risks of the lignite phase-out: it is acknowledged

that all regions have their own, very different and specific strengths and weaknesses which the regional players know best. Therefore, the impulses and decisions for the regional economic development have to come from the regional stakeholders, e.g. organised in self-developing economic clusters with innovative, forward-looking business areas (bottom-up approach), basically by (1) development of new markets and (2) extension of key competences (smart specialisation). In this understanding, the national and federal government should promote sounding activities like fostering biotechnologies or *Power to X* (smart electricity storage technologies), electro mobility and other smart energy technologies. The political and administrative focus should lie on business support, e.g. by the implementation of the necessary (digital) infrastructure but also specific investment promotion opening new markets in a globalised world.

So far, the demographic development is overruling the loss of approximate 20,000 jobs in the mining and generation sector in the same period. That makes sense to separate the political questions of structural change induced by lignite phase-out and the demographic trend (MARKWARDT & ZUNDEL 2017). However, looking at the very special socio-economic situation of the region it is essential to develop proactive strategies because the economic actors are still there. Together with the announced national subsidies we are having a good chance to push the economic transition towards clean energy and other forward-looking business segments of the future.

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6 Greece, Western Macedonia Region

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6.1 Description of the region

6.1.1 Region overview

The Western Macedonia Region (WMR) is located in the northwest part of Greece, bordering Albania to the west and FYRoM (now, "North Macedonia") to the north, and is the only Greek region not bordering the sea (see Figure 15). It consists of the Regional Units (RU – the former "prefectures") of Kozani, Grevena, Kastoria and Florina. It covers an area of 9,451 km^2 (7.16% of the country's total area) and comprises mostly mountainous and semi-mountainous land (82%). WMR is well-known for its rich natural resources, such as fossil fuels (lignite), ores (asbestos, chromite, marble etc.), forests (50% of its total land) that form ecosystems defined by rich biodiversity, as well as pastures, while it also has the greatest surface water potential in Greece (approximately 65% of the country).

Figure 15: GR: The Greek NUTS and TRACER target region – Western Macedonia

At Regional Unit level, the RU of Kozani, on the eastern side of WMR, is the largest in size (3,516 km^2), and is covered mainly by mountainous and semi-mountainous land (77%). The RU of Grevena, covering a total of 2,291 km^2, is the most mountainous region in WMR (93% of its land is considered mountainous and semi-mountainous), while the Florina RU is the third largest (1,925 km^2) and has the highest share of lowlands (26%). The smallest region of WMR, the RU of Kastoria (1,720 km^2), is covered almost entirely by mountainous and semi-mountainous areas (90%).

Western Macedonia is one of the less populated regions in the country. The population of WMR has been significantly reduced over the past 50 years, as, according to the official population census, it has dropped by 9.7% between 1961 and 2011 (from 311,136 to 283,689 people).

According to the latest Eurostat figures, the population of the area was estimated at 278,706 in 2014, i.e. there is an additional 1.8% drop between 2011 and 2014 [Eurostat data].

The most significant population reduction trend is noted in the RU of Grevena (27% between 1961 and 2011) - which also has the highest ageing rates - followed by the RU of Florina (23.7%) and Kozani (1.7%), which is the most populated, too. The RU of Kastoria is the only one where the population shows an increasing trend (6%). The population density in 2013 was 42.8 people/km^2 in the RU of Kozani, 29.2 people/km^2 in the RU of Kastoria, 28.1 people/km^2 in the RU of Florina and 13.7 people/km^2 in the RU of Grevena, making the latter the least populated Regional Unit in the whole of Greece.

The age 65+ category is by far the largest population group in WMR (more than 60,000 people), followed by the groups of 35-44 and 45-54 (with equal shares, of around 40,000 people each), and the one of 1-14 (with less than 40,000). On the other hand, the smallest population group is the one corresponding to the ages 15-24 (about 30,000), followed by the group of 55-64 and the one of 25-34 (around 35,000). These figures clearly show the “ageing” of the region, as well as the fact that the productive workforce is missing.

6.1.2 Social situation

Based on the distribution of employment per sector within the WM Region, 16.53% of the active population is employed in the primary sector, 23.85% in the secondary sector and 59.61% in the tertiary sector. In absolute figures, employment per sector of productive activity in 2013 consisted of 14,579 employed in the primary sector, 12,033 employed in the secondary sector and 52,560 employed in the tertiary sector.

By examining the percentage change in the distribution of the active population per sector since 2008 (the year of reference in which the economic crisis actually hit Greece) and until 2013, the largest drop can be noted in the construction sector (-50.22%), followed by the Real Estate sector (-24.29%). An increase can be noted only in the “Professional, scientific and technical, administrative and supportive activities” (+22.73%) and the “Arts, entertainment, recreation, other service-based activities, household activities as employees” (+20.4%) sectors.

Table 38: GR: Main macroeconomic data of the Region of Western Macedonia (Source: Hellenic Statistical Authority - ELSTAT)

	2012	2013	2014	2015	2016
GDP*	4,724	4,398	4,530	4,304	n.a.
GDP per capita**	16,711	15,707	16,320	15,642	n.a.
Gross fixed capital formation*	1,071	1,071	929	911	n.a.
Workforce (‘000)	114.4	112.6	113.9	117.0	118.0
Unemployment Rate (%)	29.7	31.6	27.6	30.8	31.3

**In million Euro*

***In Euro*

The jobs created by the Public Power Corporation (PPC) in Western Macedonia Region are examined separately, given the fact that this company is the largest employer in the area (see Section 2.2). Finally, according to Eurostat (2014), WMR ranks 9th in unemployment amongst all European Regions, with an unemployment rate of 27.6% (22.4% for men and 34.6% for women, respectively). According to the ELSTAT’s data, the situation remained the same in the 3rd semester of 2017 (27.3% unemployment rate).

As regards education, it must be noted that in the WMR there are located two higher education institutes, namely:

1) The University of Western Macedonia (UoWM), established on 2002 and today consisting of three Schools and six Departments, offering undergraduate and postgraduate study programs; the University of Western Macedonia employs 91 members of teaching and research staff and 51 employees in its administration, while there are about 4,000 students (undergraduate and postgraduate students);

2) The Technological Educational Institute of Western Macedonia (TEIWM), which is a state-run institute of highest education based in Kozani (the institution also operates satellite campuses in the nearby towns of Kastoria, Florina, Grevena and Ptolemaida) founded in 1983; there are four Schools in the TEIWM (School of Engineering, of Business and Finance, of Agriculture Technology, Food Technology and Nutrition, and of Health and Welfare).

It must be further noted that, Western Macedonia boasts a number of comparative advantages related (basically) to its numerous Tourism and Cultural sites, as well as to the skilled work force, especially in Tourism and Agriculture. Indeed, WMR is a popular destination offering an upgraded and diversified tourist product that includes hiking in the mountains, sightseeing, local gastronomy, lake sports, etc. (ENTERPISE GREECE, Region of Western Macedonia Investment Profile).

As regards “fuel poverty”, the share of WMR households whose energy expenses exceed 10% of their annual income is 66.9%, compared with a 39.5% average across Greece (CRES, National Poverty Observatory), i.e. 1.7 times higher than the rest of the country. The magnitude of the issue of energy poverty in WMR, intensified by the region’s climate conditions, is also evident in TCG-WM's assessment (2014), according to which even the households whose income exceeds €50,000 fall in the “energy poverty” category.

6.1.3 Economic development

WMR produced 2.43% of Greece's GDP in 2013. According to Eurostat, WMR's GDP in 2013 was estimated at €3.97 billion (current rates), and its distribution per sector was:

(1) 45% from mines, quarries, industry, electricity supply, etc.

(2) 17% from public administration, social insurance, education, human health, social care, etc.

(3) 11% from wholesale and retail trade, transportations, accommodation & catering services,

(4) 10% from Real estate,

(5) 6% from agriculture, forestry and fishery,

(6) 4% from the construction sector,

while all the rest (ICT, scientific, technical, administrative activities, entertainment & recreation, arts, finance & insurance, etc.) show percentages of 1-2%.

As regards the gross added value per production sector, similarly the mining, industry, power production etc., sector contributes the largest share, €1.45 billion at current rates (2013). The energy production sector (electricity production through lignite combustion and hydroelectric energy) is the main economic activity of the regional economy, rendering WMR as the Greece's “energy centre”. As 49% of the production occurs in the secondary sector, and the primary sector is limited to very low production rates, WMR can be described as an industrial region of limited job sectors. This structure, which reveals the region's huge dependence on PPC’s activities, is unique throughout Greece.

The main characteristics of each economic activity sector in WMR, as described in detail in the RIS3 plan, are the following:

- The primary sector has been gradually shrinking over the past years. However, WMR has the ability and potential to increase the contribution of the primary sector to the regional GDP and to job creation.

- The secondary sector is dominated by lignite mining - electricity production activities, which share all the characteristics of a "monoculture" (the fur processing and fur-bearing animal breeding constitute the 2nd most important activity in the secondary sector).
- The tertiary sector is defined by an important reduction in trade since 2009, as a result of the economic crisis. Moreover, the insufficient exploitation of the natural capital and the cultural assets keeps the contribution of the tourism sector at particularly low levels.

As regards infrastructures, Western Macedonia is served by two airports in Kozani ("Filippos") and Kastoria ("Aristotelis"), the national highway, the "Egnatia Road" that extends from Panagia (Brown Bear Area) to Polymylos, and the railway network. Especially as regards the transport infrastructure, it is important to notice that the region disposes over substantial infrastructure, capable to support wide investment activity in the area. Also, the region disposes industrial zones, providing land and easy licensing procedure for industrial use. Last, it must be mentioned that it is currently under construction the Trans Adriatic Pipeline (TAP), passing from the three northern Prefectures of WMR.

6.1.4 Environmental situation

The nature of the region is mountainous (82% of the total surface are mountainous and semi-mountainous areas), while river Aliakmonas travels down through it. Western Macedonia is the only Greek region without sea coast. The region has two National Parks, sixteen NATURA areas of immense natural beauty and totally 1,707 km^2, three ski centers, eight lakes (seven natural and one artificial), gorges, rivers, interesting geological formations, two world trekking paths, remarkable traditional settlements, a great number of archaeological sites and a plethora of Byzantine monuments of international interest.

As already mentioned, the primary sector, especially agriculture, plays a key role in the region's GDP. The arable plains (40% of them are irrigated) are cultivated intensively, producing cotton, corn, tobacco, grains, tomatoes, etc. The cultivated areas in WMR amount to around 210,400 hectares.

Pollutant emissions from PPC's power plants, as well as from lignite extraction and the transportation from the mines to plants, cause significant air pollution problems in the region, most importantly high PM10 concentrations. According to data from the Environmental Centre of the Region of Western Macedonia, in 2010, at 9 out of the 15 measuring stations in the Prefectures of Kozani and Florina, the European limit values were exceeded by more than 20%.

With regard to public health, although the lignite-fired plants and the lignite mines have operated for over 60 years, it is striking that no epidemiological study has been conducted on their impact on the health status of the inhabitants of lignite mining regions. However, according to a study conducted by AHEPA University Hospital, Thessaloniki, in three villages in the Prefecture of Kozani, deaths from thromboembolic events in the period 1992-2007 rose from 43% to 55%.

A study conducted by Bodosakio Hospital, Ptolemaida, found that the inhabitants of Ptolemaida were three times as likely to suffer from allergic rhinitis as the average Greek. Moreover, the Greek branch of Greenpeace conducted an analysis of data and methodologies employed by the European Environment Agency and estimated that ambient air pollution due to the operation of lignite-fired plants in Western Macedonia led to 461 premature deaths in 2009.

The operation of lignite-fired plants also has a very significant footprint on the water resources, used for cooling. In Western Macedonia, PPC pumps from the river Aliakmon and Polyfytos lake 72 million m^3 of water annually, at a 60 km distance and 390 m elevation difference. For the purpose of comparison, the water supply needs of the 300,000 inhabitants of the region are met with 43 million m^3. There has also been considerable deterioration in water quality in the region as a result of pollutant loads (e.g. heavy metals), as well as a drastic lowering of the water table in the vicinity of the mines in Ptolemaida.

One more considerable negative aspect of the extracting activities of PPC in Western Macedonia is the forced relocation of several villages, with major economic, social, cultural, spatial and technical consequences. From 1972 to 2003, almost 4,000 inhabitants were resettled, after their 5 villages were swallowed up by the mine extensions. At present, the relocation of an additional 4 villages is either underway or has been decided.

Last, and as regards the climatic situation, the area of Western Macedonia has a cold continental climate, with long, cold, humid winters and short warm and dry summers. The microclimate of the area is affected by the presence of large mountains volumes and is characterized by significant inter-seasonal and diurnal difference, due to the high latitude and the morphology of area.

6.2 Role of coal mining in the region

6.2.1 Coal sector in the region

The country's largest lignite potential is concentrated in three areas-basins along the Florina - Amynteo - Ptolemaida - Kozani - Servia axis, with an estimated deposit of 1.9 billion tonnes. So, gradually, one of the largest Lignite Centers in the world was created in the Ptolemaida - Amynteo area. Five lignite mines are currently operating in the West Macedonia Lignite Center (WMLC): the South Field Mines, the Mine of “Kardia”, the Mine of “Kiriou pediou” (Main Field), the Amyndeon Mine Field, and the mines in Florina area.

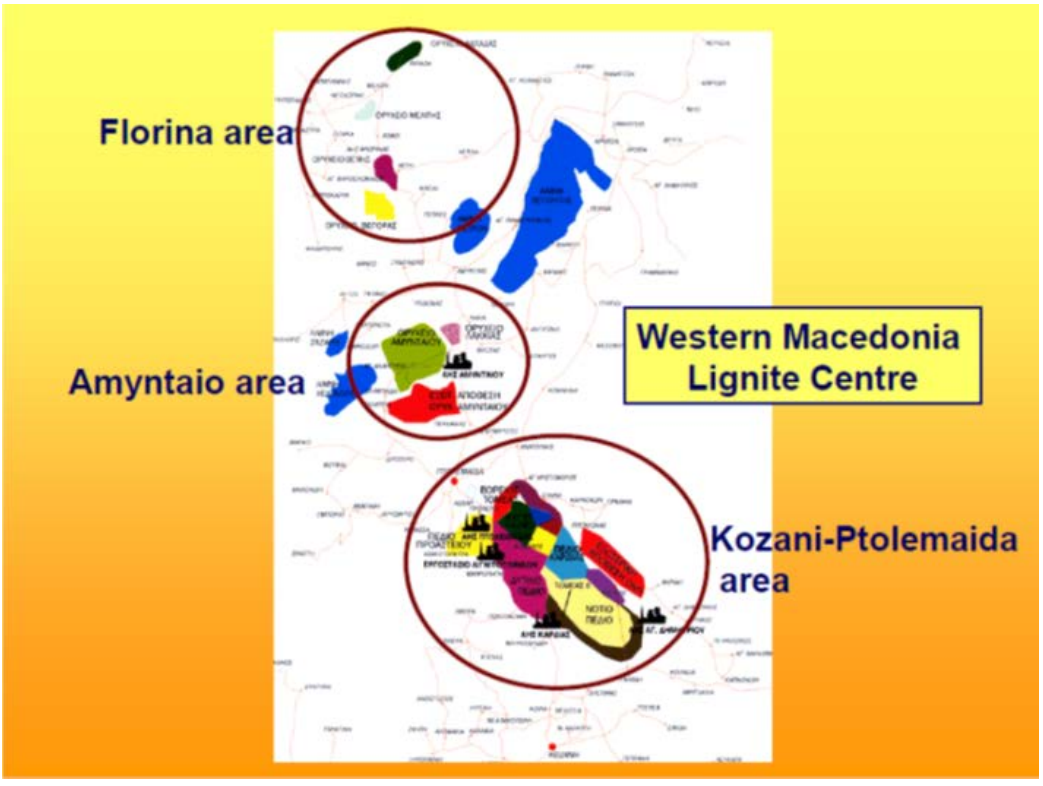

Figure 16: GR: The Western Macedonia Lignite Centre – WMLC

Source: PPC

PPC has priority in the development and exploitation of all lignite fields and is also responsible for most production. However, there are also a small number of privately operated mines in the West Macedonia/Florina area. These have estimated reserves of ~150 million tonnes. Most of the private sector output is supplied to PPC. Most recently, a leasing agreement for the mining rights of a lignite deposit in Florina’s Vevi region was concluded. This particular deposit was signed over to Aktor, a subsidiary of Athens-listed company Ellaktor S.A. It is linked directly to the lignite supply

for the Meliti power plant. The contract covers the extraction of 90 million tonnes of lignite (exploitable reserves) and during the first 15 years of operation, is expected to produce >€150 million net profit for the Greek state.

Up to 2012, annual lignite production from the Western Macedonia region, exclusively in opencast mines, had been a steady 50 million tonnes/year, while more than 300 million m^3 total masses were excavated annually (overburden and interburden, corresponding to an overburden-interburden-to-lignite ratio of 5.6:1), using by 70% the Continuous Excavating Method (selective mining) and by 30% the Discontinuous Excavating Method. In 2015, PPC extracted 35.7 million tonnes of lignite at the West Macedonia Lignite Centre (WMLC). The few privately operated mines in the Florina area (in Western Macedonia also) – namely the Vevi mine and the Vegora pit - produced a total of 2.2 million tonnes of lignite. Today, the PPC's mines extend over an area of 17,000 ha. Their total annual excavations exceed 170 million m^3 and the lignite production is 27.2 million tonnes (2017).

The Lignite Center also includes the Lignite Factory (exploitation of lignite for its use in the production of briquettes, nitrogenous fertilizers and semicoke) and LIPTOL Steam Power Station. Until 2010, there were six lignite-fired power plants (18 units) supplied from the WMLC, with a total installed capacity of 4.438 MW. In the following table an overview of the lignite technology status in WM Region (in 2010) is given.

Table 39: GR: Lignite technology status in 2010

No	Power plant name	Plant capacity / power unit (MW)	Technology type	Low heating value (LHV) (kJ/kg)	Year of starting operation	Efficiency (%)	Specific CO_2 emissions (tCO_2/ MWh)
1	Agios Dimitrios Power Station	1,595 5 Units (2 x 300 + 2 x 310 + 1 x 375 MW)	Steam turbine generating units with condensing system and feed water heating systems	5,276 - 6,757	1984-1996	37.3 (gross)	0.982
2	Amyntaio Power Station	600 2 Units (2 x 300 MW)	Steam turbine generating units with condensing system	4,079 - 5,774	1986	32.0	1.122
3	Florina (Melíti) Power Station	330 1 Unit	Steam turbine generating units with condensing system - FGD*	8,062 – 9,443	2003	36.2	1.015
4	Kardia Power Station	1,250 4 Units (2 x 300 + 2 x 325 MW)	Steam turbine generating units with condensing system and feed water heating systems	5,276 - 6,757	1974-1981	36.5 (gross)	1.050
5	Liptol Power Station	43 2 Units (10 + 33 MW)	Steam turbine generating units with condensing system	5,276 - 6,757	1959-1965	Not available	Not available
6	Ptolemaida Power Station	620 4 Units (1 x 70 + 2 x 125 + 1 x 300 MW)	Steam turbine generating units with condensing system	5,276 - 6,757	1959-1972	32.0	1.116

**FGD: flue gas desulphurisation*

Note: The unit of 70 MW (Unit I) of the Ptolemaida Power Station ceased its operation in 2011 (it was officially decommissioned by Ministry Decision in March 2011). Units III and IV were

destroyed in a fire in November 2014, while Unit II is on standby mode since 2013. Also, the Liptol Power Station (2 Units) was decommissioned in June 2013. Thus, a total capacity of 663 MW was shut down in the Region since 2011.

In addition, due to the need to comply with the new, stricter EU Directive 2010/75/EC on industrial emissions, PPC had to put 6 lignite units of a total capacity of 1,850 MW (all located at WMR) under restricted operation. Thus, from January 2016, these units operate around a third of the time they used to, before completely withdrawing at some point until 2023 at the latest. So, currently in WMR operate at full power only the remaining 6 of the above-mentioned units, with a total capacity of 1,925 MW.

Another important aspect of lignite fired TPPs in the region is that PPC SA made a series of investments in energy supply in the form of hot water for urban teleheating purposes, in an attempt to provide a method of continuous heating of urban residences, without the urban pollution of the environment, via a number of Power Plants: Ptolemaida III (50 MW_{th}), Agios Dimitrios III (67 MW_{th}), IV (67 MW_{th}), V (70 MW_{th}), Amyntaio (20 MW_{th}), and LIPTOL (25 MW_{th}). The expansion-enhancement of the Municipality of Kozani's teleheating from Ag. Dimitrios TPP (maximum teleheating capacity: 137 MW_{th}) was concluded in 2008, while the teleheating interconnection of the Municipality of Ptolemaida and Kardia TPP was made in 2009. Furthermore, the teleheating of Florina city from Meliti TPP (70 MW_{th}) was concluded in 2010.

Thus, about 100,000 citizens of Kozani, Ptolemaida and Amynteo are heated by district heating systems from lignite power plants. The cessation of the operation of Unit III in Ptolemaida plant since the accident, had an additional negative impact, since 50 MW_{th} of thermal energy for district heating, provided to the nearby city of Ptolemaida were lost, causing a gap to the energy needed for the heating of city's households. This was the case with the Unit I of Liptol lignite-fired power plant which provided 25 MW_{th} of thermal energy to the city of Ptolemaida (decommissioned in 2014). It's obvious that closing down the aforementioned TPPs that are currently providing thermal energy to the towns of Western Macedonia will create the need to identify and develop alternative sources of energy.

Ptolemaida V is to be the fifth coal-fired unit at the Ptolemaida power station, with a generating capacity of 660 MW. The total projected budget for the construction of the plant is 1.32 billion euros, of which German investment bank KfW will provide 700 million euros. The plant was permitted in March 2013. The plant will be constructed on the site of a dismantled lignite mine. Construction was set to begin in 2015, and the plant was scheduled to begin commercial operation in 2019, but, due to the economic tightness of PPC, construction on the new unit began in 2016 and it is now planned for 2022.

In the mid-term planning of PPC it is foreseen the construction of a second unit in Meliti - Florina (Meliti II) of 450 MW gross nominal capacity (already included in PPC's investment programme), while PPC has revealed publicly its plans to extensively upgrade the Amyntaio Power Station in order to extend its operation beyond 2023. There is also provision for energy supply for teleheating from the new Ptolemaida V Unit (660 MW_e): 140 MW_{th}, and the new Unit II of Meliti TPP (450 MW_e): 70 MW_{th}.

6.2.2 Social aspects

According to the employment data provided by PPC's Human Resources Department, per power station and mine, in 2014 the permanent personnel in all TPPs of PPC reached 1,628 employees and the temporary 346. Similarly, the permanent workforce in the mines accounted for 2,571 employees and the temporary 977. Therefore, the total permanent and temporary personnel employed by the PPC in WMR were 5,522 employees (2014), 4,199 out of which were permanently employed. Based on these data, it is estimated that PPC creates approximately 45.9% of the direct job opportunities in the secondary sector of the region. PPC provides 6.3% of

all the jobs in WMR, without taking into account the indirect employment created (WWF, Economic & Technical Assessment, 2016).

Based on an analysis made and the estimated technology multipliers for WMR, the Technical Chamber of Greece – Department of West Macedonia (TCG-DWM) estimates that for 1 permanent job position in mines or in TPPs in WMR, there are 3.28 positions created and maintained in the local economy. Similarly, every €1 spent by the PPC in salaries and other employer obligations provides €3.09 to the local economy. The study concludes that the withdrawal of 2,400 MW of power from WMR would lead to 12,468 jobs and a local income of approximately €670 million to be lost, as a result of the multiplying effects.

The region of Western Macedonia is already being affected by the upcoming transformation of the energy model and the reduction of lignite activity. According to the local press, since the beginning of 2016 the contractor companies, which carry out 60% of the total mining works, have fired 70 workers, while according to Ptolemaida's Labour Centre another 1,000 jobs are under threat. The limited operation of PPC units is also the reason why companies such as LARCO and METE SA, employing approximately 350-400 workers, are expected to cut down significantly the operation hours of the lignite mines they control.

The numbers speak for themselves. Based on the latest official data from the Hellenic Statistical Authority (ELSTAT), the projected retirement of approximately 3,500 MW of lignite capacity currently operating in the Region of Western Macedonia (WMR) by 2030 will lead to a loss of 6,128 jobs and € 1.14 billion local income in a region that is already a champion in unemployment. Insisting on constructing new lignite plants such as Ptolemaida V and Meliti II, will not solve the problem, since they can recover only 30% of the losses, despite the fact that their construction will require investments of about € 2.5 billion.

More precisely, according to the Environmental Impact Assessment of Ptolemaida V, the unit will create 250 permanent jobs. To estimate the number of jobs that will be created in the mines, the job indicator per unit of power in the Kozani RU was used, leading to 662 direct employment opportunities. If the funds required to construct a second unit in Meliti (Florina RU) of a total 450 MW of nominal capacity will be secured, the permanent jobs in the TPP are estimated to around 170, while the respective number of jobs in the mines (calculated using the pre-calculated indicator of the RU of Florina and the power of the new unit under plan) rise to 335 jobs.

6.2.3 Economic effect

The lignite industry in Western Macedonia strongly affects the regional economy in a multidimensional way, which can be systematized into direct, indirect and inductive effects. The direct effects are mainly characterized by the effects that arise mainly from lignite industry and include the primary production, jobs and employee salaries. The indirect effects include investment and expenditure on products, services and goods required for the proper lignite industry function. Indirect effects originated from the satellite business as well as from the jobs that are created by the aforementioned requirements. The induced effects are pointed to the wealth and jobs. They are the result of workers incomes that are employed directly or indirectly in the lignite industry.

The quantitative characteristics, emerging with regard to the lignite industry influence on both wealth creation and local labour market, are summarised as follows (TCG-DWM, 2012):

- At the peak of lignite production, more than 34% of the Gross Added Value of the Region of Western Macedonia, about € 1.5 billion, came from the mining and energy sector, wile 22.5 thousand of direct, indirect or inductive jobs are related to the power production industry.
- For each permanent staff position in the lignite mining and power production, 3.28 positions are created and maintained in the local labour market. For each Euro spent by the lignite

industry in salaries and sub-contracting, more than three Euros are inductively generated to the local economy cycle.

- Decommissioning of 300 MW lignite power would deprive the local economy by 83 million EUR on annual basis. If 2,400 MW are decommissioning, without equivalent support measures, the results may be extremely catastrophic for the regional socioeconomic status.

Furthermore, from the comparison of Annual Gross Value Added in Western Macedonia Greece with the relevant figures of Greece, it is concluded that Western Macedonia entered in the economic downturn in 2006, before the start of national economic crisis (2009). On the other hand, the economic crisis effects have milder features in Western Macedonia than in the rest of Greece. The abovementioned findings are the result of the regional productive model structure. The labour market dependence on the lignite industry is prevailed. This high dependence on lignite industry is a financial mound against the widespread economic downturn.

A gradual decline in total Gross Value Added at Western Macedonia level has been observed since 2009, with a simultaneous increase of energy sector impact. This means that the relatively stronger shrinkage of other manufacturing sectors in Western Macedonia highlights the mining industry more and more dominant in the local economy. In 2000, only 32% of the Gross Value Added in Western Macedonia came from lignite while in 2014 the percentage rose to 42% (TCG-DWM, 2018).

A first phase of local lignite industry shrinkage occurred during the period 2010 – 2015, where 663 MW of the oldest lignite-fired units have ceased operation. In parallel lignite electricity production has lost its significant position in the Greek energy mix. A second, more severe wave of lignite sector reduction will occur in 2020, due to the 6 lignite-fired units planned operation termination dealing with 1812 MW capacity, according to the existing environmental limitations.

Furthermore, according to the proposed National Strategy for Adaptation Measures to Climate Change, Ministry of Environment & Energy (2015), where regions vulnerability was examined in terms of economic activity sectors, it was estimated that the local negative impact could possibly be fourfold compared to other Greek regions, mainly derived from the reduction of lignite mining.

6.2.4 Environmental effect

Obviously, the extensive use of poor-quality lignite in the TPPs is responsible for a significant proportion of the country's emissions of SO_2, NOx, particulates, and CO_2. During the 1980s and 1990s, PPC instigated a programme aimed at improving the efficiency of its major power plants and their associated pollutant control systems. A major goal was to reduce levels of particulates and SO_2 – significant investments have since been made in order to minimise these. In addition, Environmental Management Systems (EMS) status has been certified for lignite-fired power plants such as Meliti, Amyntaion and Kardia. The West Macedonia Lignite Centre has also been granted EMS certification (according to ISO 14001:2004).

According to PPC's recent annual business plans, any new PPC power plants will comply fully with the Industrial Emissions Directive (Directive 2010/75/EU) - IED's provisions for new installations. With only small-scale interventions, the newest lignite-fired units (e.g. Meliti-Florina) will meet the IED provisions. Older lignite-fired units (expected to operate post-2016) such as Kardia, Amyntaion and Agios Dimitrios will face greater problems and may require considerable expense for necessary upgrades. PPC continues to follow IED developments and assess all technical, environmental and economic elements, in order to reach to the best solution for their lignite-fired fleet.

As part of its contribution towards the country's "National Emission Reduction Plan" (NERP), and the EU environmental Directive 2001/80/EC on the limitation of atmospheric pollutant emissions, PPC is continuing to undertake actions aimed at reducing power plant emissions (primarily SO_2,

NOx and particulates). In some cases, older lignite units are now only operated for a limited number of hours. Such limited running has helped to reduce overall SO_2 (and other) emissions. As part of its monitoring programme, PPC operates a network of 35 stations that measure air quality and meteorological parameters in the areas around its power plants and mining sites.

The emission limit values for SO_2 from lignite-fired combustion plants depend on plant capacity, age, fuel characteristics, and hours of operation. For existing smaller plants, a sliding scale is applied. However, for larger plants (rated thermal input >300 MW_{th}), at least 95% desulphurisation rate is required – the maximum permissible emission limit value being 400 mg/m^3. All future new plants will be expected to achieve 200 mg/m^3. Currently, no FGD (a technique used for desulphurization) plants are operating only on Amynteon Units I and II, or Kardia I and II.

For plants of >500 MW_{th}, the limit is 500 mg/m^3. From 1 January 2016, the general IED NOx emission limit values for existing plants are 450 mg/m^3 for lignite-fired combustion plants with a rated thermal input of 50–100 MW_{th}, and 200 mg/m^3 for 100–300 MW_{th}. There are some exceptions to these – for instance, where specified plants operate for only a limited number of hours a year. No Greek power plants currently deploy deNOx systems such as selective catalytic reduction (SCR), although some have adopted primary measures and/or fitted low NOx burners.

As regards particulates, Greek power plants are equipped with ESP units. Historically, some units have been upgraded via the installation of new, improved systems. As part of this, starting in 1987, PPC instigated a programme for reducing particulate emissions from its power plants. This focused mainly on replacing and upgrading existing ESPs, plus the addition of new state-of-the-art high-performance units (Units I-II of the Kardia plant, Units I-IV of Ptolemaida, Units I and II of LIPTOL, Units I-IV of the Agios Dimitrios plant). This was carried out under the terms of the EU Directive 96/61/EC on Integrated Pollution Prevention and Control, and the Best Available Technologies Reference Documents on Large Combustion Plants. The implementation of the programme led to a significant improvement in ambient air quality, particularly in areas around power plants. To date, significant reductions have been achieved. For example, in the Ptolemais/Kozani region, between 2007 and 2010, airborne particulate levels fell by 55%. The reduction at Agios Dimitrios was 90%, and at Kardia, 41%.

Greek fly ash produced is usually classified as type C (according to ASTM C 618). It exhibits both pozzolanic and hydraulic behaviour. Ash from power plants in Western Macedonia is classified into two groups:

- calcareous ash (from Agios Dimitrios, Kardia and Ptolemais power plants) with a total calcium content of 25–50% and containing 20–35% silica; and
- siliceous ash (from Amynteon and Meliti plants) with a total calcium content of 5–25% and silica content of 35–50%.

Potentially, there are a number of outlets for fly ash that include road construction, incorporation into mortars, waste treatment, embankment construction, and cement grouting. It has also been used in major construction projects.

6.3 Coal mining and coal utilization policies

6.3.1 National policy

For some years, as with many other countries, Greek energy-related priorities were focused on safeguarding and managing energy resources such that they provided a secure, uninterrupted supply, capable of meeting national requirements. They also centred on the viable and sustainable development of the energy sector (from production through to end-use) in an environmentally acceptable manner. The aim was to meet the country's energy needs by accessing a variety of

energy sources that included an increased reliance on domestic resources and the greater uptake of renewable energies.

In addition, in order to increase competitiveness, the strategy envisaged that the energy sector would be increasingly liberalised. Monopolies in the electricity and natural gas sectors would be ended; this move was expected widely to increase significantly the participation of the private sector. However, whereas some goals remain under consideration, others have been affected by recent political and economic events.

Lignite is virtually the only fossil fuel available in Greece. Greece imports 100% of the natural gas and 98% of the oil consumed in the country, with an energy dependency rate as high as 62.1% (2013) as opposed to an average 53.2% for the EU-28.

The need to use local domestic resources and the traditionally low cost of lignite were the reasons why Greece back in the 1950's turned to lignite combustion as the backbone of its electricity system. However, in the past few decades, a debate has been initiated (albeit timidly) about the country's transition to the post-lignite era, as a result of a number of factors: the EU Directives on the reduction of CO_2 and industrial emissions, the increasing public awareness of environmental and public health issues, the gradual depletion of the reserves, the introduction of natural gas in the country's energy mix, and the dramatic drop in the cost of renewable energy sources.

From 2002 onwards, there has been a gradual reduction noted in the share of lignite in covering Greece's electricity demand. For example, the share of lignite in the electricity distributed to the interconnected system dropped from 69.8% in 2002 to 38% in 2015. Between 2014 and 2015, lignite power production dropped by 14.5%, which was offset by an increase in the share of RES (12.8%), natural gas (14.6%), hydro power (38%) and energy imports.

Since 2015, a number of significant changes were proposed for parts of the Greek energy sector. Thus, although a strong commitment to renewables remained in place, the government announced plans for the greater use of domestic lignite resources, primarily for electricity generation, as well as development of a new major gas pipeline (the east Mediterranean gas pipeline). However, this may not now happen as more recent government announcements suggest a gradual reduction in the use of all fossil fuels, coupled with the greater use of renewables. Alongside these measures, there will also be sustained emphasis on improving energy efficiency in general, viewed as an effective cost-effective means for simultaneously cutting emissions and reducing fuel poverty.

A further important move has been the reversal of an earlier decision to privatise the PPC – the Greek government currently owns 51% of the company. PPC is responsible for generating ~72% of Greece's electricity from its 98 power plants, which are fuelled predominately by lignite, oil and natural gas. It also owns and operates major lignite mines at Ptolemais and Megalopolis. In 2014, despite strong protests from the workforce, the previous government approved legislation paving the way for the sale of 30% of the company. There were particularly strong protests over the proposed sale of the Florina power plant to foreign investors.

In the case of PPC, a new vertically integrated company "small PPC" was to be created, comprising 30% of PPC's mines, generation and supply activities. This approach was proposed for the partial PPC sell-off to the private sector. Discussions focused on the possible sale of between four and six lignite-fired units. An Implementation Law (4273/2014) detailed the units for sale. These included the Amyntaio I and II lignite-fired plants (total capacity of 600 MW), the existing Meliti I lignite-fired plant (330 MW), the generation license for the proposed Meliti II lignite-fired plant (450 MW), plus 903 MW of hydropower capacity, the Komotini gas-fired plant (485 MW), and PPC's rights to extract lignite from the Amynteon (including the Lakkia mine), Kleidi, Lofoi Melitis, Komninon I & II, and the Vevi mines (in which PPC has concessions for 40% of the reserves).

But in January 2015, the new government announced that it would freeze privatisation plans and suitably restructure PPC. Halting privatisation was viewed as a crucial first step in the process of redeveloping the Greek energy sector. However, the financial crisis continues to have major impacts on PPC's day-to-day operations. During the first quarter of 2015, reports in the media suggested that the company was owed more than €2 billion in unpaid electricity bills. The associated shortfall in income means that PPC has been forced to rely on its cash reserves, increasing the risk of destabilising the company's investment plans and impacting on planned future operations.

At the moment, more than 93% of Greece's energy is provided by fossil fuels, compared to the European average of 75%. Domestic lignite currently produces ~48% of the country's electricity (not taking into account imports of 9857 GWh). It is also important to mention that the energy sector in Greece has a higher contribution to growth value added (GVA) and employment than in most other EU countries.

Significant investment in the energy sector is needed. In the period up to 2020, various forecasts suggest a figure of between €22 and €30 billion. This will be needed for upgrading existing power plants, the construction of new generating capacity, improvements to the grid, and the installation of more renewable energy sources. It will include €1.4 billion for the lignite-fired Ptolemais V plant, currently under construction. However, in the foreseeable future, no other lignite- or gas-fired power plants are planned (either by PPC or the private sector). Thus, the scale of investment noted above may be overly optimistic.

As regards renewables, the Greek renewable energy policy is guided by EU requirements. There is a legally binding target for renewable sources to generate 40% of the country's electricity by 2020. In 2010, Greece endorsed its National Renewable Energy Action Plan (NREAP) covering the period 2010 to 2020. This ambitious plan aims to reform the country's energy sector such that by 2020, 20% of primary energy will be provided by renewables (40% electricity, 20% heat, and 10% transport). The aim is to produce this using a combination of ~7.5 GW of wind power, together with 2.2 GW of PV, 250 MW of CSP plants, 120 MW of geothermal energy, 250 MW of bio-energy installations (biogas and solid biomass), 250 MW of small hydro plants, plus an additional 350 MW of larger hydro plants and 880 MW of pumped storage.

In the electricity sector, the biggest contributions are expected to come from existing hydro, plus new wind and PV capacity. In particular, both wind and PV have experienced significant growth during the past few years. By 2013, wind capacity amounted to more than 1.8 GW, with PV at 2.58 GW. Although the country's financial problems have undoubtedly hampered the process, there has been a steady increase in the amount of renewables-based capacity installed and investment made. However, the various cuts in incentives, coupled with the current general difficulty of raising funds for new projects, had an impact of the viability of some projects.

In the future, renewables are expected to be of greater importance for both the mainland and the islands that lack connection to the mainland grid – a major priority for many is their eventual interconnection. This would result in the closure of some older island-based oil-fired plants, plus the development of local renewables-based generation facilities (using wind, solar and geothermal) and supply of the excess electricity to the mainland via new grid connections. An estimated €5 billion will be required for grid reinforcement and new interconnections.

Last, but not least, it must be mentioned that in early 2018 the process for developing the National Energy and Climate Plan (NECP) for 2030 (and beyond) started. The draft NECP that was submitted to the EC in the end of 2018 foresees the following:

- Binding national 2030 target for non-ETS GHG emissions under ESR compared to 2005: -16%
- Annual national non-ETS GHG emissions reductions 2021-2030: -31%
- Planned share of energy from renewable sources in gross final consumption of energy: 31%

- Estimated share of RES in the heating and cooling sector: 32.3% (from 15.23% in 2016)
- Estimated share of RES in the electricity sector: 56.4% (from 24% in 2016)
- Estimated share of RES in the transport sector: 20% (from 2% in 2016)

- National contribution for energy efficiency:
  - Primary energy consumption in 2030: 22.2 Mtoe
  - Final energy consumption in 2030: 18.1 Mtoe
- Level of electricity interconnectivity by 2030: 13-13.5%

According to the Greek NECP, a key challenge for the coming period is the reduction of the country's energy dependence, along with the promotion of the decarbonisation of the energy system, including the gradual reduction of domestic lignite fuel production, making it imperative to exploit the high domestic RES potential. Given that natural gas, although a fossil fuel, has lower greenhouse gas emissions than conventional fuels, the substitution of oil or lignite with natural gas is an intermediate policy step forward in reducing greenhouse gas emissions.

The essential characteristics of the electricity generation system until 2040 are presented in the table below:

Table 40: GR: Characteristics of the electricity generation system

Electricity generation	2016	2020	2025	2030	2035	2040
Installed Capacity (GW)						
Solid Fuels - Lignite	3.9	3.4	3.5	2.7	1.5	1.3
Oil	1.7	1.8	1.0	0.5	0.1	0.1
Natural Gas	5.2	5.2	5.2	5.4	4.9	4.6
Bioenergy	0.1	0.1	0.1	0.3	0.3	0.4
Hydroelectric	3.4	3.4	3.7	3.9	3.9	4.0
Wind farms	2.4	2.8	4.0	6.6	7.3	7.4
PV	2.6	3.5	5.3	6.8	7.4	8.0
Solar thermal plants	0.0	0.0	0.1	0.1	0.1	0.1
Geothermal	0.0	0.0	0.0	0.1	0.2	0.3
Total	19.3	20.3	23.5	27.8	27.6	28.0
New power of storage systems	0.0	0.0	0.0	0.7	0.7	0.7
Net Electricity Generation (GWh)						
Solid Fuels - Lignite	14,800	13,128	9,213	9,026	5,197	4,588
Oil	5,381	3,529	2,913	1,536	1,525	1,509
Natural Gas	13,218	17,163	15,265	10,255	13,017	11,503
Bioenergy	253	269	518	1,736	2,023	2,361
Hydroelectric	5,603	5,152	5,983	6,269	6,361	6,453
Wind farms	5,146	6,575	9,491	15,508	17,302	18,055
PV	3,930	5,655	8,319	10,342	11,039	11,827
Solar thermal plants	0	0	257	260	264	267
Geothermal	0	0	0	631	1,301	1,971
Total	48,339	51,471	51,959	55,563	58,029	58,533
Net imports [GWh]	8,796	6,200	5,196	4,156	3,460	5,191

In particular, the total installed capacity for electricity generation will be increased by 44%, mainly due to the significant penetration of variable RES plants, as variable RES have a lower utilisation rate in relation to conventional thermal power plants. The installed capacity of lignite plants and

petroleum plants is expected to decrease by 1.3 GW individually in 2030 in relation to the year 2016, while the total installed capacity of RES shall increase by 9.2 GW in the same period, with more than 90% of the increase occurring in wind farms and solar parks (see below Graph).

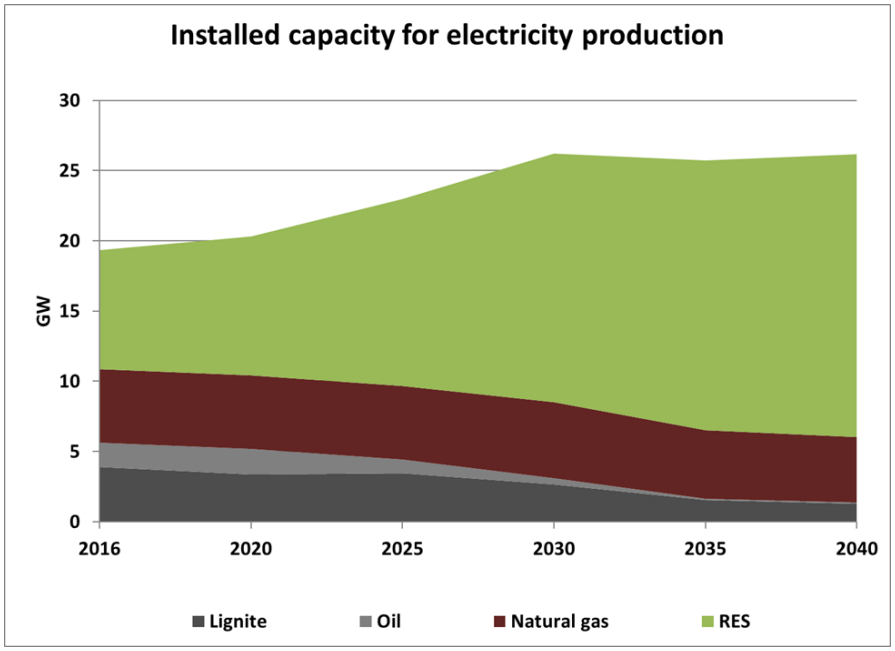

Figure 17: GR: Evolution of the installed capacity of electricity generation plants in Greece until 2040

Source: Draft NECP for Greece

One recent development as regards the national policy is that, the (new) Prime Minister, in his speech to the special UN Climate Action Summit (21-23/9/2019), announced that the (new, i.e. the one that came up from the parliamentary elections of July 2019) Greek Government's goal is to shut down all lignite-fired power plants by 2028 (instead of the initial plans for 2050). This has forced the radical change of the Greek NECP's objectives, targets, etc. (that was supposed to answer to the Commission's remarks / requests for clarifications to the draft submitted in January 2019 only), which now foresees the RES participation in gross final energy consumption to rise to 35% (from 31% in the draft NECP), with a 61% share for RES in the gross final electricity consumption in 2030 in association with the phasing out of all lignite fired power plants by 2028. No further details can be given now, as the final NECP's full texts are expected to be given to consultation with the Greek energy market stakeholders in November 2019.

In addition, and as regards the development plans for the areas that will be affected most by the transition to a low-carbon economy, in the NECP is mentioned that the challenges faced by lignite-dependent areas for the transition to a low-carbon economy can be tackled with tailored solutions to support structural transformation and accelerate the process of economic diversification and technological transition. The aim is to elaborate a sustainable development strategy plan, focusing on the sectors with dynamic prospects in terms of output, employment and income indicators. In this case, local satellite companies of every scale will be mobilised so that every region or local society can reap the benefits of switching to clean energy, new jobs be created and investments in new technologies be promoted.

Particular reference is also made to the financing of development actions in the areas of Greece whose economy is strongly dependent on coal mining for electricity generation. Already, for the period 2018-2020, Greece will auction part of its revenues from greenhouse gas emission allowances of at least EUR 60 million to finance low carbon and environmental footprint development projects in the Florina and Kozani Regional Units of WMR and in the Municipality of Megalopolis to support the fair transition of these areas through the creation of a "Special Account

for the Fair Transition of Lignite Areas". The development operations to be financed on an annual basis for revenue sharing from auctioning allowances shall be generated through an open public consultation on the basis of the following axes:

- Development of clean forms of energy by funding projects implemented by energy communities with the participation of natural persons and/or local authorities and/or legal persons governed by private/ public law, aiming at the promotion of RES and the reduction of energy poverty. This axis could include generally self-generation projects with the possibility of utilising the existing energy infrastructure.
- Energy savings: improving the energy performance of public/private buildings in compliance with the minimum energy performance requirements of buildings and tackling energy poverty.
- Support for the primary sector: promoting energy crops, namely locally produced biomass for the supply of alternative district heating systems and enhancing local crops with high added value (e.g. saffron). Geothermal field utilisation projects could also be included in this axis to support greenhouse crops and greenhouse parks, as well as circular economy operations with the treatment of sewage sludge and the disposal of products as soil improvers, land reclamation and/or irrigation projects, etc.
- Interventions in the field of circular economy/exploitation of secondary materials: treatment of sewage sludge and disposal of products as soil improvers, use of ash, etc. with emphasis on the respective actions/projects/priorities of the National Circular Economy Plan.
- Industrial heritage: utilising lignite stations to promote the industrial heritage of the lignite areas of Greece.
- Implementing integrated action programmes in the field at work (e.g. new forms of energy, agri-food industry, tourism, subsidising new jobs in companies dealing with systems or techniques for managing and saving energy, or energy upgrading, etc.) as well as training programmes in the above areas.
- Implementing entrepreneurship and innovation support programmes in various sectors and especially in those mentioned above.
- Providing technical support to potential beneficiaries for the maturation of projects/actions for public projects.

The Fair Transition Support Initiative will continue over the period 2021-2030 through the use of a potential surplus of auctioning revenues, while the possibility of using Special Account funds to co-finance actions whose main funding comes from other sources is already being considered. It is also aimed that "Fair Transition" be supported through other financial instruments from the period 2021- 2027.

6.3.2 Regional and local policy

The current policy of WMR is reflected in the Western Macedonia Operational Programme (OP) 2014-2020. The Programme aims to boost economic development and create job opportunities in West Macedonia. It contributes to achieving Europe 2020 targets for smart, sustainable and inclusive growth, also in line with the smart specialisation strategy. It should create jobs and help SMEs to become more competitive and innovation driven. EU funding will also contribute to meeting the requirements of the Union's acquis, in particular as regards greenhouse gas reduction in CO_2 and increase energy efficiency.

The OP support will substantially contribute to promoting the following key EU and national development priorities:

- "Strengthening research, technological development and innovation" (ERDF – 3.13% of EU allocation).
- "Enhancing access to, and use and quality of, ICT" (ERDF – 3.13% of EU allocation).
- "Enhancing competitiveness of SMEs" (ERDF – 9.40 % of EU allocation).
- "Supporting the shift towards a low-carbon economy in all sectors" (ERDF – 8.26% of EU allocation).
- "Promoting climate change adaptation, risk prevention and management" (ERDF – 7.36% of EU allocation.
- "Preserving and protecting the environment and promoting resource efficiency" (ERDF – 18.48 % of EU allocation).
- "Promoting sustainable transport and removing bottlenecks in key network infrastructures" (ERDF – 16.34% of EU allocation).
- "Promoting sustainable and quality employment and supporting labour mobility" (ESF – 0.53% of EU allocation).
- "Promoting social inclusion, combating poverty and any discrimination" (ERDF – 7.03% of EU allocation).
- "Promoting social inclusion, combating poverty and any discrimination" (ESF – 6.44 % of EU allocation).
- "Investing in education, training and vocational training for skills and lifelong learning" (ERDF – 18.06 % of EU allocation).
- "Technical Assistance" (ERDF – 1.71 % and ESF – 0.13 % of EU allocation respectively): provision of technical assistance.

As regards the expected impacts, these are the following:

- Support of more than 240 SMEs and promotion of cooperation with research institutions
- 50% additional population should benefit from e-government services
- Creation of 200 new full-time equivalent employment positions
- 60 public buildings should receive support for energy efficiency and annual greenhouse gas emissions reduction of 5,550 CO_2 tons is expected
- Improved anti-flood measures and waste treatment infrastructure for additional 2,000 inhabitants and additional 95,000 from forest fire prevention measures
- Protect additional 60,000 ha of Natura sites and cover 24,000 additional inhabitants by waste treatment infrastructure
- Cover more than 70,000 additional people by improved healthcare services and some 12,800 disadvantaged citizens by "Health Safety Net" actions
- The construction of 6.7 km of new road and 40 km of road upgrade should be supported
- 4,500 more people should benefit from measures improving education infrastructure.

It must be further mentioned that, although the draft of the National Energy and Climate Plan (NECP) has been prepared and submitted to the EU for commenting, etc., there are no specific targets (for 2030 and beyond, i.e. until 2050) in it for each country's regions (so no specific targets for WMR too). The energy related decisions (thus, also those concerning coal's mining and utilization for power generation) in Greece are centralized at national level and it is basically the competence of the Hellenic Ministry of Environment and Energy (the regions and/or local municipalities have no power there, i.e. in drafting energy plans, etc.).

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7 Poland, Upper Silesia Region

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7.1 Region overview

Upper Silesia has an area of 12,209 km² and is located in southern Poland at Silesian Lowland, Silesian-Cracow Upland, the Oświęcim Basin, the Westbeskid Foothills, and the Western Beskids. In the north-south dimension, the province extends over a length of 189 km; in the east-west dimension, the region span is 138 km. The shape of the surface is upland and mountainous. The highest point is at the top of the Five Mounds Mountain, which is 1,534 m above sea level.

At the end of 2017, the population of the Silesian Voivodeship amounted to 4.55 million people. The province has the highest degree of urbanization and population density: 77% of its population live in towns and cities. The population density is 379 people per square kilometre (compared to the national average of 124). The downward trend in the number of inhabitants has been maintained for years: compared to 2016, the number of inhabitants at the end of 2017 was lower by 0.2%. People of a pre-working age (up to 17 years of age) constituted 16.9% of the population, people of a working age (18-64 years of age for men, 18-59 years of age for women) constituted 61.1% of the population, and people of a post-working age constituted 22% of the total number of inhabitants. The share of women in the total number of inhabitants in 2017 was 51.8%. The balance of internal and international migrations for permanent residence was negative and amounted to minus 4.2 thousand people (Provincial Environmental Protection Inspectorate, 2018).

According to the Statistics Poland (GUS) data, in 2013 women in the Silesian province lived on average 80.1 years, while men lived on average 72.4 years. A favourable trend that could be observed between 2006 and 2013 was a systematic increase in average life expectancy. Compared to 2006, women in the Silesian Voivodeship lived on average 1.3 years longer, while men lived on average 1.9 years longer (Regional Centre of Social Policy of the Śląskie Voivodeship, 2015).

Upper Silesia does not have one centre devoted to metropolitan functions. The administration, universities, cultural units, and corporate headquarters are primarily concentrated in the largest cities of the region: Katowice, Chorzów, Tychy, Sosnowiec, Bytom, Rybnik, Gliwice, and Zabrze. Silesia Voivodeship Office is located in Katowice.

7.1.1 Social situation

In 2017, 7.7% of the residents worked in the agricultural sector (agriculture, forestry, hunting, and fishing), 37.8% worked in industry and construction, 20.7% worked in the service sector (trade, vehicle repair, transport, accommodation and catering, information, and communication), and 3.5% worked in the financial sector (financial and insurance activities, real estate services). In 2018, there were 1,873,000 employed in the region, of whom 1,020,000 were men and 853,000 were women. 659,000 of those who were employed had higher education; 721,000 had a secondary education, 435,000 had vocational education, and 58,000 had only a primary education (Statistics Poland, 2019).

The rate of extreme poverty (population with incomes below the subsistence level) in 2016 in the Silesian Voivodeship was at the level of 3.0%. The rate of relative poverty (where a household's expenditure amounted to 50% less than that of the average household in the country) in the Silesian Voivodeship was at the level of 10.3% of the total population in the region. Since 2013, some actions were taken to deal with a reduction in the level of poverty in the region of Upper Silesia (Regional Centre of Social Policy of the Śląskie Voivodeship, 2017).

In 2013, the gross enrolment rate for primary schools was 98.93% (compared to an enrolment rate of 98.58% for Poland). For vocational schools, the gross enrolment rate was 14.90% (compared to an enrolment rate of 14.63% for Poland); the gross enrolment rates were 58.92% for general upper secondary schools (with Poland at 59.19%), 48.38% for vocational and general vocational schools (with Poland at 43.75%), and 25.19% for post-secondary schools (with Poland at 19.26%). At the province's 41 universities, constituting 9.4% of the universities in the country, in 2013 there were 144,545 students, i.e. 9.3% of the students in the country. Among them, 58% were women and 42% men (Regional Centre of Social Policy of the Śląskie Voivodeship, 2015).

In the Silesian Voivodeship, as in the whole country, the demographic aging of the population is observed. In 2013, persons belonging to the 65-69 age group dominated in the elderly population. They constituted 30.9% of all seniors. As the age range increased, the share of a given category decreased, therefore 25.5% of all seniors were in the age range of 70-74 years, 20.5% were in the age range of 75-79 years, and 14.0% were in the age range of 80-84 years, while the oldest seniors, aged 85 years or more, accounted for 9.1% of all seniors. A phenomenon commonly occurring in the modern world is the feminisation of the elderly. It is also present in the Silesian Voivodeship. In 2013, among people aged over 65, women accounted for 60.7%. With the increase in the age category, this share increased. In the case of persons belonging to the range of 65-69 years, it amounted to 55.8%, but it amounted to 58.4% among persons belonging to the age range of 70-74 years, 61.4% among persons belonging to the age range of 75-79 years, and 65.7% among persons belonging to the age range of 80-84 years, while women accounted for 74.2% of the population aged 85 or more years (Regional Centre of Social Policy of the Śląskie Voivodeship, 2015).

In the Silesian Voivodeship, as of the end of May 2019, the unemployment rate was low (4.0%). Among the unemployed, however, the long-term unemployed represented a 47.1% share of the total number of registered unemployed. Persons up to 30 years of age constituted 22.2% of the unemployed, while those over 50 accounted for 28.9% of the unemployed. The share of people with at least one child up to 6 years of age amounted to 20.4%, and the share of disabled people amounted to 7.7%. Only 2.5% of the unemployed were using social assistance benefits, however (Statistical Office in Katowice, 2019).

Currently, representatives of 13 national and ethnic minorities live in the Silesian Voivodeship. The most numerous national minority is the German nationality (according to the census in 2011) with 35,000 citizens. The second-largest minority are the Roma, who in Upper Silesia number exactly 1,733. On the next place in statistics were Ukrainians (1,041 people), Russians (829), Czechs (580), Jews (557), Belarusians (352), Slovaks (264), and Lithuanians (188) (source: Silesian Voivodeship Office).

7.1.2 Economic development

The Silesian region is the most industrialised region in Poland. The most important regional industries are mining, iron, lead and zinc metallurgy, the power industry, engineering, automobile, chemical, building materials, and the textile industry. There are 19 coal mines operating in the region. Most of the mining is derived from the Upper Silesian Industrial District (Górnośląski Okręg Przemysłowy) and the Rybnik Coal District (Rybnicki Okręg Węglowy) with its major cities, Rybnik, Jastrzębie Zdrój, Żory, and Wodzisław Śląski. The coal mining industry dominated the Silesian economy in the past, but nowadays other industries, such as car manufacturing, steel production,

transport, machinery, and chemical industries, are becoming increasingly important. There are almost 200,000 companies and enterprises operating in the region, and 60% of them are in the service sector.

At the end of 2017, 469,900 thousand companies were registered in the Silesian Voivodeship. The largest number of companies was involved in the wholesale and retail trade (123,300), vehicle repairs (123,300), construction (52,800), professional, scientific, and technical industries (44,900), and industrial processing (44,800) (Provincial Environmental Protection Inspectorate 2018).

Per capita income in the Śląskie Voivodeship in April 2019 was 5,325 PLN (1,250 EURO) (approximately 1,150 GBP).

In 2017, there were almost 25,000 km of public roads in the Śląskie Voivodeship, of which highways constituted 175 km and expressways represented 132.5 km. The density of roads was 176.8 km/100 km^2; the density of expressways and motorways was 2.49 km/100 km^2. The length of the railway lines was 1,943 km, with a density of 15.8 km/100 km^2 (Statistics Poland, 2019).

The Silesia has an international airport, Katowice Airport. In 2018, it served 4.838 million passengers and 18,500 tonnes of cargo.

The gas network in 2017 was 17,500 km, and its density was 129.4 km/100 km^2. In cities, the density of the gas network amounted to 256.3 km/100 km^2, and in rural areas it amounted to 73.2 km/100 km^2. The length of the sewerage network in the Śląskie Voivodeship at the end of 2017 amounted to 16,300 km. The density of the sewerage network was on average 131.9 km/100 km^2, while the rate reached 276.6 km/100 km^2 in urban areas and 67.7 km/100 km^2 in rural areas (Provincial Environmental Protection Inspectorate, 2018).

7.1.3 Environmental situation

Over half of the land area in the Śląskie Voivodeship was arable land (50.9%). The area of forest constituted 33.4%, urbanised lands 12.6%, waters 1.5%, and wasteland 1.1%. The area of degraded land requiring reclamation on 31 December 2017 was 5,259 ha. In comparison with the previous year, the area of degraded land had increased by 10.9%. The principal factor affecting the formation of degraded land was mining activity. The functioning of this industry was responsible for the degradation of 92.1% of all degraded lands. In 2017, 42 ha of land were re-cultivated, including 16 ha for agricultural purposes and 2 ha for forestry (Provincial Environmental Protection Inspectorate, 2018).

The average annual concentrations of PM10 in 2017 ranged from 62% to 139% of the value considered acceptable (40 µg m-3). The number of exceedances of the permissible level of 24-hour concentrations of PM10 was higher than the permissible frequency of 35 days per year. The limit values for PM2,5 (25 µg m-3) in 2017 were exceeded at eight out of nine measuring stations (Provincial Environmental Protection Inspectorate, 2018).

The unit load of the substance deposited with atmospheric precipitation in the area of Upper Silesia was 62 kg ha-1 in 2017 and was higher than the average for the entire Polish area by 30.5%. The quantities of deposited substances decrease in number: SO4 > Nt > Cl > Ca > NNO2-+NO3 > K > Na > Mg > Zn > P > Cu > H+ > Pb > Ni > Cd > Cr (Provincial Environmental Protection Inspectorate, 2018).

In 2017, monitoring tests revealed that out of 111 Uniform Bodies of Surface Water (UBSW) identified in the Śląskie Voivodeship, only 1 was characterised by good water status. The most important impact on the poor condition of waters was from biological elements (phytobenthos and benthic macroinvertebrates), physicochemical elements (nitrite nitrogen and phosphate), and chemical elements (benzo(a)pyrene, fluoranthene, and nickel) (Provincial Environmental Protection Inspectorate, 2018).

The Upper Silesia region is located in the temperate climate zone and, according to Köppen-Geiger, in the humid continental climate zone (Dfb). The average air temperature for the years between 1960 and 2018 was 8.4°C, and the sum of atmospheric precipitation was 740 mm (Source: https://en.tutiempo.net). The progressive global warming observed for many years is noticeable in the Śląskie Voivodeship. For the monitoring period, the number of days with temperatures exceeding 25°C increased, while the number of days with temperatures below -10°C decreased (Provincial Environmental Protection Inspectorate, 2018).

7.2 Role of coal mining in the region

7.2.1 Coal sector in the region

In Upper Silesia in Poland, 19 coal mines are in operation.

Active mines in the Upper Silesia Coal Basin are as follows:

- Jastrzębska Spółka Węglowa (European Union's largest coking coal producer)
  - KWK Borynia-Zofiówka-Jastrzębie
  - KWK Budryk
  - KWK Knurów-Szczygłowice
  - KWK Pniówek
- Polska Grupa Górnicza
  - Zespolona KWK ROW
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  - KWK Piast-Ziemowit
  - KWK Sośnica
  - KWK Bolesław Śmiały
  - KWK Wujek
  - KWK Mysłowice-Wesoła
  - KWK Murcki-Staszic
- Tauron Wydobycie
  - ZG Nowe Brzeszcze
  - ZG Janina
  - ZG Sobieski
- Przedsiębiorstwo Górnicze Silesia
  - KWK Silesia
- Siltech Sp. z o. o., Eko- Plus Sp. z o.o.

The domestic sale of mined coal in 2015 and 2016 reached 64,564,800 and 64,222,600 tons, respectively. The greatest amount of hard coal was sold to professional energy (34,724,300 in 2015 and 32,831,300 tons in 2016). Hard coal in Poland is also sold for industrial power (1,914,100 in 2015 and 1,663,900 tons in 2016), heating plants (4,306,500 in 2015 and 4,569,200 in 2016), coking plants (10,717,400 in 2015 and 10,819,700 tons in 2016) (Programme for the hard coal mining sector in Poland, 2018).

Hard coal consumption in 2016 (last available data) was 38.5 million tons in power plants and combined heat and power plants, 12 million tons in the sector of small customers, and 4.4 million tons in the heating boilers of professional power engineering and in professional and non-professional heating plants (Programme for the hard coal mining sector in Poland, 2018).

Table 41: PL: The most important facts about coal in Poland

2015		2016	2017
coal mines production (million tons)			
63,4		58,0	53,0
coal mines productivity (tons per employee per year)			
700			
coal supply (million tons) to local TPPs, other TPPs, industry, briquetting, export, etc.			
professional energy	64.6	64.2	No data
industrial power	34.7	32.8	No data
heating plants	1.9	1.7	No data
others suppliers	4.3	0.46	No data
coking plants	10.7	10.8	No data
other domestic customers	12.5	13.9	No data
capacity (MW) and electricity generation (GWh) in local TPPs			
No data		No data	Electrical power installed in total: 43,612.0 MW Main activity producer of thermal power plants: 32,233 MW including: Hard coal: 20,989.5 MW Brown coal: 9,286.9 MW
77,649 (GWh)		80,173 (GWh)	79,265 (GWh)

Source: Programme for the hard coal mining sector in Poland, 2018; CIRE, 2019

7.2.2 Social aspects

At the end of 2017, over 435,000 people were working in the industry, of whom 84,000 people were working in the mining and quarrying sector. 10,500 people were working in the electricity, gas, steam, and air conditioning supply sectors at the end of 2017 (Statistical Yearbook of Śląskie Voivodeship, 2018).

In the Upper Silesia there is a very low employment rate among women and among older men and women (less than 25% of women were employed in the Upper Silesia in coal mining, and approximately 35% of men over 50 years of age were employed in the Upper Silesia in coal mining in 2015). The primary reason for women's inactivity concerns the traditional model of a family, in which the man worked in a mine and the woman took care of the housework. The low economic activity of older generations is a result of the so-called "young pensioners." Underground mineworkers can retire after working for 25 years, which for many of them means that retiring age is 45 or 55. Social protection measures in the form of mining leaves have further deepened this phenomenon (Szpor K., Ziółkowska K., 2018)

Table 42: PL: The most important data about the employees in Upper Silesia

Structure of employed persons in the enterprise sector by sections in 2016	Industry 57.9%; including mining and quarrying 11.6%
Average monthly gross wages and salaries in the enterprise sector (Mining and quarrying in Upper Silesia)	2014: 6,916.73 PLN 2015: 6,854.23 PLN 2016: 6,945.75 PLN
Average paid employment in the industry (mining and quarrying)	2015: 98,402 2016: 89,117 2017: 84,662

Persons injured in accidents at work in mining and quarrying	1,485
Per 1,000 employed persons (incident rate)	17.22

Source: Statistical Yearbook of Śląskie Voivodeship, 2018; ARP, 2016.

7.2.3 Economic effect

The economic effect, e.g. in terms of gross value added, is as follows:

Table 43: PL: The economic effect, e.g. in terms of gross value added

Gross value added in Poland in total	2015: 1,597,202 million PLN 2016: 1,643,981 million PLN 2017: 1,746,459 million PLN
Gross value added in Poland in Industry	2015: 417,174 million PLN 2016: 435,749 million PLN 2017: 453,890 million PLN
Gross value added in Poland in Mining and quarrying	2015: 27,914 million PLN 2016: 27,230 million PLN 2017: 31,533 million PLN
Gross value added in Śląskie Voivodeship in total	2015: 197,739 million PLN 2016: 202,337 million PLN
Gross value added in Śląskie Voivodeship in industry	2015: 68,934 million PLN 2016: 71,382 million PLN
Share in gross value added (current prices) in the industry in Poland	2015: 26.1% 2016: 26.5% 2017: 25.9%

Sources: Statistical Yearbook of the Republic of Poland, 2018; Statistical Yearbook of Śląskie Voivodeship, 2018

Table 44: PL: Average nominal monthly wages in coal mine activities

POLAND Average monthly gross wages and salaries in PLN in 2017 in total	4,283.73 PLN
Upper Silesia Average monthly gross wages and salaries in PLN in 2017 in total	4,400.05 PLN
POLAND Average monthly gross wages and salaries in PLN in 2017 in industry	4,365.76 PLN
POLAND Average monthly gross wages and salaries in PLN in 2017 in mining	7,022.39 PLN
Upper Silesia Average monthly gross wages and salaries in the industry	2015: 4,769.95 PLN 2016: 4,792.77 PLN 2017: 5,003.27 PLN
Upper Silesia Average monthly gross wages and salaries in Mining and quarrying	2015: 6,916.73 PLN 2016: 6,854.23 PLN 2017: 6,945.75 PLN

Sources: Statistical Yearbook of the Republic of Poland, 2018; Statistical Yearbook of Śląskie Voivodeship, 2018

7.2.4 Environmental effect

The protection of the environment is a constitutional obligation (Article 86 of the Constitution of the Republic of Poland). As regards the protection of mineral deposits and soils, in connection with the extraction of minerals, this obligation rests with the mining entrepreneur.

The regulations stipulate that the exploitation of the mineral deposit must be executed in an economically justified manner, using measures limiting environmental damage and ensuring rational extraction and management of minerals.

The owner of the mine/company is obliged to perform the necessary treatments to protect the resources of the deposit, the surface of the ground, surface, and groundwater through reclamation of post-mining areas and restoring other natural elements to the proper state.

Due to Polish regulations, the mine owners are obliged to plan, design, and implement land reclamation and development (Art. 20 para. 3 Act on the Protection of Agricultural and Forest Land). Reclamation treatment can be provided a maximum of 5 years after the finished mining process (Source: www.pgi.gov.pl).

Coal Basin in Upper Silesia is around 5,600 km^2, of which:

Table 45: PL: Coal Basin in Upper Silesia

	2015	2016	2017
	[ha]		
Land requiring reclamation (as of 31 XII)	4,889	4,890	5,259
devastated	3,812	3,824	4,175
degraded	1,077	1,066	1,084
Land (during the year):			
reclaimed	108	43	42
of which for purposes:			
agricultural	41	14	16
forest	50	10	2
managed	27	22	10

Sources: Statistical Yearbook of Śląskie Voivodeship, 2018

The extraction and exploitation of bituminous coal exert a number of adverse effects on the natural environment, both in the immediate vicinity of mines and in larger areas.

The negative effects of coal mining are as follows (Bednorz J., 2011):

- pumped saline waters, contaminated by trace elements from the drainage of mining plants (AMD);
- water leaks from dumping grounds to surface and groundwater;
- waste from hard coal mining;
- degraded areas, transformed by mining activities;
- emissions of dust and gas to the air;
- mining damage (caused by mining exploitation and impact;
  rock mass on buildings, roads, infrastructure, agricultural land, and forest land);
- the risk of auto-ignition on post-mining dumping grounds.

Table 46: PL: Reclamation and management of degraded areas and financial expenditures incurred for their implementation (a condition in 2018)

	Area [ha]	Costs [thousand PLN]
Degraded area, taken by recultivation and management works	228.7	27,146.1
Included areas with reclamation and management are finished	7.3	745.4

Source: ARP, 2019

Table 47: PL: Drains sewage to surface waters [thousand m3]

	2010	2017	2018
In total	1,446,699.6	171,179.9	177,042.1
Containing Cl + SO4	11,185.3 (26.8%)	1,368220.8	1,453,314.3 (18.8%)

Source: ARP, 2019

Table 48: PL: Mining waste production [thousand ton]

	2010	2017	2018
In total	29,981.4	29,031.5	28,341.7
Stored on the surface	46.7	7,048.9	6,826.7
Used on the surface	29,806.6	21,753.5	21,452.8
Stored under the surface	698.1	173.1	155.9

Source: ARP, 2019

Table 49: PL: Emission of gases and dust to atmospheric air [tone]

	2010	2017	2018
Gases in total Including Greenhouse gases (methane)	953,438 944,624	812,432 810,272 (502,053)	763,908 761,942 (483,086)
dust	669	940	883

Source: ARP, 2019

Social effects of dust and gas emissions are as follows (Bednorz J., 2011):

- dust increase in heavily urbanized areas, which directly influences health of society;
- higher incidence of lung disease in mining areas than in other regions;
- contamination of plants, waters, and soil that prevents agricultural production or breeding livestock farming;
- a decrease in the attractiveness of mining areas as investment areas;
- the broadly understood threat of the “greenhouse effect”.

Table 50: PL: National sector emissions (from 1990 to 2017) in Poland: Main pollutants, particulate matter, heavy metals, and persistent organic pollutants connected with hard coal mining

PL: 15.03.2019: 2017	NFR sectors to be reported		Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	Priority Heavy Metals (from 1990)			Additional Heavy Metals (from 1990, voluntary reporting)				
			NOx (as NO2)	NMVOC	SOx (as SO2)	NH3	PM2.5	PM10	TSP	BC	CO	Pb	Cd	Hg	As	Cr	Cu	Ni	Zn
NFR Aggregation for Gridding and LPS (GNFR)	NFR Code	Longname Notes	kt	kt	kt	kt	kt	kt	kt	kt	kt	t	t	t	t	t	t	t	t
A_PublicPower	1A1a	Public electricity and heat production	180.08	2.40	260.89	NA	7.10	12.45	14.97	0.16	52.92	26.22	0.71	5.26	4.52	5.69	17.53	14.30	97.75
D_Fugitive	1B1a	Fugitive emission from solid fuels: Coal mining and handling	NA	18.78	NA	NA	0.63	6.33	12.88	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA
D_Fugitive	1B1b	Fugitive emission from solid fuels: Solid fuel transformation	5.13	0.07	2.67	0.05	0.94	1.88	1.88	0.46	13.37	2.07	0.00	0.01	0.19	1.60	0.85	0.61	2.07
D_Fugitive	1B1c	Other fugitive emissions from solid fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NO	NA	NO	NO	NO	NO	NA	NA
	NATIONAL TOTAL	National total for the entire territory (based on fuel sold)	803.66	690.74	582.66	307.52	147.28	246.31	340.60	23.81	2,543.25	305.49	12.37	9.58	16.71	41.61	203.65	90.39	652.48
DATE:	15.03.2019	Share of public electricity and heating in total emissions	22.4	0.35	44.8		4.8	5.1	4.4	0.68	2.1	8.6	5.7	54.9	27.1	13.7	8.6	15.8	15.0

Source: https://www.kobize.pl/pl/fileCategory/id/16/krajowa-inwentaryzacja-emisji

Table 51: PL: Emissions of main pollutants in 2015-2017

Pollutant	SO2 [thousand T]			NOx [thousand T]			NMVOC			PM 2.5			CO2		
Source of emissions:	2015	2016	2017	2015	2016	2017	2015	2016	2017	2015	2016	2017	2015	2016	2017
Total	711.5	590.7	582.7	725.3	742.2	803.7	640.8	674.2	690.7	136.0	141.9	147.3	2,342.6	2,456.5	2,543.3
Combustion processes in the energy production and transformation sector	370.2	261.2	251.3	198.9	178.3	168.9	2.83	2.67	2.55	6.05	6.13	6.03	45.1	47.2	51.2
Combustion processes outside industry	165.6	173.2	170.9	82.6	87.7	85.7	112.7	118.4	116.2	66.3	69.5	68.5	1,456.0	1,529.4	1,505.8
Combustion processes in industry	152.9	133.3	138.8	73.5	70.8	73.4	36.6	37.9	41.3	28.5	28.5	31.0	199.2	196.3	212.8
Extraction and distribution of fossil fuels	2.01	1.99	1.94	1.41	1.39	1.36	49.7	49.4	50.5	676.5	653.2	633.2	0.31	0.31	0.30

Source: Bębkiewicz K., et al., 2019

7.3 Coal mining and coal utilization policies

7.3.1 National policy

This chapter refers to the entire hard coal mining industry of Poland and not only to the Upper Silesia region. At the beginning of the 1990s, however, there were only five hard coal mines outside the Upper Silesia. Four of them were located in Lower Silesia Coal Basin and one in Lublin region. All the mines of the Lower Silesia Coal Basin were phased off based on the decision made in 1990, and only the mine in the Lublin region still exists as the sole hard coal mine in Poland outside Upper Silesia. Therefore, the following information describes the transformation of hard coal extraction primarily in the Upper Silesia.

The production of hard coal in Poland was very high in the 1970s and 1980s, peaking in 1979 when it achieved 201 million tons per year. Such an amount proved to be far too high at the beginning of the 1990s, when the political and economic system of Poland and Eastern Europe had changed. In 1989, Poland regained full independence. Simultaneously, the economic system of Poland changed from a centrally controlled economy to a free-market economy. During this period, the economic conditions for Polish hard coal mining worsened dramatically. The unfavourable conditions included the following:

- economic recession and a decline in overall industrial production;
- decreasing energy demand in the domestic market due to decreasing industrial production, changes in the production structure, and the introduction of energy-saving technologies;
- decreasing coal prices in global markets;
- increasing importance of other energy sources, such as petroleum and natural gas.

Polish hard coal mining encountered unfavourable economic conditions (overemployment, excessive production abilities, centralized management system, a large share of non-productive assets, high level of debts, lack of own financial resources for modernization, outdated machinery, significant negative impact on the natural environment). The prices of the hard coal commodity initially remained frozen and then were centrally regulated while all other prices depended only on the markets. The governmental subsidies for mines proved to be insufficient, however, and, in consequence, at the beginning of the 1990s, the hard coal mining industry fell into serious debt.

The transformation of Polish hard coal mining began in 1989, and it has only just reached its conclusion. The primary objective of the mining restructuring in Poland was to convert it into a profitable, economically effective industry capable of competing on the open market. There were several fundamental preconditions that needed to be fulfilled in order to achieve this goal. These included the following:

- eliminating all non-productive assets and outsourcing several tasks to specialized external entities;
- reduction of employment, since labour costs represented a high share of overall mining costs;
- reduction of coal extraction in order to adapt it to the declining demand for coal.

Several phases of the hard coal mining restructuring process were executed by consecutive governments of Poland. The following description of the hard coal industry restructuring is based on a paper by Paszcza H. (2010):

I phase – 1990 – 1992 – hard coal mines as independent enterprises

The centralized management system of hard coal mining had been eliminated. The five existing Coal Exploitation Companies (in Polish, Przedsiębiorstwo Eksploatacji Węgla) were liquidated, and the Hard Coal Union was replaced by the State Hard Coal Agency ("Państwowa Agencja Węgla Kamiennego" S.A.), which wielded no decision-making powers towards mines. This completely removed any supervision over the mines. In April 1990, the mines were transformed from public-utility enterprises into independent state-owned enterprises.

Restructuring by making the mines independent exerted many negative effects. Competition between the mines increased, and there was a tendency to reduce losses by increasing production without taking into account the real coal demand on the market. In consequence, the coal was sold at prices inadequate to cover production costs. In addition, the mines took out very high interest-bearing loans for current operations, primarily wages and purchases of machinery. These negative effects were quickly noticed and, already in 1991, the government had begun working on the transformation of the entire power production system, including hard coal mines. The assumptions of the new programme included resignation from centrally regulated coal prices, closing of unprofitable mines, and joining the profitable mines into ten independent enterprises that would compete on the national market. This programme has not been launched, however, due to rapid changes in economic conditions and political changes. The short period of independent hard coal mines indicated clearly that this approach was not beneficial and that its continuation would lead to an uncontrolled collapse of the hard coal mining industry.

II phase – 1993 – 1995 consolidation of mines

Six coal companies became the sole shareholder companies of the State Treasury comprising a total of 49 mines; besides these, there were 3 independent mines also having the status of sole shareholder companies of the State Treasury and Katowicki Holding Węglowy SA comprising 11 mines. Simultaneously, the government introduced a new program called "Restructuring of hard coal mining in Poland - Implementation of the first stage as part of financial possibilities", which indicated the necessity to divide the mining restructuring process into three stages. The first stage involved stopping the losses of coal companies and creating conditions for them to obtain profitability. Despite the introduction of this new programme, the situation of coal companies further deteriorated. In the second half of 1993, a restructuring programme for employment in mining was launched. It established the first legal bases for the use of social assistance and benefits for miners (underground workers) laid off due to the liquidation of mines. The implementation of mine liquidation processes was met with considerable opposition. Therefore, the decrease in coal extraction was lower than initially assumed. The bankruptcy of coal companies was averted, but their debts continued to grow. Financial restructuring of coal companies was limited to settlements with suppliers of goods and services and banks. The debts of coal companies to the State Treasury, Social Security Office, National Fund for Environmental Protection, etc. were allowed to grow. The financial results of coal companies improved for a short time in 1994 but subsequently worsened again in 1995, partly due to a rapid increase in salaries and a lower-than-assumed reduction of employment in the mining.

III phase of restructuring – 1996 – 1997

Restructuring focused almost exclusively on the technical issues without ensuring any financial support for the planned activities. The legal background for the restructuring was a governmental programme, "Hard coal mining – the policy of the state and sector for years 1996 – 1997. Programme for adapting hard coal mining to market economy conditions and international competitiveness". According to the programme's assumptions, the major goal, the profitable hard coal mining, was to be achieved in 1998. The programme was intended to last for 5 years. Within this time, the employment was to be decreased by 80,000, and the annual extraction of coal was to be reduced to 140,000,000 tonnes per year. The programme was not properly realised, however. The coal extraction was higher than assumed (by 4.3% in 1996 and 7.1% in 1997). The production was so high that it induced a rapid increase of coal stocks in landfills (by 124.5% in 1997). In this phase, no decisions were taken regarding the complete liquidation of the mines. Only previously started liquidation processes were continued. The financial losses of the hard coal mining continued to increase, reaching 1.8 billion PLN (approximately 0.4 billion GBP) in 1996 and 2.6 billion PLN (approximately 0.55 billion GBP) in 1997. Due to the ineffectiveness of the programme, rapidly growing debts, and the dramatically worsening financial situation of the hard coal mining industry, a new restructuring programme for hard coal mining was launched in 1998.

IV phase of restructuring – 1998 – 2002

The governmental program entitled “The reform of hard coal mining in Poland in the years 1998-2002” represented the widest and most comprehensive restructuring programme of hard coal mining to date. The general objectives were defined as adapting hard coal mining to functioning in market-economy conditions and maintaining the competitiveness of Polish coal on the domestic market as well as satisfying by 2010 the domestic demand for hard coal while maintaining the requirements of environmental protection and competitiveness in conditions specified by the European Union.

A total decrease in production capacity reached 34.5 million tons/year. This was possible due to complete liquidation of 13 mines and partial liquidation of 10 other mines. The employment rate in hard coal mining decreased from 1998 to 2002 by over 40%, from 243,304 to 140,717 persons. The main instrument for employment restructuring was the Miners’ Social Package. It was used by 67,000 mine employees. Around 37,000 miners used so-called “mining vacations”, while 29,000 people took advantage of the cash clearances. Social benefits did not have any meaning for the effects of employment restructuring, as only 419 people benefited from them. Additionally, the employment decreased due to the employees' retirement (ca. 23,000 people) and as a result of the transfer of employees to units created on the basis of mining assets (6,000 people). The rules for the operation of “mining holidays” were regulated by a special law introduced by the government. The programme achieved its goals in employment reduction. It was less successful, however, in the financial restructuring of mining companies. The debts increased from 13.3 billion PLN (approximately 2.85 billion GBP) in 1997 to 16.5 billion PLN (approximately 3.5 billion GBP) at the end of 1998. Due to formal and legal requirements contained in the restructuring program, the mining debt deleverage failed to live up to expectations. The Mining Act did not lead to effective debt reduction, as only ca. 19% of the total amount of commitments proposed for restructuring (15.9 billion PLN, or approximately 3.4 billion GBP) was restructured by the end of 2002. In consequence, despite a significant reduction of employment, the financial results of the mining industry in the years between 1998 and 2002 were not satisfactory, and the objectives of the restructuring program were not achieved. Until the end of 2002, mining continually failed to obtain a positive net financial result.

V phase of restructuring 2003 – 2006

The ineffectiveness of the financial restructuring of hard coal mining created the necessity to adopt another restructuring programme. At the end of 2002, the new “Programme for the restructuring of hard coal mining in Poland in 2003-2006 with the use of anti-crisis laws and initiation of privatisation of some mines” was introduced. This programme became the basis for executing general organisational changes in the mining sector. In 2003, five coal companies were merged to create Kompania Węglowa S.A. (Coal Company S.A.), the largest mining enterprise in Europe. The new Mining Act passed at the end of 2003 included the assumptions associated with the new restructuring programme. On its basis, the largest debt relief process in Poland was executed. Public-law liabilities in the amount of 16.0 billion PLN (approximately 3.4 billion GBP) were waived; another 2.1 billion PLN (approximately 0.45 billion GBP) were deferred. The restructuring implemented from 2003 to 2006 solved the financial problems; however, it did not effectively solve the problem of non-productive assets and unnecessary production assets.

VI phase of restructuring 2006 – 2015

Typical restructuring programs ended in 2006. At this time, there were few entities extracting hard coal:

- Kompania Węglowa S.A. - 17 mines,
- Katowicka Grupa Kapitałowa - 7 mines,
- Jastrzębska Spółka Węglowa S.A. - 5 mines,
- Południowy Koncern Węglowy S.A. - 1 mine,
- The mine KWK "Budryk" S.A.,
- Siltech Sp. z o.o. (A private mine).

There was also one mine outside the Upper Silesia region: Lubelski Węgiel “Bogdanka” S.A.

In 2007, the government adopted the document “Strategy of hard coal mining in Poland in 2007-2015”, which defined the directions of operation in the hard coal mining sector for these years. The document did not enumerate any specific restructuring measures but established only the general directions of mining operations strategy. The Strategy specified that the goal of the State's policy on hard coal mining was the rational and effective management of the coal so that its resources could serve future generations. An important element included in the mining aims were investments that should have allowed for maintaining coal production at a level corresponding to the demand on the domestic market. The implementation of the Strategy was significantly affected by changes in global coal and financial markets. In 2007-2008, there was a dynamic increase in the demand for hard coal; producers did not keep up with production, and transport companies did not keep up with coal supplies to recipients. Underinvested coal companies were not able to take full advantage of the coal market boom. Despite the increasing demand, coal production dropped from 94.3 million tons in 2006 to 80.0 million tons in 2008. At the end of 2008, the dynamic development of the coal market slowed down rapidly due to the global financial crisis. The coal production in Poland further decreased to 70.9 million tons in 2009, whereas the import of coal peaked to ca. 10 million tons as the coal prices in global markets became lower than the prices of some of the Polish producers. Hard coal production in Poland in the years between 2009 and 2016 exhibited a clear downward trend (except for in 2012). Coal extraction in 2016 was 70.4 million tons and was 19% lower than in 2007. Due to declining production, decreasing hard coal prices on global markets, and the increasing role of energy sources other than coal (e.g. renewables, petroleum, and gas), the financial situation of Polish mining enterprises worsened in the years between 2010 and 2015. Despite this, the degree of implementation of public-law payments by mining enterprises was at a very high level (ca. 99%). The deterioration of the mining industry demanded further structural changes in this sector.

VII phase of restructuring 2015 – now

The transformation process in this period included an agreement with the social side (unions), amendments to the Act on the Functioning of Hard Coal Mining in 2008 – 2016, organisational and ownership changes, and privatisation of mining enterprises.

Most of the changes had already been introduced by 2015 and are still valid. An agreement with the social side was concluded between the government and several trade unions. The agreement established that for certain parts of the enterprise of chosen mines, corrective plans would be prepared in consultation with the relevant trade unions and competent local government authorities.

The amendments to the Act on the Functioning of Hard Coal Mining in 2008 – 2016 extended the possibility of government financing of liquidation measures implemented by SRK S.A (Spółka Restrukturyzacji Kopalń S.A., Mine Restructuring Company S.A.). The possibility of payment-free transferring of non-productive mine assets to SRK S.A. was extended until 1 January 2019. In addition, the amendments included possibilities of financing additional payments for current production losses and extension of the outstanding liabilities to the social insurance system by 31 December 2017.

There were significant changes in the organisation of the hard coal mining sector. Polska Grupa Górnicza Ltd. (PGG Ltd., Polish Mining Group Ltd.) was established to take over the assets and liabilities of the bankrupt Kompania Węglowa S.A. Nowadays, PGG Ltd. is the largest hard coal producer in the European Union. Kompania Węglowa S.A. transferred to SRK S.A., Węglokoks S.A., and Polska Grupa Górnicza Ltd. all mines, combined heat and power plants, refurbishment plants, and others. After the sale of assets related to coal production, only non-productive assets remained in the structures of Kompania Węglowa S.A. Katowicki Holding Węglowy S.A. transferred to SRK S.A. a part of one mining plant. Jastrzębska Spółka Węglowa S.A. completed the formation of a coal-coke group and transferred part of some mining plants to SRK S.A. for liquidation. In July 2011, shares in JSW S.A. debuted on the Warsaw Stock Exchange as part of the First Public Sale Offer. Since 2017, in the Polish hard coal mining industry, there have been 23 mines held by 11 companies (public, sole-

shareholder companies of the State Treasury, as well as private ones). In addition, a restructuring company operates in the sector: Spółka Restrukturyzacji Kopalń S.A.

Legal regulations on general mining currently exist, such as “Geological and Mining Law” and “Programme for the Hard Coal Mining Sector in Poland”, adopted by the Council of Ministers on 23 January 2018. The programme covers the period up to the present. The main objective of the programme is to create conditions favourable to the construction of a viable, effective, and modern hard coal mining sector, based on cooperation, knowledge, and innovation. There have also been several partial tasks defined in the programme. These include the following:

- recovery and stabilisation of profitability and economic efficiency of the hard coal mining sector by adjusting production capacities to the needs of the market and export opportunities;
- integration of mining and power production as well as the creation of an effective model of the coal-coke group;
- satisfying domestic demand for hard coal for the production of electricity, heat, and coke;
- ensuring access to new coal deposits warranting an appropriate level of investment, where they ensure the highest economic efficiency;
- development of employee competencies and knowledge;
- reducing the impact of the hard coal mining sector on the environment and increasing the use of mining waste and accompanying minerals;
- innovations in hard coal mining, such as creation of the so-called intelligent mine, ensuring a high level of work safety;
- diversification of the economic use of hard coal;
- elimination of the effects of previously performed activities restructuring;
- unification, flexibility, and simplification of remuneration systems.

The programme describes the activities and projects needed to achieve the partial tasks. They include, for instance, the following:

- preparation of the integrated model of the fuel and energy market in Poland;
- implementation of innovative solutions throughout the entire production of coal and coke;
- low-emission fuels in individual households through a set of legal and environmental standards and activities towards the replacement of low-efficiency furnaces in a household by new-generation furnaces;
- preparation of a map of strategic hard coal deposits along with a management model for these resources and the necessary laws for their security;
- balance of employee competencies in the coal mining sector, which will support employee allocation processes.

Various scenarios have been created for the level of hard coal extraction until 2030; the social problems related to hard coal mining restructuring have been highlighted, and activities to solve them have been foreseen. The basic scenario assumes keeping the hard coal extraction at ca. present levels until 2030. This is hardly possible considering necessary investments, geological conditions in Upper Silesia, and current and future policy on energy production in the European Union. The “high-level scenario” is even less probable. Considering the observed trends in hard coal extraction levels in Poland and extraction strategies of principal coal producers, the most probable is the “low-level scenario”. Polish mining uses the old methodology to assess the quality of deposits, while the developed mining world uses the JORC methodology that was developed by the Australians. Hence, the estimated coal resources in Poland are burdened with high uncertainty, and it is not possible to assess what part of them allows for profitable exploitation. The programme deals partly with this problem, as the establishment of new geological service (Polish Geological Agency) that would use modern methods to assess available coal resources has been foreseen. Nevertheless, a reliable assessment of available resources should have been conducted prior to adopting the

program. Another weak point is that certain assumptions of the program (particularly those associated with the "high-level scenario") are contrary to the assumptions of other programmes being prepared by the government, namely, "Energetic policy of the State until 2040". For instance, the "Energetic policy of the State until 2040" assumes increasing efficiency of coal-based power plants and, thus, decreasing demand for this commodity. The lack of reference in the programme to the decision of the Council of the European Union (2010/787/EU), in force since 2011, is difficult to explain. This decision extends public aid to the employees of liquidated mines, whereas all unprofitable hard coal mines in the European Union must be closed. Finally, the coal mining recovery programme is incompatible with the European Union's climate and energy policy, formulated in the European Commission documents over the past 7 years, in line with the consistent position of the Council of the European Union and the European Parliament (Wilczyński and Derski, 2017).

The official document on the energy production strategy is "Poland's energy policy until 2030" ("Polityka energetyczna Polski do roku 2030"), adopted by the Council of Ministers in 2009. Nevertheless, a new document, entitled "Poland's energy policy until 2040", has already been prepared by the new government that was established after the most recent elections. Because this document is under consultancies, we will focus on it in the following elaboration.

"Poland's energy policy until 2040" (PEP2040 – Polityka Energetyczna Polski do 2040 roku) is a description of state strategy in the field of energy. According to PEP2040, 60% of electricity will be produced from coal by 2030 and the share of renewable energy sources in final use of energy will be 21%, nuclear power energy will be introduced by 2033, CO_2 emissions will be reduced by 30% (as compared to the emissions in 1990), and energy efficiency will increase by 23% (as compared to 2007). The strategy provides eight directions of activities that will be implemented to achieve these goals:

- optimal use of domestic energy resources;
- expansion of electricity generation and network infrastructure;
- diversification of fuel supplies and development of network infrastructure;
- development of energy markets;
- implementation of nuclear energy;
- development of renewable energy sources;
- development of heating and cogeneration;
- improving the energy efficiency of the economy.

The strategy clearly states that hard coal is the basis of the national energy balance because Poland has large resources in this raw material and the coal-based power plants enable maintenance of a stable energy supply. The mining and coal power industries are also of high social and economic importance, as they provide numerous jobs and inflows to the state budget. The need to diversify the electricity generation structure will contribute to reducing the role of coal in the energy balance, but the use of this commodity for power production will remain constant over the next several years. The strategy assumes that the demand for hard coal should be covered from domestic mines and the import of raw materials should be limited. Realisation of strategy goals related to hard coal mining involves ensuring the profitability of this sector, rational management of existing coalfields and the opening of new deposits, rational distribution of coal, the use of extraction by-products (e.g. methane, hydrogen, accompanying commodities), and innovations in coal mining. Investments in new coal blocks made after 2025 will be based on co-generation or another technology meeting the emission standard at 450 kg CO_2 per MWh of energy generated. In order to reduce the impact on the environment, new coal combustion methods, i.e. gasification, oxy-burning, and other clean coal technologies will be used.

The other activities foreseen in the PEP2040 may have an indirect effect on hard coal mining. For instance, implementation of nuclear power and development of renewable energy sources will constitute a significant competitor for hard-coal-based power plants and, thus, for hard coal mining. On the other hand, PEP2040 introduced the so-called "power market" favours for coal-based energy producers. In the power market mechanism, the energy producers receive money not only for the energy supplied but also for the readiness to supply it.

7.3.2 Regional and local policy

The policy restructuring of the hard coal mining was based on the programmes adopted by the central government or, in some cases, the parliament. Hence, there are only a limited number of regional policies available to review. The basic programme is “The programme of mitigating the effects in the Silesian region of restructuring of employment in coal mining stone", launched in 2003 (“Program łagodzenia w regionie śląskim skutków restrukturyzacji zatrudnienia w górnictwie węgla kamiennego”). The assumptions of the programme were adopted by the Council of Ministers so that it could be regarded as a central governmental programme (Herbst et al.2003). Nevertheless, it was targeted towards the Upper Silesia region and was realised in practice at the regional level and by regional agencies and authorities. Contrary to above-described strategies of hard coal mining restructuring, “The programme of mitigating the effects in the Silesian region of restructuring of employment in coal mining stone” was a region-oriented, and not a sector-oriented, strategy. The programme assumed that it was necessary to develop the economy in the region so that it could absorb the miners and workers losing their jobs. A major task of the programme entailed raising the competitiveness of the region through the restructuring of the economy, increasing its investment attractiveness and developing the adaptation skills of residents in the regional labour market. Activities under the program were divided into two groups:

- activities directed towards employees of hard coal mining;
- activities supporting the development of the region.

Activities directed towards employees were aimed at workers losing their jobs and at activating the labour market. Activities supporting the development of the region were diverse and included the following:

- activities supporting the development of entrepreneurship;
- activities towards infrastructure development in the region;
- actions to protect the environment and reclamation of post-industrial areas;
- activities for the development of tourism;
- actions resulting from multi-annual programmes;
- new institutional solutions.

The support from the “Fund for the development of local infrastructure directed at the development of entrepreneurship” consisted of subsidies for communes and points for the modernisation or construction of infrastructure in their area. The amount of the subsidy for a single investment project could not exceed 50% of the eligible costs of the project. There was also a measure called “A line of loans for small and medium enterprises”, which supported local small businesses.

The regional targets in the field of energy and climate for Upper Silesia are described in the programme “Śląsk 2.0 - industry support programme for Silesia and Western Małopolska”. The programme was prepared by the interministerial team for strengthening the industrial potential of Silesia and Western Małopolska in 2015. There are six major actions planned in the programme, and two of them are directly related to coal mining and emission control. The activity I, “Increased competitiveness of the economy of the Silesia and Western Małopolska voivodeships”, includes a package of solutions for mining and a package of solutions to increase the global competitiveness of energy-consuming companies. The activity III, “Low-emission and resource-efficient economy” includes support for projects in the field of low-emission and resource-efficient economy (“E-KUMULATOR”) and actions supporting the elimination of low emissions. The package of solutions for mining is going to separate the economically viable components of Kompania Węglowa S.A. from assets whose operation is not economically justified. The latter ones are to be transferred to the SRK S.A. The new Kompania Węglowa S.A. will have sound and solid foundations that will enable it to function well in the competitive hard coal market. Another action is to promote the export of hard coal from Polish mines to Ukraine. To enable this, a government of Poland will support the modernisation of Ukrainian power plants in order to adjust them to the parameters of hard coal extracted in Upper Silesia. Successful implementation of this action could enable the export of 9.5 to 15 million tons from Upper Silesia. The “Śląsk 2.0” programme assumes the introduction

of support for the energy-intensive sector, primarily for the companies from the metallurgical and steel industries and, to a lesser extent, from the chemical and mining industry. This support will include, for instance, the dismissal of enterprises of the energy-intensive industry from part of the costs of the support system for renewable energy sources (i.e. the obligation to purchase green certificates and the obligation to pay the so-called renewable energy payment), which form a component of electricity costs. The cumulative value of this exemption on a national scale will amount to approximately PLN 450 million (or approximately 95 million GBP) per year.

The “E-KUMULATOR” priority programme is a new offer, from the Ministry of the Environment and the National Fund for Environmental Protection and Water Management (NFOŚiGW), addressed to entrepreneurs who want to reduce the negative impact of industry on the environment. The principal assumption and goal of the program is to create a comprehensive financial instrument for entrepreneurs who want to reduce harmful emissions to the atmosphere, better manage raw materials, and optimise energy management. Entrepreneurs joining the programme can expect co-financing in the form of a loan (in an amount from 0.5 to 90 million PLN, or approximately 0.1 to 20 million GBP) covering up to 75% of the eligible costs of the undertaking. In order to decrease low-emission sources, a programme entitled “Comprehensive liquidation of low emissions in the Silesian-Dąbrowa agglomeration” has been launched. The following projects will be implemented under the programme:

- comprehensive energy modernisation of multi-family residential buildings;
- reconstruction of existing heating systems and cold supply networks to reduce losses on transmission and distribution of heat/cold;
- construction of new sections of heating networks with connections;
- construction of heating networks or cold supply networks enabling the use of thermal energy generated in high-efficiency cogeneration sources, waste heat, heat from RES installations, as well as increasing the use of heat produced in such installations.

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8 Romania, West Region / Jiu Valley

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8.1 Description of the region

8.1.1 Region overview

TRACER target region in Romania is Jiu Valley coal intensive micro-region, as part of West Region (NUTS 2 region RO42). West Region is located in the extreme West part of Romania, bounded by Serbia and Hungary borders. Jiu Valley is also called the Petroșani coalfield, being the gateway to Retezat National Park, surrounded by Parâng and Retezat Mountains and crossed by the Jiu River. The total surface (Săgeată, 2010) of Jiu Valley coal intensive micro-region is 1,033 km^2, representing 3.2% of West Region (INS, n.d.) covering 32,042 km^2 (13.4% of Romania). Demographic data described in Table 52 include population, age distribution and life expectancy.

Table 52: RO: Jiu Valley micro-region - population, age distribution and life expectancy

Category		Romania				West Region (RO42)				Hunedoara County (of which Jiu Valley)			
years		2015	2016	2017	2018	2015	2016	2017	2018	2015	2016	2017	2018
Population (no.)		19,875,542	19,760,585	19,644,350	19,530,631	1,812,183	1,802,212	1,792,503	1,784,522	403,701	398,950	393,154	388,600
										141,142	139,340	137,744	135,989
Age distribution (no.)	< 15y	3,086,604	3,066,712	3,057,024	3,052,479	257,097	256,519	256,899	257,877	55,373	54,751	54,075	53,729
										19,420	18,708	18,159	17,589
	15-64y	13,413,984	13,258,418	13,091,697	12,927,891	1,256,305	1,240,993	1,225,507	1,211,220	274,132	268,719	262,743	257,236
	working age									104,722	103,229	101,771	100,134
	> 65y	3,374,954	3,435,455	3,495,629	3,550,261	298,781	304,700	310,097	315,425	74,196	75,480	76,336	77,635
										17,000	17,403	17,814	18,266
Life expectancy (year)		75.35	75.56	75.73	76	75.04	75.28	75.53	76	74.6	74.7	74.9	74.9

Source: INS (POP105A); black ink - usually resident population at January 1st; blue ink - Permanent resident population on July 1

West Region has a large share (68%) of its population in working age (15-64 years), while 14% of the total population are under working age (< 15 years) and 16% are over working age (> 65 years), in comparison with Jiu Valley micro-region where the aging process is slightly lower (13% for > 65 years) and the working force potential is 74%. Important to note is that the population in Jiu Valley micro-region, representing 35% of Hunedoara county inhabitants, is slowly declining mainly due to the acceleration of the de-industrialization process, emigration to West Europe, low natality rate and ageing. A slight increase of life expectancy, one of the key measures of population's health, can be observed both at regional and county level, but unfortunately no data available at local level in Jiu Valley.

In terms of administrative structure Romania is divided into villages, communes, towns, municipalities and counties (42 counties, including Bucharest). As a territorial unit (non-administrative and non-legal person), eight development regions (NUTS 2) were created, formed by the conjunction of several counties. West Region (NUTS 2 region RO42) includes four counties: Timiș, Arad, Caraș-Severin and Hunedoara, 12 municipalities, 30 cities, 281

communes and 1,327 villages. Jiu Valley micro-region is subordinated to Hunedoara, being situated in the South-Eastern part of the county. The territorial administrative structure inside Jiu valley Micro-region, including 3 municipalities, 3 cities, 14 communes and their subordinated villages, is presented in Figure 18.

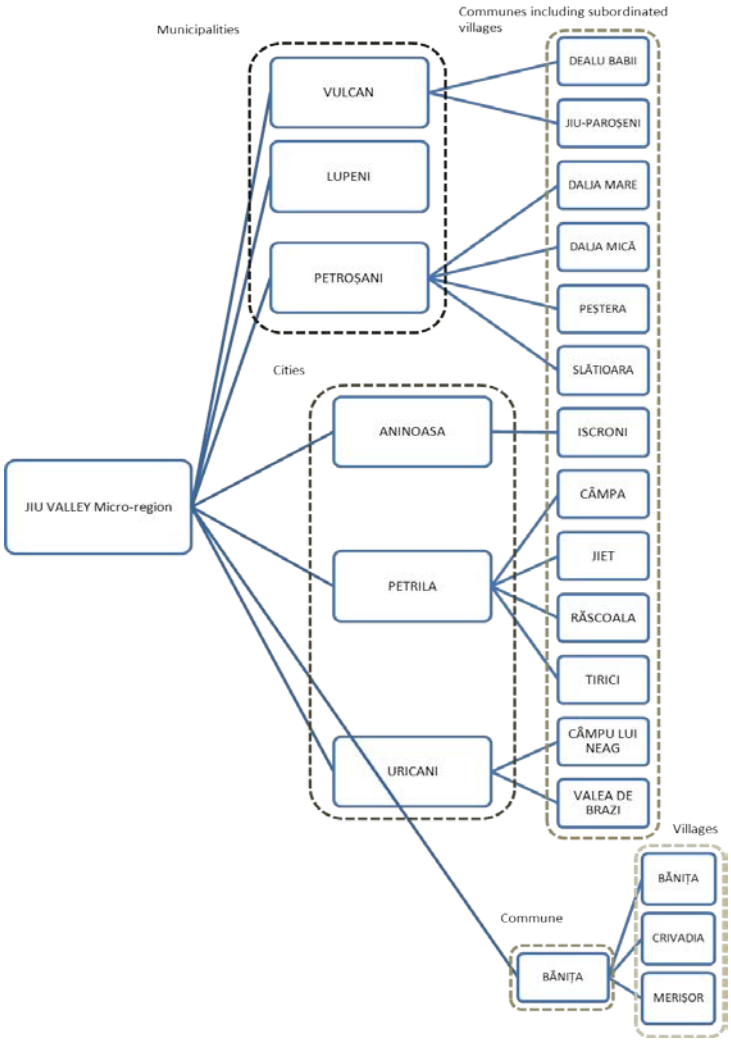

Figure 18: RO: Jiu Valley administrative structure

From an institutional point of view, Romania is a Republic, organized according to the principle of separation of legislative, executive and judicial powers (Romanian Parliament – legislative body, Presidency, Government – executive body, Central Public Administration subordinated to the Government, Regional Public Administration composed by the County Councils), within the frame of a constitutional democracy. The administrative-territorial units are functioning based on the principle of decentralization and autonomy. The regional public administration consists of the County Councils, elected each 4 years and which coordinates the activities of the Local Councils, related to the provision of public services of county interest.

County Councils have an important role in local economic development, being responsible for managing public funds, having decision-making power over key issues such as land use planning and development, road network and other infrastructure. The degree to which county councils have the necessary capacity, competences and sensitivity to the needs of their electorate, can play an important role in deciding the development path of the region. West Region is institutionally defined as a development region in Romania, its core responsibility being to coordinate regional policy, especially within the framework of European funding structures. Against this background, the West Regional Development Agency (ADR Vest) acts as a planning and implementation coordination agency, with executive and control responsibilities related to ESIF accession and projects deployment. ADR Vest acts as a non-profit organisation, consisting of the voluntary association of the region's counties. It is governed by the Regional Development Council, which brings together representatives of county and local authorities and ADR Vest has an executive role. However, there is no real

regional political structure and few regional policy decisions can be taken at this level and basically when decisions are taken in Bucharest, regional agencies are not considered. In contrast, regional policy in Romania is decided at national level (to be developed in Chapter 8.3 - Coal mining and coal utilization policies). Today, efforts are made for generating a decentralised micro-regional governance structure called “Jiu Valley Partnership for a Right and Fair Transition”, with committed and pro-active involvement of all 6 local councils, aiming to support the development of a roadmap to pave the way to a sustainable energy transition and economic development in the benefit of their citizens.

Both in terms of the administrative-territorial and institutional structure, Jiu Valley micro-region has no legal basis (e.g. internal organization and operation regulation, governmental decisions or emergency ordinance) for functioning as a regional legal authority such as the Danube Delta Biosphere Reserve Administration Authority. During 2002-2005 there was an attempt to build a governance structure coordinated by a governor, but it was abandoned at the suggestion of the World Bank, none of the proposed projects being finalized. We hope year 2020 to bring good news for Jiu Valley by setting up an appropriate governance structure, starting with 2018 initiative of the Romanian Ministry of European Funds, which gathered key local stakeholders to prepare strategic document packages and proposals for government decisions. Thus, an association can be founded, with legal personality, as public utility under private law, named after the Danube Delta model - Intercommunity Development Association “ADI-ITI Jiu Valley”, with the purpose of implementing the Integrated Territorial Investment (ITI) mechanism to unlock the area.

8.1.2 Social situation

Romania is a country of contrasts with significant regional and interregional disparities in terms of social issues and more, at local level there are lot of data difficult to quantify and delayed statistics. Additional data along with those presented in Table 52 (population, age distribution and life expectancy), are emphasizing statistics related to employment and unemployment rates, poverty risk and social exclusion (Table 53).

Table 53: RO: Hunedoara County – Labour market, poverty

Category	Romania				West Region (RO42)				Hunedoara County			
years	2015	2016	2017	2018	2015	2016	2017	2018	2015	2016	2017	2018
Employment rate (%)	66.00	66.30	68.80	69.90	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Registered unemployed (th. inh.)	436.2	418.2	351.1	288.9	25.6	22.1	18.6	15.0	11.34	10.78	7.89	5.83
Unemployment rate (%)	4.9	4.8	4.0	4.0	2.40	3.0	2.20	1.70	6.6	6.0	4.5	3.3
Labour transitions by pay level (%)	6.9	8.3	7.4	9.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
People at risk of poverty or social exclusion by NUTS regions (%)	37.4	38.8	35.7	32.5	32.0	40.7	32.5	22.1	N/A	N/A	N/A	N/A
In-work at-risk-of-poverty rate by months worked - EU-SILC survey (%)	32.8	37.6	51.2	41.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Source: Eurostat, National Commission for Strategy and Prognosis – Projection of the main economic and social indicators until 2021

On the background of the economic transition process, the Romanian labour market experienced significant transformations in terms of volume and structure of the main labour force indicators (Table 54).

Table 54: RO: Economically active, employed and unemployed population, by gender and area

Population category (thou persons)	2015	2016	2017	2018
Total economically active population (1+2)	9,159	8,979	9,120	9,069
by gender (female / male)	3,916/5,243	3,834/5,145	3,936/5,184	3,883/5,186
by area (urban / rural)	5,013/4,146	4,962/4,017	4,994/4,126	4,955/4,114
Total employment (a+b)	8,535	8,449	8,671	8,689
by gender (female / male)	3,687/4,848	3,643/4,806	3,777/4,894	3,748/4,941
by area (urban / rural)	4,662/3,873	4,684/3,765	4,769/3,902	4,769/3,920

Population category (thou persons)	2015	2016	2017	2018
Employee, of which	6,062	6,201	6,390	6,497
Industry and Construction	2,227	2,300	2,372	2,392
Services	3,657	3,707	3,820	3,903
Agriculture	178	194	198	202
Others	2,473	2,248	2,281	2,192
Total unemployed	624	530	449	380
by gender (female / male)	229/395	191/339	159/290	135/245
by area (urban / rural)	351/273	278/252	225/224	186/194

Source: (Irimie & Popescu, 2019)

According to the Labour Inspection Activity Reports (Law no. 544 of 2001) the number of individual active labour contracts and the number of active employees had an upward trend at national level over the period 2015-2018. Table below shows contracts by type and number of active employees.

Table 55: RO: Employment contracts

Year	Number of individual active labour contracts								
	Unlimited duration				Limited duration				TOTAL
	Full time	Part time	Total	%	Full time	Part time	Total	%	
2018	5,151,844	691,358	5,843,202	91.61	308,251	226,511	534,762	8.39	6,377,964
2017	5,001,008	807,758	5,808,766	92.51	331,756	138,381	470,137	7.49	6,278,903
2016	4,763,323	997,865	5,761,188	92.34	346,181	131,798	477,979	7.66	6,239,167
2015	4,641,738	950,126	5,591,864	91.76	362,156	139,626	501,782	8.24	6,093,646

Source: Labour Inspection Activity Report for the years 2018/2017/2016/2015

Regarding Jiu Valley micro-region (URBANPROIECT, 2003) the number of active employees in 2015 is presented by three categories of activity sectors: primary, secondary and tertiary.

Table 56: RO: Jiu Valley – Occupied population by categories of activity sectors, 2015

Territorial Administrative Units	Total employees	of which by sectors					
		Primary		Secondary		Tertiary	
		Number	%	Number	%	Number	%
Petroşani	14,085	20	0.14	6,487	46.05	7,578	53.8
Aninoasa	1,737	3	0.17	1,376	79.21	358	20.61
Vulcan	7,362	1	0.01	5,691	77.3	167	22.68
Uricani	2,746	-	-	2,134	77.71	612	22.28
Petrila	5,802	2	0.03	4,796	82.66	1,004	17.3
Lupeni	6,077	4	0.06	4,196	69.04	1,877	30.88
Băniţa	75	1	1.33	8	10.66	66	88
Total	37,884	31	0.08	24,688	65.17	13,165	34.75

Source: National Agency for Employment

In the last years the Jiu Valley is facing several problems as: laid off workers who cannot find jobs anymore; the population has dropped significantly with nearly 30,000 inhabitants (25%) reaching 120,734 inhabitants (Official census 2011) and the urban infrastructure status is disastrous, the collective dwellings and individual houses being in an advanced state of degradation. According to the 2011 official census, the population structure in Jiu Valley micro-region by ethnicity is as follows: the majority are Romanian (87.71%), the main minorities are Hungarians (5.78%) and Roma (1.46%), living together with the Germans (0.3 %), Italians (0.03%), Ukrainians (0.02%), other nationalities (0.22%) and undeclared ethnicities (4.48%). The registered number of unemployed people in 2015 in the Jiu Valley is presented below.

Table 57: RO: Jiu Valley – Unemployed population, 2015

Territorial Administrative Units	Number of unemployed	Total population	Percentage of total population, (%)
Petroşani	1,513	37,160	4.07
Lupeni	843	23,390	3.60
Vulcan	946	24,160	3.91
Petrila	905	22,692	3.98
Aninoasa	116	4,360	2.66
Uricani	230	8,972	2.56
Total	4,553	120,734	3.77

Source: (Davidoiu T. A., 2017)

The unemployment rate in Jiu Valley had the highest share per country (25-30%), a value that does not appear in the declared statistics. There are people who cannot find a job, but who represent a large potential of labour force, including staff both unqualified and qualified.

In terms of poverty risk about 80% of Jiu Valley population currently has debts to at least one of the lending financial organisations / commercial banks and a large part of the families also have maintenance debts to the tenants. Poverty is a rather an important issue in Jiu Valley, considering mainly: the low level of income; limited access to education and health care services; limited access to utilities as running water, access roads in good condition, communication system, etc.

The decline of this micro-region accelerated after 1995, when the first massive mining industry lay-offs took place, and now local communities (Petrosani, Petrila, Vulcan, Lupeni, Uricani, Aninoasa) are hardly surviving the precarious economic situation.

Table 58: RO: Jiu Valley – Poverty rate by ages and gender categories

Age groups, Years Gender	Total population (inh.)	Poverty rate: people below the poverty line / total number of people, (%)						Average for 2010-2015
		2010	2011	2012	2013	2014	2015	
0-17	23,088	31.3	32.9	34.6	32.1	32.0	29.9	32.1
18-64	83,046	19.2	21.0	21.0	21.5	21.3	21.1	20.8
≥65	14,600	16.7	14.1	15.4	15.0	14.7	14.3	15.0
Weighted average for the entire population	120,734	21.2	22.4	22.9	22.7	22.5	22.0	22.3
Male	59,475	21.0	22.3	22.6	22.9	22.6	21.7	22.2
Female	61,259	21.4	22.5	23.2	22.5	22.4	22.3	22.4
Weighted average for the entire population	120,734	21.2	22.4	22.9	22.7	22.5	22.0	22.3

Source: Calculated based on INS data

The health care system at Hunedoara County level is presented synthetically in Table 59.

Table 59: RO: Hunedoara County – Health care system

Indicator category	2015	2016	2017
Number of hospitals	10	10	11
Number of medical units	1	2	2
Number of TB sanatoria	2	2	2
Number of school and student medical offices	36	35	41
Number of dispensaries	14	13	11
Number of medical laboratories	57	60	61
Number of medicine doctors	672	693	689
Number of personnel in health care	2,219	2,333	2,395
Auxiliary medical staff	1,276	1,346	1,434

Source: Regional Statistics – Year Book 2018

The Jiu Valley's sanitary network includes three other municipal hospitals in Vulcan and Lupeni, as well as school and student medical offices, family medical practices, dental practices, pharmacies and pharmaceutical points, medical laboratories, dental laboratories, etc.

In terms of Education and Culture the main indicators are presented in Table 60 at the level of Hunedoara County.

Table 60: RO: Hunedoara County – Education and Culture

Indicator category	2015	2016	2017
Total school population, of which:	66,495	63,430	62,070
Students enrolled	53,128	50,622	49,352
Children in kindergartens	9,059	8,553	8,539
Students	2,890	2,868	2,863
Teaching staff	4,224	4,047	4,000
Cultural Institutions	2	2	2
Performances and concerts	241	221	297
Spectator	21,861	39,051	67,150
Museums	16	17	18
Libraries	187	180	171

Source: Regional Statistics – Year Book 2018

It is worth mentioning that in Hunedoara County, in Petrosani Municipality, Jiu Valley micro-region activates the University of Petrosani, the only university in Romania that is not located in the county residency (Deva Municipality).

8.1.3 Economic development

The economic dynamics at national, regional and local level is presented in Table 61 by the following indicators: GDP per capita and contribution of economic activities to GDP. The Western Region is the second representative region of Romania, with a GDP per capita 4-6% higher than the national average in the years 2016-2017, but with discrepancies between the four component counties (ADR Vest, 2014), Timis County being the leader of the region and Hunedoara on 3rd place out of 4 component counties. West Region has seen wage growth faster than the other regions, but the existing spatial inequalities in the region have increased considerably. The current economic engines of West Region are activities in the small and medium technologic industry. Against 20 or even 10 years ago, the great transformation and challenge in this region is the transition from mining and heavy metals to light industry. Textiles, agro-food industry, ICT (including hardware, software and services) and the furniture industry, as well as car manufacturing industry (spare parts) have seen a marked upward trend, coal exploitation and use still being an important economic sector in the region, both in terms of electricity supply safety and workforce employer. Agriculture has also seen an increase due to the Banat plain’s potential. Instead, the services sector recorded small increases in RDI and management consulting. It is worth mentioning the important role of strong clusters established in the last decade in the West region – mainly in Timiș County (e.g. ROSENC - Alternative Sustainable Energy, Automotivest Association - Automotive Industry, ICT, Tehimpuls Association - Innovation and Technology Transfer etc.), which contributed to the emergence and development of inter-sectoral links.

Table 61: RO: Jiu Valley micro-region – GDP per capita and share of main economic activities in GDP; Gross added value in the country economy

Category		Romania			West Region (RO42) (Hunedoara County)			
years		2015	2016	2017	2015	2016	2017	2018
GDP per capita (euro)		8,087	8,646	9,574	8,392	9,194	10,016	10,732
					6,496	6,591	7,282	7,905
Share in GDP (%)	Agriculture	4	4	4	4	5	N/A	N/A
	Industry	24	24	24	29	30	N/A	N/A
	Construction	6	6	6	4	4	N/A	N/A
	ICT	5	5	5	4	4	N/A	N/A
	Professional, Scientific and Technical activities; activities of administrative services and of support services	7	7	7	4	4	N/A	N/A
Gross added value (mil. euro) current prices, in the country economy	Total economy	140,941	152,840	169,758	13,342	14,835	N/A	N/A
	Agriculture	6,710	6,920	8,104	666	744	N/A	N/A
	Industry	38,593	40,923	44,614	4,325	5,002	N/A	N/A
	Mining and quarrying	1,442	1,124	N/A	N/A	N/A	N/A	N/A
	Electricity, Gas and HAC	4,461	4,116	N/A	N/A	N/A	N/A	N/A
	Construction	9,416	10,299	10,454	638	690	N/A	N/A
	ICT	8,098	8,682	9,751	602	687	N/A	N/A
	Professional, Scientific and Technical activities; activities of administrative services and of support services	7,912	8,253	13,456	606	656	N/A	N/A

Source: INS (CON103H); (CON103G); National Commission for Strategy and Prognosis – Projection of the main economic and social indicators until 2021

In Jiu Valley micro-region, the mining settlements in Petroşani basin (Petroşani, Lupeni, Petrila, Uricani, Aninoasa) first was developed as coal extraction centres and subsequently received the status of a city. According to R. Săgeată in Urban Geography (Săgeată, 2010), as natural resources are exhausted or diminished, cities are either devolved or pass through reconversion - functional change. Closure of the exploitation has resulted in unemployment, and local communities are looking for new development alternatives such as the exploitation of the tourist heritage, recreative, sporting, environmental or industrial. Currently, major employers in the micro-region are active in the industry (mining, electricity and heat, textile and car spare parts manufacturing, water-sewage infrastructure), education and health.

According to Jiu Valley SUMP (Sigma Mobility Engineering SRL, 2018), in terms of road network, the Jiu Valley micro-region has a high degree of connectivity, being connected to the Trans-European Transport Network (TEN-T Comprehensive). At the same time, within the General Transport Master Plan of Romania, the Trans-Regio Country of Hateg route is foreseen on the TEN-T network sectors in the area: Filiasi - Tg. Jiu - Petrosani - Hateg - Deva - A1 (highway). In Jiu Valley micro-region, the major road infrastructure is represented by national roads - DN 66 (E 79), which cross the territory of Petroşani and DN 7A, which depart from DN 66. In the south of Petroşani, DN 66A splits from DN 66. Due to geographic conditions, the street network, with a length of about 415 km, of which 60% was modernized, developed in a longitudinal structure, along Jiu River and Jiu West. Improving the quality of internal roads in the West Region and connectivity with the A1 motorway are essential to increase enterprises competitiveness. Regarding eco-friendly public transport, it should be noted that local community's concerns for the reduction of pollutant emissions are gradually yielding, Greenline project adopted by HCJ 86/2015 being promoted to be financed from ESIF (development of a public electric transport bus line to serve all settlements in Jiu Valley). Regarding the alternative modes of transport, this is a poor chapter with no deployed projects, but only planned: rehabilitation and accessibility of the pedestrian infrastructure by implementing the measures proposed in Jiu Valley SUMP, the development of both bicycle and V2G infrastructures. At the level of the railway infrastructure, the main railroad that crosses Hunedoara County is the

M200, part of the TEN-T Rin - Danube (Pan - European IV) corridor connecting Curtici crossing point to Arad, Deva, Sibiu and Brasov municipalities, which is in an upgrading process as part of the project “Modernization of the Pan-European Railway corridor IV for the speed of 160 km/h”. Sub-line 202 starts from M200 in the county's main railway junction, Simeria railway station and connects to the southern part of the county - Jiu Valley micro-region through Petroşani, Jiu and Livezeni stations. The nearest international airport is in Sibiu (neighbouring Centre Region), accessible in a 130-minute interval, through which the connection with destinations from Austria, Germany, Spain, Great Britain and Israel is ensured. Traian Vuia International Airport from Timisoara, 180 minutes away, provides connections to France, Germany, Belgium, Italy, Great Britain, Spain and Israel. Both Sibiu and Timisoara airports also offers domestic flights to Bucharest.

Electricity transmission networks (400 kV, 220 kV and 110 kV) and dispatching are managed by our national TSO Transelectrica and the electricity DSO (20 kV, 6 kV, 0.4 kV) is Enel Distribuție Banat, subordinated to Enel Romania. The connectivity rate to the electricity distribution network, at Hunedoara county level, is 93.8%. The heat and hot water transport and distribution network is supplied by Hunedoara Energy Holding, as unique power & heat generator and DHS operator in the area, owning 35 thermal stations (TS) out of a total of 52 TS, networks included. Other public or private DHS operators are managing the rest of 17 TS and related networks. Several local councils took the responsibility of managing small DHS, but due to more and more people choosing the individual heating systems, the operators have to shut down their ineffective businesses (e.g. Vulcan in 2016 and probably Petroșani in 2019).

The natural gas distribution network in Hunedoara County (GEA Strategy & Consulting SA, 2015) has a length of about 845 km supplying 56 localities, of which 13 municipalities and cities, including 6 municipalities and cities in the Jiu Valley, where the natural gas network is of about 150 km long. Considering the perspective of developing new projects aimed at diversifying the natural gas pipes routes from Caspian Sea to Central Europe, as well as exploiting new offshore natural gas resources in the Black Sea perimeters, the national natural gas transmission company Transgaz started the construction of a new natural gas corridor, included in CESEC (Central East Europe Gas Connectivity) priority list. Thus, on the territory of Romania, the National Gas Transport System will be developed on the Bulgaria-Romania-Hungary-Austria corridor - the BRUA (SN Transgaz SA, 2017) project with an estimated completion date in 2022, which will cross Hunedoara and Jiu Valley.

8.1.4 Environmental situation

Land use management influences the distribution and functioning of ecosystems and thus the delivery of ecosystemic services. The degradation, fragmentation and unsustainable land use has a negative effect on the supply of many essential ecosystem services, threatening biodiversity and increasing the vulnerability of the West Region to climate change and natural disasters. They emphasize soil degradation and desertification, soil erosion by water, which compromises soil functions and the quality of freshwater. Contamination and waterproofing of the soil are also persistent problems in the West Region.

Out of Jiu Valley total surface of 1,033 km^2 about 51.83% are forests, approx. 39.75% agricultural land, approx. 0.82% lands covered with waters and ponds, approx. 2.33% covered by construction, approx. 1.33% communications and railways and approx. 3.93% are covered by degraded and unproductive lands. Forested land occupies a large share, which has a beneficial impact on the local climate in the Jiu Valley micro-region.

Table 62: RO: Hunedoara County – Land use

Category	Romania		West Region (RO42)		Hunedoara County					
years	2015		2015		2015		2016		2017	
M.U.	ha	%	ha	%	ha	%	ha	%	ha	%
TOTAL	23,839	100%	799,939	100%	707,212	100%	707,261	100%	707,319	100%
Agriculture land	14,591	61%	457,630	57%	281,144	40%	281,742	40%	279,301	39%
Forests and other forest vegetation lands	6,801	29%	283,073	35%	366,566	52%	365,078	52%	368,205	52%
Water and ponds	822,703	3%	13,299	2%	5,776	1%	5,865	1%	5,713	1%
Constructions	541,522	2%	22,653	3%	16,473	2%	16,297	2%	16,510	2%
Communication routes and railways	627,044	3%	7,087	1%	9,463	1%	10,018	1%	9,818	1%
Degraded and unproductive lands	456,001	2%	15,418	2%	27,791	4%	28,261	4%	27,772	4%

Source: Hunedoara Environmental Protection Agency; Regional Environmental Protection Agency Timisoara; Romania's Statistical Yearbook

Changing the air quality in Jiu Valley micro-region depends mainly on population evolution and compliance with emission limit values (ELV) by the industrial, transport and energy sectors. Jiu Valley climate is temperate-continental, with slight influences of the Mediterranean currents, the average annual temperature being 6-8ºC. The climate is harsh, but not excessive, winters are not very cold (never bellow -30 °C), and summers are generally cool. Air pollutants emissions are mostly generated by industrial and social activities, posing a risk to ecosystems and population health. Emissions of acidifying substances in the micro-region come from sources listed in the years 2015, 2016 and 2017, such as the fossil fuels based power and heat generation, a significant source of sulphur dioxide; fossil fuels, fire wood and wood wastes combustion in thermal plants for heat and hot water use by commercial, institutional and residential clients, etc. Global West Region emissions of acidifying pollutants remain at a low level, mainly due to the drastic activity reduction of heavy industry sectors.

Table 63: RO: Hunedoara County – CO2 and acidifying pollutants emission (%)

Category		Romania			West Region (RO42)			Hunedoara County		
years		2015	2016	2017	2015	2016	2017	2015	2016	2017
Total (%)		-	-	-	44.3	45.7	54.1	64.3	65.1	69.9
Agriculture	SO2	6.35	9.28	-	-	-	-	-	-	-
	NOx	6.43	6.30	-	-	-	-	-	-	-
	PM10	4.74	4.02	-	70.1	42.2	71.2	49.1	50.6	50.6
	PM 2.5	1.55	1.56	-	68.6	36.5	81.3	66.5	72.8	72.8
	CO2[1)]	1.47	1.53	1.66	-	-	-	-	-	-
Industry	SO2	20.46	27.54	-	61.9	76.9	95.7	99.9	99.9	99.9
	NOx	22.35	19.66	4.9	31	33	44.2	74.4	78.6	78.6
	PM10	4.28	4.29	-0.4	34.6	16.2	47.8	31.9	35.4	92.8
	PM 2.5	3.58	2.97	1.4	19.2	12.7	50	16	18.7	96.3
	CO2	2.62	2.58	2.56	2.1	2.1	-	-	-	-
Hard coal and lignite mining	SO2	0.70	1.09	-	63.2	79	71.6	100	99.7	99.7
	NOx	0.79	0.66	-	36.7	52.1	50.8	59	55	55
	PM10	12.61	13.08	-	25.7	51.5	18.8	65.7	61.9	35.4
	PM 2.5	3.28	3.13	-	32.2	57.9	10.2	81.4	78.3	18.7
	CO2	2.52	2.35	2.34	-	-	-	-	-	-

1) Source: (European Environment Agency); Hunedoara Environmental Protection Agency; Regional Environmental Protection Agency Timisoara

Water resources consist of surface waters and groundwater. They can be a limiting factor of regional economic development, especially if they are in large deficit compared to the requirements of society. The water quality is good due to the existing mining water treatment plant and the retrofitted Coroieşti Coal Preparation Plant, the diffuse sources of pollution being from the agricultural activities and other anthropic activities taking place on rivers Jiu West and East.

Table 64: RO: Hunedoara County – Water pollutants by economic activity

Category		Hunedoara County		
years		2015	2016	2017
Total (tons/years)		4,061.652	4,061.652	4,061.652
Industry	NH4	0.008	0.008	0.008
	CBO5	73.449	73.449	73.449
	CCO-Cr	148.993	148.993	148.993
	P	0.002	0.002	0.002
	VOCs	139.367	139.367	139.367
	Filterable residue	1,302.741	1,302.741	1,302.741
	SO4	286.072	286.072	286.072
	Extractable substances	118.585	118.585	118.585
Hard coal and lignite mining	NH4	0.252	0.252	0.252
	CBO5	1.952	1.952	1.952
	CCO-Cr	31.05	31.05	31.05
	P	0.044	0.044	0.044
	VOCs	40.503	40.503	40.503
	Filtrable residue	1,594.973	1,594.973	1,594.973
	SO4	321.371	321.371	321.371
	Extractable substances	2.29	2.29	2.29

Source: Hunedoara Environmental Protection Agency

Pollution caused by different industrial activities affects soil quality in varying degrees. The degree of pollution was assessed on 5 classes either according to the percentage reduction of the crop in terms of quantity and / or qualitatively to the production obtained on the unpolluted soil, or by exceeding in different proportions the thresholds established by Order no. 756/1997 for the approval of the Regulation on Environmental Pollution Assessment issued by the Ministry of Forests and Environmental Protection. The industrial sector activities in the West Region and the Jiu Valley micro-region generate waste that requires final disposal. Also, the municipal waste disposal is still carried out on sites which do not meet the environmental protection conditions. The land under the landfills is degraded, but there is a risk of soil contamination also outside the landfills. The industrial waste landfills and the surrounding areas are degraded (inferior phenomena, irrigation), infertile and, some of them, have a rather pronounced contamination with heavy metals (Cu, Zn, Pb, Mn, Cd) especially the soil near the mining and processing facilities.

Table 65: RO: Hunedoara County – Soil affected by industrial activities (Ibid.)

Category		Hunedoara County		
years		2015	2016	2017
Total (ha)		655.85	758.65	748.6
Industry	Historical contamination	-	-	-
	Current contamination	193	193	220.45
Hard coal and lignite mining	Historical contamination	16.3	27.45	27.45
	Current contamination	167.05	217.8	189.5
Metallurgic industry	Historical contamination	179	219.9	219.9
	Current contamination	100.5	100.5	91.3

Climate change is a phenomenon attributed directly or indirectly to human activity that alters the global composition of the atmosphere and which adds to the natural climate variability, observed during a comparable period. The most important issues concerning air pollution are generated by pollutant emissions. They produce atmospheric acidification, affect the production of tropospheric ozone, increase the concentration of particulate matter in the atmosphere, heavy metals and greenhouse gases, deplete the ozone layer and produce climate change.

Due to climate change impact in Jiu Valley micro-region, we've identified the followings:

- an increased frequency of high intensity localized rains, that have generated more rapid floods affecting local neighbouring communities and causing concentrated damage. The increased frequency of precipitation extremes is in line with climate change-induced changes;
- reduced flow rates of Jiu and East Jiu rivers, as a result of the drought increased intensity and frequency;
- temperature changed during summer and winter, generating a higher energy consumption compared to previous years during the summer period as a result of increased use of air conditioning or heating appliances.

8.2 Role of coal mining in the region

8.2.1 Coal sector in the region

In Romania main coal areas (US Environmental Protection Agency , 2010), presented in Figure 19, are:

- the Southern Carpathian Mountains, including all the high-grade coal such as anthracite, pit coal (higher ranking than brown coal – bituminous and sub-bituminous), and hard coal from Petroșani mining basin (Jiu Valley Micro-region), Anina, and Țebea-Brad basins;
- the Sub-Carpathian creep of the Getic Plateau, between the river Olt and the Danube, including the lignite deposits of Rovinari, Motru, Jilț, Berbești-Alunu (more than 90% of lignite reserves are located here in Oltenia mining basin), and Mehedinți.

Figure 19: RO: Coalfields in Romania; Jiu Valley in West Region

Source: Euracoal (2014)

In Jiu Valley micro-region, organised hard coal exploitation started in 1840, summing up, according to Jiu Valley National Mines Closure Society (SNIMVJ), at the end of IX century mining perimeters of about 8,991.5 ha. According to ANRM, 17 hard coal mining perimeters were exploited in 1990, in Petroșani basin – Jiu Valley. In 2012, when the European Commission approved the first state aid for financing uncompetitive mines closure program, the mining activity was carried out only in 7 underground mines (perimeters no. 1, 4, 5, 10, 11, 12, 15 in Figure 20) and 2 surface units (Jiu Valley Coal Preparation Exploitation – Câmpu lui Neag open pit and the Mining Rescue Centre) under the management of the state owned Hard Coal National Company (CNH); 2012 is also the year when SNIMVJ was founded, taking over in 2013 all three uncompetitive mines no. 4, 11 and 15 scheduled to be closed until 31 December 2018. According to the Romanian Academy (Vlad, 2016) the main issues which led to an economically inefficient exploitation of the coal mines are:

- heavy coal deposits conditions in Romania (complicated tectonics, thin coal layers, low calorific value, high exploitation depth, difficult hydrogeological conditions);
- the acute lack of investments in the past 20 years, none retrofitting or upgrading programs of the extraction methods, since 2007 zero investments being initiated.

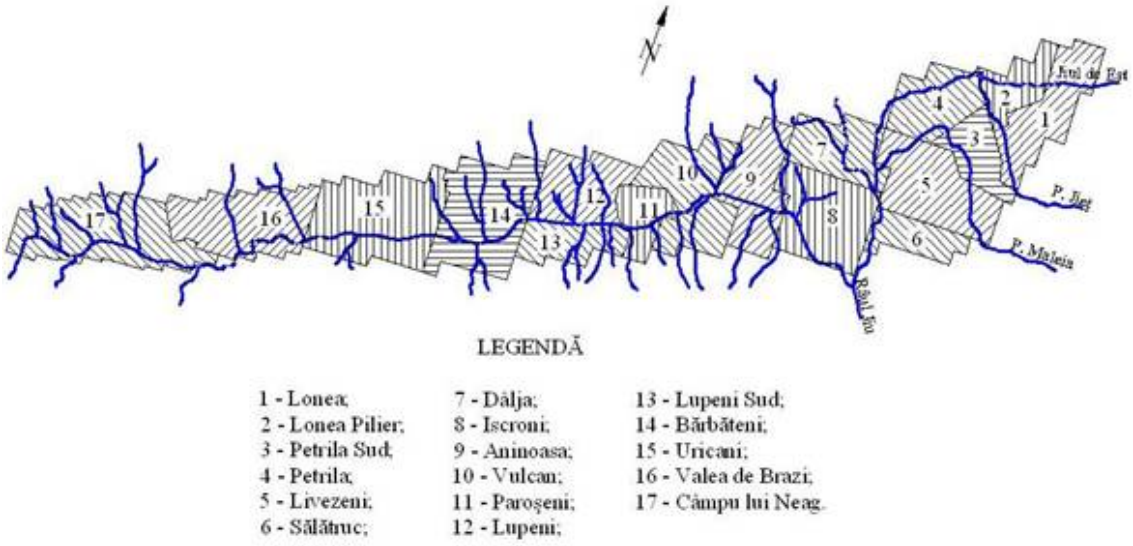

Figure 20: RO: Jiu Valley mining perimeters

Source: CEH

SNIMVJ will produce hard coal until the reserves are exhausted, starting in parallel a safe closing and remediation procedure. In the same year 2013, CNH was restructured as the new National Hard Coal Society (SNH) which was taken over by Hunedoara Energy Holding (CEH), as the future Mining Subsidiary managing all 4 mining perimeters (no. 1, 5, 10, 12 underground mines in Figure 20).

Starting with 2019, CEH is the only producer of hard coal in Romania through its Mining Division. Hunedoara Energy Holding has a strategic role in the Romanian National Power System in terms of security of electricity supply and geographic location. CEH has today the following business areas:

- hard coal-based Power and Heat Generation, with 1,225 MW installed in Subsidiaries:
  - Paroşeni CHPP Subsidiary (1 x 150 MW);
  - Deva TPP Subsidiary (4 x 210 MW + 1 x 235 MW).
- hard coal underground Mining Exploitation – Lonea, Lupeni, Vulcan and Livezeni Mines Subsidiaries (no. 1, 5, 10, 12 in Figure 20) covering 2,230 ha of mining perimeters;
- services – PrestServ Petroșani Subsidiary (Jiu Valley coal mining operation and the mining rescue station).

Paroşeni CHPP Subsidiary has in operation:

- 1 x power unit (no.4) with an installed capacity of 150 MWe – extracting steam turbine type, with 150 Gcal/ht, having a completed upgrading program in 2007, an ongoing FGD system implementation and qualified as highly efficient cogeneration unit;
- 1 x hot water boiler (HWB) with an installed capacity of 103,2 Gcal/h supplying 4 DHSs (Lupeni, Vulcan, Aninoasa, Petrosani), of which only Petrosani is still operational and includes 25 km of transport networks.

Deva TPP Subsidiary has in operation:

- 1 x power unit (no.3) with an installed capacity of 235 MWe – extracting steam turbine type, with 120 Gcal/ht of hot water, a steam boiler (660 t/h, 140 bar, 540°C), having a completed retrofitting and upgrading program;
- 4 x power units (no.2,4,5,6), each with an installed capacity of 210 MWe – extracting steam turbine type with 50 Gcal/ht of hot water, a steam boiler double module (660 t/h, 140 bar, 540°C).

CEH Mining Subsidiaries are:

- Vulcan and Livezeni underground mines (no. 5, 10 in Figure 20) hold an operating license until 2024;
- Lonea and Lupeni underground mines (no. 1, 12 in Figure 20) due to the economic reasons were planned to be closed in 2018, but after several intensified land subsidence phenomena both experts conclusions (GIG Poland and INSEMEX, Romania) indicated, in 2019, for safety reasons “the imperative necessity to extract the open and prepared coal reserves for an additional period estimated at 4 to 6 years”.

The average calorific value of the Romanian hard coal is 3,650 kcal/kg. Jiu valley hard coal, even if it is devoid of pyrite, has a high sulphur content being energetically weak with no export market potential, being strictly used for the domestic electricity and heat generation and supply. Jiu Valley hard coal is used for energy purposes (power and heat generation) mainly at CHPP Paroșeni and Deva TPP, the rest of its production being delivered to steel manufacturing industry and, less than 20% to citizens for domestic purposes.

SNIMVJ – Jiu Valley National Society for Mine Closure responsible for hard coal mining exploitation until the exhaust of opened reserves, and closure & post-closure activities at the following perimeters:

- Petrila, Paroșeni and Uricani underground mines (no. 4, 11, 15 in Figure 20)

At West Region level there is also a private hard coal open pit named Balomir-Uricani, with no data available, and one more cogeneration plant operating in Timiș County, running on lignite from Oltenia basin - South CHPP (CET Sud) subordinated to COLTERM Timisoara, including the following main equipment:

- 2 x HWBs of 100 Gcal/h, using lignite with natural gas support;
- 3 x industrial steam boilers (100 t/h, 15 bar, 250 °C) running on lignite, with natural gas support;
- 1 x undispatch CHP unit with a counter-pressure turbine (19.7 MW).

Coal production, productivity and supply to local energy producers and other coal-based industries are presented in Table 66.

Table 66: RO: Jiu Valley micro-region - Coal sector

Category		Romania (gross production)			West Region (RO42) (Jiu Valley) (net production) only dispatch power units		
years		2015	2016	2017	2015	2016	2017
Coal mines production (th. tons)	Coal, total	26,726	23,225	26,017↑	1,254	1,032	757↓
	Hard coal	1,301	1,069	784↓	956	754	742↓
	Lignite	25,425	22,157	25,232↑	0	0	0
Coal productivity (tons per employees)	Productivity calculated	1,554	1,511	1,873↑	213	209	178↓
					234	203	207↑
	Coal mines employees	17,194	15,373	13,890↓	5,898	4,948	4,262↓
					4,080	3,722	3,588↓
Total installed and available coal generation capacity (MW)	dispatch units	6,535	6,240	6,240	1,225	1,225	1,225
					1,225	1,225	1,225
	undispatch units	370	325	325	N/A	N/A	N/A
Coal based electricity generation (TWh)		18.11	15.87	16.92↑	1.84	1.42	1.20↓
Total energy supply from coal (th. toe)		5,892	5,278	5,389↑	327	262	209↓
Coal in Final energy consumption (th. toe)	total - energy use	777	729	628↓	N/A	N/A	N/A
	industry sector - energy use	696	672	593↓			
Coal in Final energy consumption (th. toe)	non-energy use	8	1	1	N/A	N/A	N/A

Source: INS (IND107A); (FOM104F); (IND120A); EUROSTAT TEN00122, 123, 129 and 130; TRANSELECTRICA National TSO; in blue ink data calculated based on CEH proceedings, CIRIT 2018, 2019 and Administrators' Reports 2015, 2016, 2017

Given the strategic and social role of CEH in the Romanian National Power System in terms of security of electricity and heat supply and balanced transmission system operation, recently inter-ministerial discussions led to a possible future scenario with CEH split in two public companies:

- Deva TPP Subsidiary taking a step forward towards decarbonisation through a comprehensive refurbishment & upgrading program for the only viable power unit

no.3, 235 MW, by switching to natural gas and ensuring compliance with all environmental requirements;
- CHPP Paroseni (power unit no.4, 150 MW) and 4 Mining Subsidiaries running on hard coal, in compliance with European ELV (emission limit value), until opened reserves are exhausted.

To this aim, The Ministry of Energy has already made first steps: ownership certificates issued by the Ministry of Economy for Lonea, Lupeni, Livezeni Subsidiaries and Paroseni CHPP will be included in the Land Registry, with administration rights in favour of the Ministry of Energy/CEH. The cadastre will be carried out and the legal regime of the buildings will be clarified.

8.2.2 Social aspects

According to WB report (World Bank, 2005) the communist legacy of privileged sector, with relatively high wages and a politically influential trade union continues to influence current relationships, making transition process more challenging. The absence of a hard budget constraint on mining companies has led to an increasing dependence on subsidies, despite mass layoffs with a pick in the early 90s and beginning of the XXI century (workforce dropped from 171,000 in 1997 to 50,000 in 2004). The welfare impact appeared through decline in living standards even if laid-off miners received special severance payments of 12-20 months wages, denied to other sectors. Those employed outside the mining sector are unlikely to receive any compensation. Far from the target of bringing foreign investors, this status facilitated the enrichment of some unions' and mines' leaders (Danciu, 2015). Those unemployed from secondary industries do not receive the generous severance benefits that mine workers do and were not considered the primary target of social mitigation programs, in effect, leaving them even worse off.

Closure of mining perimeters and the mono-industrial specificity of Jiu Valley hard coal basin generated a "domino" effect in terms of: unemployment; social vulnerability and depopulation; decrease in population incomes, in quality of life and local budget revenues; deterioration of education, health and utilities services; environmental issues etc.

Further, in order to understand the complex and problematic social state of play in Jiu Valley micro-region, main indicators are presented for characterizing the hard coal mining sector during two crossroad years: 1990 and 2018. (Table 67)

Table 67: RO: Jiu Valley micro-region – Hard coal mining sector

Category	M.U	Year	
		1990	2018
Jiu Valley population	inh.	167,456	120,734
Employees in the mining sector	no.	55,000	4,797
Mining perimeters in operation	pcs.	17	4
Active preparation plants	pcs.	5	1
Exploited layers	pcs.	12	3
Gross hard coal mines production	mil. tons	10.5	0.8
Investments in the mining sector	mil. lei	128.59	0
Population below the poverty limit	%	-	10.25
Unemployment	%	-	1.26
Contribution to the local budget	%	76	1.71

In the 90's the mining activities contribution to the local budgets was approx. 76%, while in 2018 has reached an insignificant value of 1.71%. The downsizing of the mining activities in Jiu Valley micro-region, sometime the largest mining basin in Romania, caused the economic and social decline of the area. The hard coal supply chain put in place during 80 - 90's was destroyed due to successive split-offs and internal restructuration processes, and the entire cluster approach was demolished. The structural mutations that took place in the Romanian economy after 1989 generated the closure of mines without viable reopening perspectives, as

well as collective layoffs. All this has led to a sharp economic downturn in the region, becoming a highly broadcasted and published issue both in the local and regional media.

The amount of state aid managed by SNIMVJ, in accordance with art. 3 of Decision 2010/787/EU, and the Mine Closure Plan (CNH, 2011) is presented in Table 68 and is summing up in 8 years about 178 million euros, and received by each mining unit under closure procedure. It can be observed that the largest amount was allocated to Paroseni, followed by Uricani and Petrila mines.

Table 68: RO: Jiu Valley micro-region – Mine closure plan, 2011 (in thousands euro)

Year/Coal production unit	PETRILA	PAROŞENI	URICANI	TOTAL
2011	14,509	14,374	13,289	42,171
2012	11,867	12,506	11,170	35,543
2013	10,414	10,368	9,548	30,330
2014	10,332	9,159	8,060	27,551
2015	7,927	6,527	6,539	20,993
2016	0	5,888	5,815	11,703
2017	0	5,737	4,036	9,773
2018	0	0	0	0
Total	55,049	64,559	58,457	178,065

Source: (CNH, 2011)

The total population in Jiu Valley according 2011 census is 120,734 inhabitants, a value more fitted to the reality in the field in comparison with INS statistical figures (see Table 52). The average number of CEH employees is shown in table below.

Table 69: RO: Jiu Valley micro-region – Number of employees in CEH and SNIMVJ mines

Category / Years	2014	2015	2016	2017	2018
Average number of employees in CEH, of which:	6,672	6,407	5,824	4,840	4,288
Administrative personnel	2,198	1,965	933	534	510
Production personnel	4,474	4,442	4,891	4,840	3,778
Number of employees in SNIMVJ mines	N/A	989	727	406	0
Petrila	N/A	0	0	0	0
Paroşeni	N/A	572	498	198	0
Uricani	N/A	417	229	208	0

Source: (CEH, 2019), (Local media, n.d.)

A structure of the labour force employed by mid-2015 at CEH four viable mines and at the Prestserv unit, by gender and by age is presented in the following table:

Table 70: RO: Jiu Valley micro-region – Number of employees in CEH mining subsidiaries by age

Unit	Men	Women	Age, years					Total
			18-25	26-35	36-45	46-50	>50	
Lonea	840	136	21	95	655	123	82	976
Livezeni	858	151	45	91	619	158	96	1,009
Vulcan	700	107	32	79	514	126	56	807
Lupeni	1,146	228	23	128	838	216	169	1,374
Prestserv	241	252	1	20	152	175	145	493
Total	3,785	874	122	413	2,778	798	548	4,659

Source: (CEH, 2019)

At SNIMVJ the distribution of employees by age shows that the highest share is the category of personnel aged 35-45 years (49%), followed by 45-50 with 41% and >55 years and 30-35 category cover the rest of 10%. The average age of the employees is 45 years old at SNIMVJ and 42 years in CEH.

Analysing the above data, the following conclusions can be drawn:

- the average age of the employees from the four viable mines in Jiu Valley is approx. 42 years old, very close to the retirement age;
- 25% of employees are aged over 46;
- only 3% are young people aged 18-25;
- Employees aged between 26-35, the most conducive period for professional training and solid experience acquirement, represent only 9%.

From a real fortress of the Romanian mining industry, including the whole chain (mining preparation facilities, high-performance mining enterprises producing even mining machinery and other dedicated equipment, large construction sites), with many cultural institutions and a reputable mining higher education institute, with first-rate sports teams and especially with "strong souls" people as the playwriter I.D.Sârbu used to call them, Jiu Valley today, but maybe also tomorrow, is a sad place in which life will not disappear, but a "way of life" will surely disappear (Bogdan, 2017).

8.2.3 Economic effect

If we look at the figures in Table 71, West Region has a significant increase in the average number of employees of 3% (2016-2017) mainly due to agriculture, construction, ICT and various other services (ex. tourism). In contrast, migration and unattractive wages generated a decrease in number of employees at the county level, and at the local level in Jiu Valley micro-region, despite the layoffs in the mining sector (15%); we notice a small increase of 0.6% (2016-2017) of the total number of employees due to agriculture, construction, tourism and other various services. The industry is declining in terms of the number of employees, both at regional, county and local level. In Hunedoara County the number of employees falls in the mining and energy industries, even if the average wages in these sectors are higher than the national and West Region average. Slightly positive developments in terms of both the number of employees and the average gross salary are observed in agriculture, construction, tourism and services.

Table 71: RO: Romania / West Region (RO42) / Jiu Valley micro-region – Average number of employees and gross income

Category		Romania			West Region (RO42)			Hunedoara County (Jiu Valley)		
years		2015	2016	2017	2015	2016	2017	2015	2016	2017
Average nominal monthly gross wages (euro)	Total economy	575	626	706	551	606	676	473	491	573
	Agriculture	426	498	563	434	547	610	383	424	470
	Industry	566	609	667	605	674	714	522	530	597
	Hard coal and lignite mining	865	822	889	947	850	923	949	852	931
	Electricity, Gas and HAC	968	1,003	1,047	905	899	987	876	844	936
	Construction	440	467	511	396	435	477	392	379	448
	Accommodation and food services	332	375	426	299	341	395	279	325	370
	ICT	1,137	1,264	1,348	1,108	1,333	1,372	587	545	615
	Professional, Scientific and Technical activities	853	925	948	654	643	732	530	665	630
Average number of employees by economic activities (no.)	Total economy	4,611,395	4,759,419	4,945,868↑	498,384	510,380	525,937↑	105,922	106,944	106,767↓
								26,544	24,916	25,062↓
	Agriculture	112,699	117,046	121,720	14,317	14,256	15,364↑	2,948	2,752	3,040↑
	Industry	1,334,943	1,352,862	1,400,975	199,238	200,751	199,122↓	42,494	40,714	39,261↓
	Hard coal and lignite mining	17,194	15,373	13,890	5,898	4,948	4,262↓	5,868	4,926	4,189↓
	Electricity, Gas and HAC	55,445	54,234	52,600	6,028	5,943	5,398↓	2,933	2,740	2,275↓
	Construction	354,706	365,298	370,415	32,152	31,077	34,184↑	8,019	8,511	8,886↑

Category		Romania			West Region (RO42)			Hunedoara County (Jiu Valley)		
years		2015	2016	2017	2015	2016	2017	2015	2016	2017
	Accommodation and food services	133,848	151,230	169,837	12,716	13,649	15,278↑	2,790	2,917	3,354↑
	ICT	143,274	154,520	170,274	11,493	12,588	15,109↑	634	726	699↓
	Professional, Scientific and Technical activities	143,863	151,242	158,459	9,510	11,309	12,021↑	1,479	1,711	2,054↑

Source: INS (FOM107E); (FOM104F); (FOM104D); National Commission for Strategy and Prognosis – Projection of the main economic and social indicators until 2021 (2018)

According to WB report (World Bank, 2005) the welfare impact appeared through decline in living standards both inside the mining sector and outside in other ancillary industries and services. Many of these ancillary industries suffered a second order impact due to mine restructuring, also facing significant decline in household welfare. Measures taken from governmental level reached no expected outcomes. The social and economic impact is topical today, even amplified, although the intensity of the coal mining restructuring process has decreased considerably. The negative effects targeted not only the mining exploitation field, mining equipment and machinery manufacturing, but also the energy sector and related support services as consulting and engineering companies, the research and academic environment. Towns that are mono-industrial have a harder time adjusting to mine closure because creation of alternative livelihoods is much slower. On the other hand, towns with textile industry have attracted foreign investors and created jobs, especially for female workers. Also, non-payment of taxes by the mining companies had a marked impact on the ability of local authorities to maintain local infrastructure and finance social services. Investments in local infrastructure would have created the enabling conditions for enterprise development and attraction for potential investors.

In Romania the land concession process is regulated, coordinated, implemented and monitored by the Romanian Regulatory Authority – ANRM (National Agency for Mineral Resources), according to the Romanian Mining Law no.85/2003 with all subsequent amendments, GD no. 1208/2003 regarding the approval of Mining Law application Norms, Mines Closing Handbook, and ANRM Technical Instruction for Mine Closure (2013 and 2019). To this aim ANRM approves the transfer of a concession license for mining activities (exploration or exploitation) to another legal entity; establishes the terms and conditions for drawing up the acts and rules for giving in administration or in concession, in order to negotiate with the concessionaire / administrator. ANRM is also organizing and conducting the public tender for concession of mining activities (exploration or exploitation). According to GD no. 1208/2003, the mine closure procedure stipulates that the former holder of the cancelled mining activities exploitation license shall remain responsible for the integrity of the technical and ancillary mining buildings, which shall be owned by the state, within no more than 3 months term after the cessation of the concession. The state-owned former mining buildings now can be transferred to a new license holder or included in the conservation process (mines with temporarily ceased operation). Final closure of the mining activity is under ANRM regulatory responsibility in compliance with Technical Instruction for Mine Closure (2013 and 2019).

Conversmin (see Chapter 8.3) is the entity responsible for unrolling, according to the Mining Law and ANRM Technical Instructions, the mine closure and post-closure process, together with the former mine owner and holder of the concession license. The following steps must be carried-on:

1. the “Holder” has the obligation to clarify the land ownership regime and to register the former mine land into the Land Registry Book, before drafting the “cessation plan”;
2. final registration of ownership rights for the former mine land and buildings free of juridical charges are transferred to the Ministry of Economy / Conversmin, in case of state-owned mines;

3. after completion of mine closure works, the environmentally restored and rehabilitated land areas are handed over by the Ministry of Economy / Conversmin to the local public authorities and / or other beneficiaries.

During the last stage of post-closure monitoring Conversmin has also the obligation to provide by request, to the local public authorities, all the information considered relevant from the construction book, as well as the monitoring results for issuing the construction permits.

The same closure and post-closure procedures are followed by SNIMVJ (see Chapter 8.3) for 3 of the mining perimeters mentioned in Chapter 8.2.1, in accordance with the Closure Plan and the Technical Rehabilitation and Environmental Restoration Project. Thus, procedures started when the hard coal exploitation process ceased – for Petrila mine in 2015 and for Paroseni and Uricani mines in 2017.

Unfortunately, local public authorities in Jiu Valley do not have the necessary financial resources to take over the land, nor the buildings of the former mining exploitations. Once final registration of ownership rights in the National Land Registry is accomplished, costs are generated (taxes), the local budget being already so burdened by debts.

8.2.4 Environmental effect

International Energy Agency emphasises in its new policies scenarios, that coal will provide around 33% of global electricity demand in 2030 (Ministry of Energy, 2018). Hard coal reserves concentrated in Jiu Valley mining perimeters, amount to 2.2 billion tonnes, of which 592 million tonnes are in four operating perimeters. The average calorific value of the Romanian hard coal is 3,650 kcal/kg. The hard coal gross production in 2015 was 1.2 million tonnes, reduced from 2012 (1.8 million tonnes) and continuing to drop until 2017 (0.8 million tonnes).

If we analyse the mix structure of the electricity generation 2016-2017, at national level we can see that fossil fuels (GHG sources) share is slightly increasing by 3% in 2017 being 44% (27% coal, mainly lignite and 17% hydrocarbons) and non-GHG sources 56% is decreasing 4%, mainly due to 6% drop in of hydro energy share; nuclear (18%) is constant and renewable sources 38% (hydro, wind, solar, biomass) slowly rising. The intensity of CO_2 emissions per unit of produced electricity (314.52 g CO_2/kWh) is close to the European average (ANRE, 2017), according to ANRE National Report, 2017. The fossil fuels based thermoelectric capacities covered 40% of the available gross installed power in 2015 and achieved 40% of the annual electricity output.

Out of the total emissions generated in Jiu Valley micro-region, approx. 18.91% are SO_2 emissions, 14.08% NOx, 6.03% PM10 and approx. 3.02% PM2.5. Global emissions of acidifying pollutants remain low in Hunedoara County, mainly due to the drastic reduction of the heavy industry sectors activity. Nitrogen oxides emissions from transport are growing slightly, from year to year, due to the increasing number of vehicles, but the emissions from the industrial sector are decreasing. (Source: ANPM data processed by the authors.)

The pollutants from hard coal combustion in Paroseni CHPP, Jiu Valley micro-region led, in the past, both to the atmospheric quality and biotic & abiotic environmental factors deterioration, thus affecting people health directly or indirectly. Pollutant substances have a negative impact on the environment quality not only as primary pollutants, but also through their reaction products into the atmosphere, the so-called secondary pollutants. It is also noted the synergistic effects of pollutants from fossil fuels combustion, both as primary and secondary pollutants.

In terms of compliance with environmental requirements, in 2018-2019 in Paroseni CHPP 2 major environmental investments were completed: the FGD installation for LCP no.2, being now in compliance with Directive 2010/75/EU on industrial emissions (IED), and the ash & slag removal system in dens slurry. Paroseni CHPP has starting with May 2019 an IEP (Integrated Environmental Permit). Deva TPP Subsidiary has no environmental protection program implemented so far, being now under permitting procedure (e.g. FGD systems, or low NOx burners or ash and slag removal system in dens slurry). CEH Mining Subsidiaries hold an operating license for concessional perimeters by 2024.

In Hunedoara County landscape, mainly in Jiu Valley micro-region, a special place is occupied by abandoned industrial sites due to cessation and / or downsizing of some economic activities. The steel, metallurgical and mining former local tradition makes it possible today to find numerous industrial sites near or even inside crowded urban spaces. These industrial sites, with private or public ownership rights generate several environmental issues related to significant soil contamination, subsoil and even groundwater. At county level the surface of these industrial sites is approx. 29.78% historical contaminated, the rest of 70.22% being with current contamination. At the level of Jiu Valley micro-region, these contaminated sites are resulting from power and heat generation industry in a proportion of around 29.42% and from coal exploitation about 25.47%.

Table 72: RO: Jiu Valley - Tailings dumps status

Mining exploitation	Number of dumps	Tailing dumps surface (ha)	Affected adjacent area (ha)
Lonea	5	24	-
Petrila	1	2.1	0.3
Petrila Sud	2	9.1	-
Dâlja	4	12.58	5.0
Livezeni	2	3.7	1.0
Aninoasa	2	8.65	3.76
Vulcan	4	15.7	15.6
Paroşeni	3	5.34	0.9
Lupeni	4	28.04	4.8
Bărbăteni	2	2.9	0.3
Uricani	2	13.0	6.0
Valea de Brazi	3	2.37	0.10
I.P.C.V.J.	5	66.7	6.70
Total Jiu Valley	39	193.68	50.71

Source: (Davidoiu T. A., 2017)

Up to now, Jiu Valley mining wastes are discharged directly onto the ground, most of the dumps being improvised without complying with environmental protection standards, with a severe impact on environmental components. According to Jiu Valley landscape planning (URBANPROIECT, 2003), the allocated areas for storage dumps are shown in the following table.

Table 73: RO: Jiu Valley - Surface of mining wastes storage deposits

Administrative territorial units	The storage area (ha)
Petroşani	7.7
Petrila	1.9
Vulcan	4.5
Lupeni	3.8
Uricani	1.3
Aninoasa	0.7
Total	19.9

Source: (Davidoiu T. A., 2017)

Water resources consist of surface waters and groundwater. They can be a limiting factor of regional economic development, especially if they are in large deficit compared to the requirements of society. The ecological status of the Jiu River basin shows 81.33% good.

Table 74: RO: Jiu Valley - Ecological potential and chemical status of highly modified and artificial water courses

River Basin	Heavily modified and artificial water bodies (%)				
	total / monitored bodies	good ecological potential	moderate ecological potential	good chemical status	bad chemical status
Jiu River Basin	8	81.33	0.60	0.60	-

Source: (Davidoiu T. A., 2017)

The most important sources of environmental components pollution in Jiu Valley are the mining industry (citizens' basic occupation) and the energy industry. The entire process of the mining activity produces, due to its specificity, multiple and various negative effects on the environment, namely:

- large land surfaces occupied for mine activity, tailing dumps, coal storage, technical and ancillary buildings, access routes, etc., which become totally unusable for other purposes, for a long period of time, with a strong impact on local communities;
- land degradation, vertical and horizontal displacement of the surface (subsidence) and possible slopes of the waste dumps, causing hazardous events;
- surface water pollution due to discharges of industrial waste water from treatment and preparation plants;
- negative impact on air quality, flora and fauna, by releasing the underground polluted and foul air through the fan stations and thermal plants inside the premises;
- chemical soil pollution as a result of uncontrolled and non-compliant dumping of domestic, industrial and hazardous wastes, which may affect the land fertility for many years;
- noises and vibrations from installations and equipment inside the mine premises, and from urban transport.

Once mining exploitation activities (production and preparation) were significantly reduced and Paroseni CHPP environmental protection investments were completed a significant improvement of the air quality have been observed in Jiu Valley, although issues related to industrial and domestic wastes storage have not yet been solved.

8.3 Coal mining and coal utilization policies

8.3.1 National policy

Transition of coal-intensive regions in Romania towards a sustainable energy system is conditioned by the development of the existing regulatory framework. As an EU Member State, Romania has to transpose the EU legislation, to harmonize the existing legislation with the EU acquits and to develop the institutional framework able to apply and monitor the legal provisions' implementation. The proper functioning of the institutional structure depends on how public policies are being developed, how often revised, and especially how policies are put into practice. Romania does not lack the institutional, legislative and regulatory framework, but has failures in terms of continuity and predictability of the legislative process. Romania needs both at central and regional/local level, an inter-institutional synchronization and capacity to monitor a proper policies' implementation. Through a bottom-up approach all along the entire policy development process bottlenecks can be avoided.

Romanian institutional overview (coal related)

The Romanian National Agency for Mineral Resources, energy and environmental authorities and local administrations may be seen as essential to the implementation of coal transition policies. The table below presents the relevant authorities with their main responsibilities.

Table 75: RO: Romanian relevant authorities for transition in coal region

Authority	Main responsibilities
National Agency for Mineral Resources (ANRM) - main institution with supervisory and regulatory authority in the mining sector; - competent authority entitled to apply the provisions of the Mining Law no. 85/2003; - organized as a national public institution, with legal personality, main credit release authority, acting under Government subordination; - operation and organization of ANRM is established by GD Subordinate to the General Secretariat of the Government	• Manages mineral resources and the national geologic fund (F.G.N), public property of the State; • Establishes the terms and conditions of licenses/permits, grants and issues licenses/permits provided by the law and regulates the development of mining activities through norms and technical guidelines on the development of mining activities, issued for the application of the Mining Law; • Receives, verifies and registers the data and information on mineral resource and reserves and organizes F.G.N.; it constitutes the national fund of mineral resources/reserves (F.N.R/R.). The official data relating to mineral resources/reserves are those included in the national fund; • Sets out rates for royalties under the law; • Monitors and verifies the production of mineral resources for calculating royalties; • Monitors the implementation of the measures set out to protect surface and subsoil, during and after the completion of mining activities, in accordance with the provisions of the law; • Monitors the compliance by title holder of the provisions of its license/permit, as well as of the norms and guidelines in the field and takes measures to enforce these measures; • Approves documentations on the execution of mining activities, as well as documentation on the termination of mining activities, only under the provision and approval, according to the law, of environmental protection measures and ecological restoration; • Sets up hydrogeological protection perimeters for the deposits of natural mineral, geothermal and thermal and mineral groundwater, of therapeutic mud and peat and approves the establishment of sanitary protection perimeters; • Works together with the local authorities of water management, environment protection and labour protection in carrying out the control activity; • Sets out the suspension of mining activities carried out outside the perimeter, of the activities without approved technical documentations, as well as those which, by the way of execution, may result in unjustified losses of reserves or the deposits degradation, until removing the causes having produced them; • Draws up norms and technical guidelines to enforce this law, with the assistance of the relevant ministries; • Draws up and maintains up to date the Mining Book and Mining Cadastre, as provided by the norms for enforcement of this law. Legal acts and documents that are not registered in the Mining Book and Mining Cadastre are not binding upon third parties; • Finds and notifies the non-observance of the provisions of this law; • Develops draft laws and draft decisions of the Government for mining activities.
Ministry of Economy The relevant Ministry that ensures the development of mining activities in accordance with the **Mining Law no. 85/2003** Subordinated to the Government Have under its authority, as unique shareholder, **CONVERSMIN** a company responsible for energetic and non-energetic mineral mining conservation and closing	• Develops strategies and policies in mineral resources (recently only non-energy minerals) field that are subject to Government approval; monitors and takes part in their implementation in accordance with its own competencies. The strategies and policies shall be applied to the participants in mining activities only favourably; • Evaluates and approves the budget to carry out the production of mineral resources to domestic mining companies and enterprises; • Develops programmes to enforce strategies and policies, as well as the budget, including prospecting programmes that are carried out with funding from the state budget; • Is the main credit release authority for budgetary allocations for upgrading - development, prospecting programmes, as provided in the annual geological plan, technological research, environment protection and restoration, restructuring, preservation/closure of mines and other activities in the mineral resources field; • Ensures the preparation of studies based on which, together with the competent authority in the finances field, selects the mining products whose exploitation is carried out with funding from the state budget; it underlies their prices, according to the law; • Approves, together with the competent authority in the field of labour and social solidarity, normative acts for mining work protection; • Approves, together with the competent authority in the field of environment protection, normative acts for environment protection specific to the mining activity; • Develops, together with the competent authority in the field of labour and social solidarity and the organizations of employers and trade union organizations, programmes of healthcare assistance and accidents and risk insurance, in order to rehabilitate and compensate the persons who have suffered accidents at work and professional diseases in the mining activity; • Approves feasibility studies and development plans of national mining companies and enterprises, as well as permanent or temporary termination of mining activities; • Sets out and develops national policies in the field of social problems in mining activity areas, together with the competent authority in the field of labour and social solidarity and the bodies of the local public administration; • Through its specialty directions, it undertakes to execute the works for preservation/closure of mines or quarries belonging to national mining companies and enterprises, as well as of mines and quarries, exploration works stopped before the entry

Authority	Main responsibilities
	into force of the Mining Law no.85/2003 and that are not subject to any license and ensures monitoring of post-closure environment factors; • Approves the draft laws and draft decisions of the Government for mining activities.
Ministry of Energy Subordinated to the Government Have under its authority, as unique shareholder: - **Hunedoara Energy Holding** – hard coal power & heat generation (Deva TPP and Paroșeni CHPP) and mining exploitation (Lupeni, Vulcan, Aninoasa, Petrosani underground mines) - **SNIMVJ – Jiu Valley National Society for Mine Closure –** hard coal mining exploitation until the exhaust of opened reserves, and closure & post-closure activities (Petrila, Paroșeni and Uricani underground mines)	• Develops the national energy strategy and the energy policy and brings it to accomplishment according to the provisions of Article 6 of the Electricity and Natural Gas Law no. 123/2012; • Elaborates studies and syntheses regarding the evolution and structural adjustment of the energy and extractive industries in accordance with the provisions of the Energy and Natural Gas Law no. 123/2012 and Mining Law no. 85/2003, with all their subsequent amendments and completions; • Approves the documentation for obtaining licenses in the field of energy resources, according to the Mining Law no. 85/2003 and the final thesis of the Oil Law no. 238/2004, with all their subsequent amendments and completions; • Ensures the management of the public property in the energy field, based on art. 868 par. (1) of the Law no. 287/2009 on the Civil Code, art. 3 par. (2) of GEO no. 86/2014 regarding the establishment of some reorganization measures at the central public administration level and for the modification and completion of some normative acts, approved with amendments and completions by Law no. 174/2015, with all its subsequent amendments and completions; • Ensures, coordinates and monitor the fulfilment of the energy and energy resource commitments resulting from the agreements concluded by the Romanian State with the International Financial Institutions (IFIs); • Accomplishes its tasks under the National Waste Management Plan, concerning the management of waste generated by the extractive industry, according to the Government Decision no. 856/2008; • Coordinates the electricity production activity and the development of projects for economic operators under the authority of the ministry.
Ministry of Environment Subordinated to the Government and having under its authority: ANPM – National Agency for Environmental Protection	• Develops the environmental and water management policy at national level; • Ensures and coordinates the implementation of government strategy on environment and water; • Coordinates the implementation of EU requirements at the national level, the development of National Allocation Plan and development of subsequent legislation related to the EU Directives
Ministry of European Funds	• Coordinates at national level the policy related to SF 2007-2013 ESIF 2014-2020; • Coordinates the local governance structure Jiu Valley Initiative and manages the process of elaborating the micro-region development strategy in order to access the future ESIF 2021-2027 and implement the transition for the Jiu Valley, according to the European Commission initiatives "Platform on Coal Regions in Transition"
National Environmental Protection Agency (ANPM) Subordinated to the Ministry of Environment	• Ensures the implementation of national strategies and environmental policies, legislation and regulations, and coordinates action plans at regional level; • Approves annually the monitoring plan for EU ETS operators and it is also the Administrator of the Romania EU ETS Register; • Approves the monitoring plans designed by the operators.
CONVERSMIN Subordinated to the Ministry of Economy	• Applies the mine closure policy being in charge with the management of this work by awarding public procurement contracts in accordance with the legislation in force for all elements (conservation, design, underground closure, greening, monitoring, monetizing the recovered materials, technical assistance), including contingencies (disasters), monitoring the implementation of projects, including in the post-closure monitoring phase, the efficient use of resources, the regular correlation of the legislation with the other areas of activity with which it comes into contact and, last but not least, the provision of a permanent dialogue with the community; • After completion of mine closure works, the environmentally restored and rehabilitated land areas will be handed over by the Ministry of Economy / Conversmin to the local public authorities and / or other beneficiaries.
National Society for Mine Closure in Jiu Valley set-up under Council Decision (2010/787/EU) on State aid aiming to facilitate uncompetitive coal mines closure Subordinated to the Ministry of Energy	• The main goal is to produce the expected amount of hard coal until the exhaustion of open reserves in order to ensure an organized liquidation of their activity, under legal conditions and by mitigating the social and regional consequences of mines closure; • Carrying out the mine closure and post-closure works by considering the safety of the staff and the deposit, as well as the greening of the closed perimeters in accordance with the Mine Closure Plan and the Technical Project for Mine Closure and Environmental Rehabilitation for Petrila, Paroseni and Uricani Mines.
Hunedoara County Council **Local Councils in Jiu Valley**	• According to the principle of local autonomy, granted by the Romanian Constitution and the Local Public Administration Law no.2015/2001 the Local Councils are not subordinated to any county or central authority; between the local council, respectively the mayor, on the one hand, and the county council, on the other hand, there is no report of subordination; same in relation with the prefect, the ministry of public administration;

Authority	Main responsibilities
	• The administrative decentralization consists in the recognition of the legal personality of the administrative-territorial units, the existence of the public authorities which represent the citizens/community and which are not part of a hierarchical system, Mayors and Presidents of the County Councils being elected; • Each administrative-territorial unit (communes, cities, municipalities, counties) has its own patrimony and its own budget, which is managed in order to satisfy local interests and needs, in accordance with the provisions of the law.

8.3.2 Romanian legislation applicable to coal mining activities

The following legislative framework in force relevant for coal mining activities, coal utilization activities and decrease of social inequalities is applicable and is being applied in sectors such as mining, air - water - soil quality, wastes and EIA:

Mining:

- Mining Law no. 85/2003, with all its subsequent amendments and completions - the "Mining Law" governs the performance of mining activities in Romania by stimulating the capitalisation of mineral resources, which are the public property of the State. Mining activities comprise prospection, exploration, development, exploitation, preparation and concentration of mines, trade in mining products and mines conservation and closure;
- GD no. 1208/2003 approving the Mining Law no.85/2003 application Norms, with all its subsequent amendments;
- ANRM Order no. 187/2002 approving the criteria for the content of documentation for the underground and open pit mines operation methods;
- ANRM Order no. 94/2009 approving the technical instructions regarding the issuing of operating permits, with all its subsequent amendments and completions;
- ANRM Order no. 116/1998 approving the technical instructions for underground and open pit mines closure and regulating the followings: a) the framework content of the documentation needed for the temporary cessation of the exploration and/or operation activity, for the preservation and final closure of the mines; b) the necessary permits for the approval of the documentation; c) procedures regarding the final and total closure of mines which ceased their activity until the entry into force of the Mining Law no. 61/1998.
- ANRM Order no. 197/2003 approving the methodological norms regarding the execution of the cadastral works in the field of mining extraction;
- ANRM Order no. 243/2019 approving the technical instructions regarding the framework content for the Report on the Execution of Closing, Greening and Post-Closure Monitoring Works;
- ANRM Order no. 254/2019 approving the technical instructions on the framework content for the Environmental Recovery Plan and the Environmental Recovery Project;
- Order no. 273/2001, issued by the Ministry of Industry and Resources, approving the Mine Closure Guide.

Wastes:

In Romania the following waste legislation is applied in the mining field:

- GD no. 856/2002 on keeping the waste management records and approving a list of wastes, including hazardous waste, with all its subsequent amendments and completions – adopts the Commission Decision 2001/118/EC (the updated European Waste Catalogue);
- Law no. 211/2011 on waste, with all its subsequent amendments and completions – transposing Waste Framework Directive 2008/98/EC;
- GD no. 856/2008 on the management of waste from extractive industries - transposing Mining Waste Directive 2006/21/EC;

- Order no. 202/2881/2348/2013, issued by ANRM, Ministry of Environment and Climate Change and Ministry of Economy, approving the technical instructions for implementing and verifying the implementation of the measures set out in the Environmental Recovery Plan, the Extractive Waste Management Plan and the Technical Project for the environmental rehabilitation, as well as the operation of the financial guarantee for restoring the environment affected by mining activities – considers the provisions of the Mining Waste Directive 2006/21/EC and the Commission Decision 2009/335/EC on technical guidelines for the establishment of the financial guarantee;
- GD no. 349/2005 on wastes storage - establishes the legal framework for the waste storage activity as well as monitoring the closure and post-closure of existing deposits by considering the environment protection and the health of the population. Its annexes stipulate the rules for authorization, monitoring and acceptance of waste;
- Order no. 95/2005 issued by Ministry of Environment and Water Management, establishing the acceptance criteria and preliminary procedures for the acceptance of waste at the storage site and the national list of accepted wastes in each class of landfill.

The wastes to be managed in mine closure activities are regulated according to the following normative acts:

- GD no. 235/2007 on waste oils management, with all its subsequent amendments and completions;
- GD no. 173/2000 regulating the special regime for the management and control of polychlorinated biphenyls and other similar compounds, with all its subsequent amendments and completions;
- GD no. 124/2003 on the prevention, reduction and control of environmental pollution with asbestos, with all its subsequent amendments and completions;
- GD no. 1132/2008 on the regime of batteries and accumulators and of batteries and accumulators waste, with all its subsequent amendments and completions;
- GD no. 170/2004 on the management of used tires, with all its subsequent amendments and completions;
- Law no. 249/2015 on the management of packaging and packaging waste, with all its subsequent amendments and completions

Environment protection:

- Law no. 265/2006 on environment protection, with all its subsequent amendments and completions;
- GD 1076/2004 on establishing the procedure for assessing the effects of certain plans and programmes on the environment, amended by GD 1000/2012 – transposing Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment;
- Order no. 863/2002 issued by Ministry of Water and Environment Protection, approving the guidelines for Environmental Impact Assessment framework procedure;
- Order no. 864/2002 issued by Ministry of Water and Environment Protection, approving the Environmental Impact Assessment procedure in a transboundary context and public participation in decision-making for projects with transboundary impact;
- Order 1798/2007 issued by Ministry of Environment and Regional Development, for the approval of the procedure for issuing the environmental permit;
- Law no. 292/2018 on the EIA of certain public and private projects on the environment – transposing EIA Directive 2014/52/EU on the assessment of the effects of certain public and private projects on the environment;
- GEO no. 57/2007 on protected areas, the conservation of natural habitats, of wild fauna and flora, with all its subsequent amendments and completions;

- GEO no. 68/2007 on environmental liability with regard to the prevention and remedying of environmental damage, with all its subsequent amendments and completions - transposing the Directive 2004/35/EC on environmental liability.

Air - water - soil quality:

- Law no. 107/1996 (Water Law), with all its subsequent amendments and completions - transposing Directive 2000/60/EC establishing a framework for the Community action in the field of water policy and provides the general framework for the use of water sources in human activities including mining;
- Law no. 278/2013 regarding industrial emissions, with all its subsequent amendments and completions - transposing Directive 75/2010/EC on industrial emissions (former IPPC);
- Law no. 104/2011 on ambient air quality, with all its subsequent amendments and completions – transposing Directive 2008/50/EC on ambient air quality and cleaner air for Europe;
- GD no.1403/2007 on the restoration of the areas in which the soil, subsoil and terrestrial ecosystems were affected;
- GD no.1408/2007 on soil and subsoil pollution investigation and evaluation procedures.

Decrease of social inequalities

In accordance with the provisions of the Council Decision 2010/787/EU the state aid facilitating the closure of uncompetitive coal mines within SNIMVJ is approved annually by Government Decisions. Such a Government Decisions for 2019 is under approval procedure. This is GD no. 224/2019 that approves the granting of state aid to facilitate the closure of uncompetitive coal mines within SNIMVJ for the year 2019 and provides for granting state aid to cover the following costs of closing down the three mining units (Petrila, Paroşeni and Uricani) of the former CNH: costs for compensation payments to employees who lose their jobs, professional reconversion costs, costs for covering the electricity consumption and the equivalent of coal for employees and costs for the closure of the underground works and the connection with the surface.

National targets, priorities, strategies and plans in the field of Energy & Climate

In Romania public policies in the field of energy & climate change, with emphasis on coal industry, have as reference 5 fundamental strategic documents which set priorities at national level and propose measures to achieve the targets:

- Romanian Mining Strategy 2017-2035 (2017)
- Romanian National Strategy on Climate Change 2013-2020 (2013)
- Romanian National Strategy for Sustainable Development 2030 (2018)
- Integrated National Plan for Energy and Climate Change 2021-2030 (Draft version 2018)
- Romanian Energy Strategy 2019-2030, with 2050 forecast (2018)

Mining Strategy 2017-2035

After defining the background at national and European level and assessing the state of play in the field of energy and non-energy mineral resources exploitation industry, the document is emphasising the vision and set-out general strategic objectives, as:

1. Repositioning the mining field as market share, for ensuring the necessary mineral resources for a sustainable development of the country, with priority from inland production;
2. Harmonising the national interest in increasing the mining sector activities, with the sustainable development requirements;
3. Country's mineral resources sustainable use in harmony with the environment, and the protection of natural and cultural sites, according with EU Directives and policies;

4. Accountability, transparency and civic engagement of mining communities' in the decision-making process and actions carried out throughout the life cycle of mining projects.

Proposed measures and actions are scheduled together with supportive necessary public policies, results indicators and implementation monitoring being finally set out, of which we underline:

- socio-economic reconstruction of the most affected communities by the mining restructuring process, in order to become development poles through job creations;
- exploitation of lignite resources from the Oltenia and hard coal from Jiu Valley mining basins.

National Strategy on Climate Change 2013-2020

Considering that the energy sector (fossil fuels combustion) was responsible, in 2010, of about 70% of the total national GHG emission amount the Ministry of Environment strongly advises that it is necessary to promote energy efficiency policies and measures, and to encourage the use of renewable energy sources for electricity and heat generation. In the same time, in order to meet national energy development priorities in the future, including the relatively constant use of inland coal resources, our country has taken all legislative steps to promote CCS technology. Other recommended measures for the energy sector (nothing directly related to the mining industry) are: promoting smart systems for the generation, transmission, distribution and consumption of electricity; high efficiency cogeneration; development of a sectoral strategy to reduce GHG emissions; public awareness campaigns for citizens and businesses about the importance of increasing energy efficiency.

National Strategy for Sustainable Development 2030

The Romanian Government through the General Secretariat and the Department for Sustainable Development declares within the Objective 7: Clean and Affordable Energy, 6 targets assumed for 2030, but without direct reference to coal.

Integrated National Plan for Energy and Climate Change 2021-2030

The 2030 climate and energy framework include EU-wide targets and policy objectives for the period from 2021 to 2030. For Romania 2030 proposed energy-climate change targets for Romania (Table 76) are enforced and monitored at national level being highlighted in this draft version of the Integrated National Plan for Energy and Climate Change 2021-2030 (under approval at the EC).

Table 76: RO: EU / Romania 2030 Energy-Climate Change Targets

Target Category	EU / 2030 vs.1990	Romania / 2030 vs. 2005
Cuts in greenhouse gas emissions (GHG)	40%	44% EU-ETS 2% NON-ETS
Share for renewable energy (RES)	32%*	27.9%
Improvement in energy efficiency (EE)	32.5%*	37.5%

Source: PNIESC – Integrated National Plan for Energy and Climate Change 2021-2030, Draft version 2018, under approval at the EC

**) The targets for renewables and energy efficiency were revised upwards in 2018*
https://ec.europa.eu/clima/policies/strategies/2030_en

Given that the energy sector (excluding LULUCF and transport) has the major contribution in GHG emissions by 2016, around 55% of total emissions at national level, it is necessary to refurbish fossil fuel power plants and electricity distribution grids, as they are very old. Fossil fuel power plants need to be upgrading considering also that wind and solar energy are variable resources, not being able to cover alone the total energy demand, especially in extreme weather conditions.

Main objectives, policies and measures in relation with coal industry are: ELV compliance and reduction of GHG and NOx emissions; phasing out of energy subsidies; high upgrading of fossil fuels combustion technologies; smart grids concept implementation promotion, increasing energy efficiency at the final consumer and scaling up the smart city concept through RDI, co-financing projects with LCT, extending Article 10c exemption scheme by 2030, incentives for private investment in new technologies.

Energy Strategy 2019-2030, with 2050 forecast

The document underlines that on extreme weather conditions, coal is the basis for power supply resilience and proper functioning of the Romanian National Energy System (SEN), covering one third of the electricity demand. In 2030, the energy produced from coal is estimated at 15.8 TWh representing a share of 20.5%. In the long term, the opportunity to install new coal-fired and natural gas capacities (a lignite source, CCS-ready with supercritical parameters) will be driven by the evolution of ETS certificate prices, the need to set up a strategic reserve for NPS safety, increased electricity demand, installed capacity performance, technology prices (including operating and maintenance costs) and sustainability of indigenous fuels. Romania's hard coal known resources reaches 232 million tonnes (85 million toes), of which 83 million tonnes (30 million toes) are concessional perimeters.

Until 2030, power and heat generation from hard coal will be supplied by inland production, with additional import support if necessary, until reconfiguration of unprofitable power capacities from hard coal to another more efficient primary energy resource. To this aim, due to negative cost-effectiveness, in the nearest future Deva TPP will have only one power unit (no. 3, 235 MW) operational, and Paroseni CHPP will keep running with power unit no. 4, 150 MW, the coal based primary energy production being mainly supported by lignite power units from Oltenia.

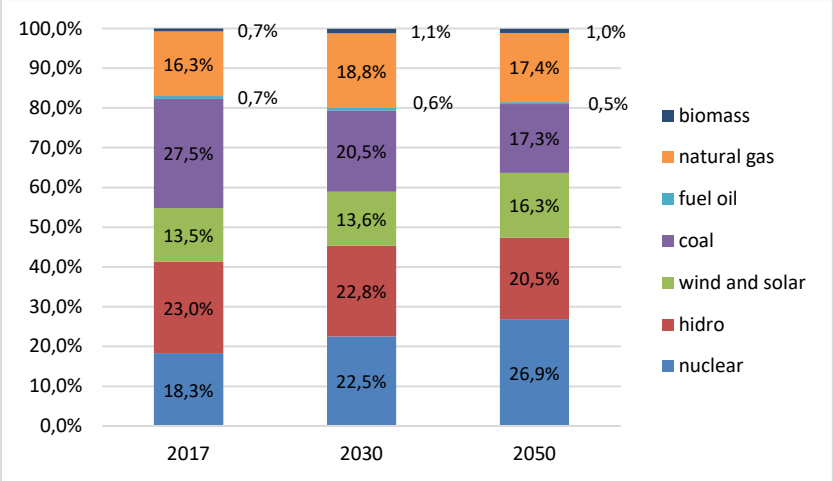

Figure 21: RO: Structure of the primary energy production by resources

Source: Romania Energy Strategy 2019-2030, with 2050 forecast. Ministry of Energy (2018)

If we look at the energy mix as a whole (Figure 21), the structure of primary energy production is diversified and balanced, making Romania, according to the Romanian Development Strategy for the next 20 years (Vlad, 2016), a regional exception, on European level being third (23%), in 2017, after Estonia (4%) and Denmark (12%) related to total energy import dependency (EUROSTAT sdg_07_50). Coal, mainly lignite and hard coal to a much smaller extent, will still play until 2050 an important role in Romania (17.3% contribution in the total primary energy production), for ensuring this energy independence and security of electricity supply. Using inland coal, as a strategic primary energy resource, in a cost-effective way in compliance with European environmental requirements, together with a rising RES and nuclear use shares, represents a challenging goal for Romania but not impossible.

8.3.3 Regional and local policy

A coherent, synchronized and homogeneous institutional structure with well-defined responsibilities without redundancy between entities is the essence of the elaboration -

implementation - monitoring process for efficient public policies. What happens in practice can often be much different than what is described on paper. This is the reality in Jiu Valley - actors in the market felt directly the impact of inadequate policies or lacking continuity and consistency, due to measures put into practice without post-monitoring activities.

The aggressive mine closures process generated, after the 90's, restructuring measures which were inadequately planned, and the transition management from mono-industrial to economic diversification did not sufficiently support former miners' professional reconversion programs or the curricula were not market oriented. Several restructuring programmes (Mustață, 2019) were carried out between 2000 and 2012, mainly funded through two loans granted by the World Bank to the Romanian Government; the programmes were implemented in 2000-2006 and 2005-2012. In April 2004, the government of Romania approved a mining sector strategy that lays out plans for restructuring the sector and meet the requirement of European Union (EU): to eliminate all subsidies to minerals other than coal by 2007 and to coal mines by 2010. In 2006 the degree of subsidies reached 62-64% (Fodor , 2016). Today in Jiu Valley micro-region subsidies have not yet been cut (General Secretariat of the Romanian Government , 2019). WB Report (World Bank, 2005) is underlining: "The absence of a hard budget constraint on mining companies has led to an increasing dependence on subsidies despite mass layoffs. Combining explicit subsidies with hidden subsidies has generated a fiscal impact of about 0.5 % of GDP by the year 2004. Although social protection obligations have been met, the mining towns affected by sector restructuring have faced severe hardships in the form of high unemployment and a decline in quality of life, local infrastructure, and social services".

One success story was highlighted by Bankwatch Romania (Mustață, 2019) namely the Social Development Scheme for Mining Communities (SDSMC), a programme developed with the support of IBRD, with a decision-making process involving local communities' members, which achieved social cohesion and a full implementation of the proposed projects: 36 finished projects, of which 21 aimed to refurbish roofs of apartment buildings in Petrila, Petroșani and Uricani, and another 9 projects restored road infrastructure in Aninoasa, Valea de Brazi and Câmpu lui Neag, totalling to almost 16 restored km of infrastructure. The rest of the projects aimed to install sewage systems and channel rivulets.

Until now, Jiu Valley local authorities did not have successful inter-institutional cooperation initiatives or at the level of the local stakeholders, that would deliver results for the development of common public policies to boost the process of transition from mono-industrial sites to urban centres with divers' economies. In Jiu Valley there is a lack of initiatives for adopting fiscal instruments with a significant impact, which local authorities can use to attract investors, the emigrated labour force and the layoffs (former miners). As singular examples for local initiative in some of the municipalities and cities in the Jiu Valley is the fiscal instrument to encourage citizens purchasing hybrid and electric vehicles by reducing with 50-90% the tax rate, and reducing rents for SMEs. Jiu Valley micro region needs a pro-active attitude. This inaction we believe is the result of insufficient local institutional capacity and necessary competences, communication gaps at stakeholders' level, unwillingness to get involved, and last but not least lack of a proper local budget.

Recently (1-16 July 2019) a MoU was established and signed, called "Jiu Valley Partnership for a Right and Fair Transition", including commitment and pro-active involvement of all 6 local councils in Jiu Valley, aiming to support: governance development; transition process planning and implementation; projects identification and adequate financial mechanism and funds for deployment; co-creation of a roadmap to pave the way to a sustainable energy transition and socio-economic development in the benefit of their citizens.

In the field of regional policies ADR Vest is performing the following activities: drawing out regional planning reports, strategies and action plans; developing thematic and sectoral analyses and syntheses using specific tools for regional planning; preparing information dissemination and promotion materials (leaflets, flyers, posters etc.) for the West Region; coordinating diversified studies and analysis.

Thus, at regional and local level, the following recent relevant documents outline the policies in the area, with only few aspects related to the energy sector (e.g. energy efficiency growth,

rising RES use share, promoting alternative fuels and electric vehicles), but nothing concerning coal directly:

Figure 22: RO: Regional and Local Strategies and Plans

Document title	Beneficiary	year
Sustainable Urban Mobility Plan - Green Line Valea Jiului	Hunedoara County	2018
Hunedoara County Regional Development Plan 2014-2020	Hunedoara County	2017
Framework Document for the Regional Research & Innovation Strategy for Smart Specialisation – West Region	West Region (ADR Vest)	2017
Research & Innovation Strategy for Smart Specialisation – RIS3	West Region (ADR Vest)	2016
Hunedoara County Action Plan – Targets of Territorial Administrative Units – Vulcan, Petrosani, Lupeni municipalities and Uricani, Aninoasa, Petrila Cities	Hunedoara County	2016
West Regional Development Plan 2014-2020	West Region (ADR Vest)	2014
Jiu Valley Local Development Strategy	Jiu Valley municipalities and cities	2007
Landscape Plan for Jiu Valley micro-region	Ministry of Transport, Construction and Tourism	2003-2004
General Urban Plan – Petroşani Municipality Local Development Plan 2014-2020 for Municipality of Petroşani	Petroşani Municipality	2016 2014
General Urban Plan – Vulcan Municipality Local Development Strategy 2014 – 2020 for Vulcan Municipality Vulcan Municipality Energy Efficiency Strategy 2016 - 2022	Vulcan Municipality	2011 2015 2016
General Urban Plan – Lupeni Municipality	Lupeni Municipality	1994
General Urban Plan – Petrila City Strategic Socio-Economic Development Plan for Petrila City Sustainable Energy Action Plan for Petrila City	Petrila City	1997 2016 2016
General Urban Plan – Uricani City Sustainable Development Strategy 2015-2020 for Uricani City Energy Efficiency Improving Strategy for Uricani City	Uricani City	2000 2015
General Urban Plan – Aninoasa City	Aninoasa City	2003

At regional and local level there are no targets set, being enforced only at national level. Regional and local stakeholders shall comply with the legal and regulatory framework in the field of environmental protection, climate change and energy efficiency in order to contribute for reaching national targets, in terms of GHG emissions, RES use and energy efficiency. Through the above sustainable development strategies and plans, respectively through the implementation of the set of proposed measures and actions, results will be achieved with the mitigation of GHG and polluting substances emissions, increased energy efficiency and the development of new renewable energy capacities.

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9 Serbia, Kolubara Region

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9.1 Description of the region

9.1.1 Region overview

Kolubara open-pit coal mine is located over two NUTS2 regions – Belgrade city region (3,234 km^2 of surface area and a population of 1,687,132) and "Sumadija and Western Serbia" region (26,493 km^2 of surface area and a population of 1,941,130). From an administrative point of view, the mine is mostly located within the boundaries of the City of Belgrade, the capital of Serbia, and with minor part within Kolubara District (2,474 km^2 of surface area and a population of 165,273) which belongs to Sumadija and Western Serbia region. It is located south west of Belgrade City centre and south of the Sava River. The area is surrounded with Koceljeva town on the west, Rudovci village on the east, Stepojevac town on the north and Lajkovac village on the south. An east-west axis is 55 km long, while the north-south axis is 15 km long. Within these boundaries, coal excavation area covers about 130 km^2, and is located within the municipalities Lazaravec,

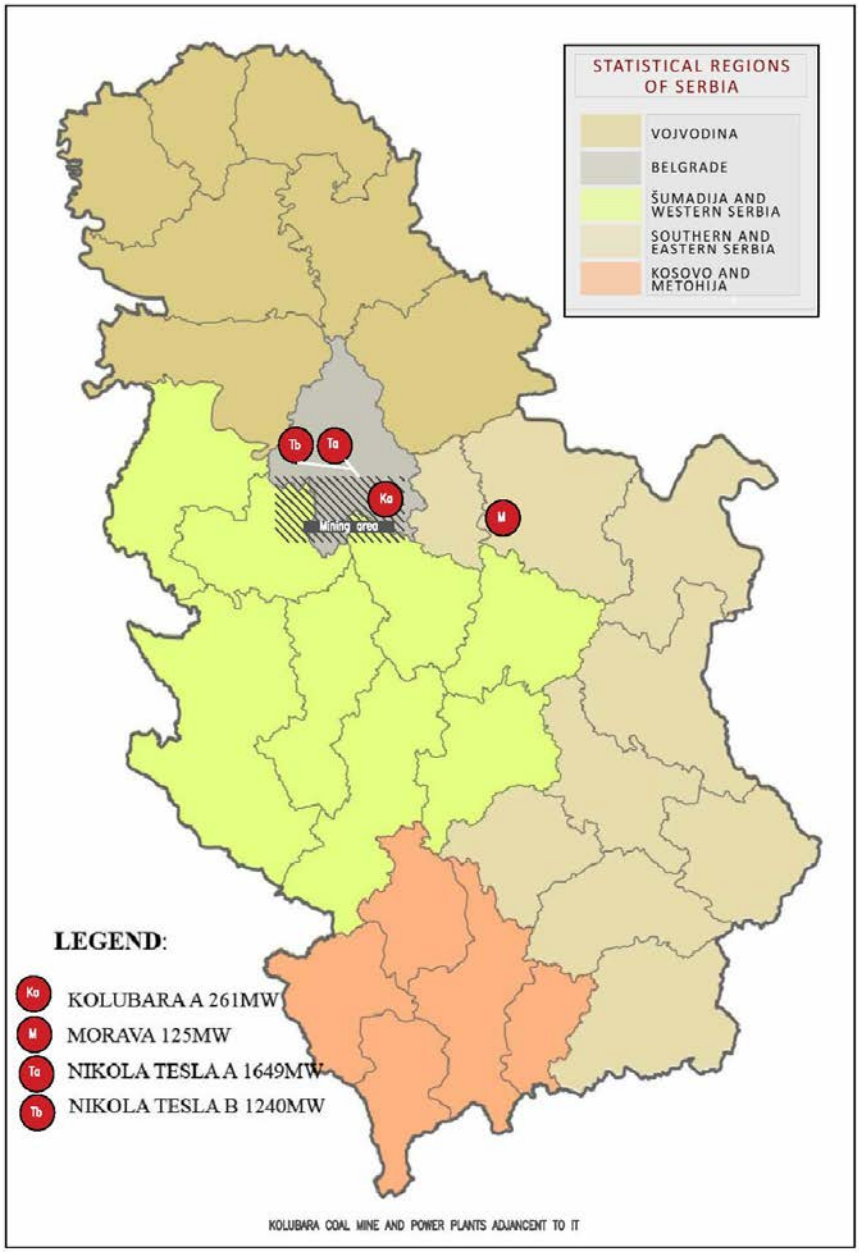


Figure 23: RS: Location of Kolubara target region

Source: Spacial plan of Kolubara mining region, 2016

Ub, Lajkovac, Obrenovac and Arandjelovac. Kolubara River divides the open mine area into two parts – larger west and smaller east (Figure 23).

Town of Lazarevac, as an administrative centre of the mining activities area, is through the local roads connected with all neighbouring towns and municipalities.

The total population of the municipalities reaches 221,947 inhabitants (SORS, 2018a). The population is mostly rural, concentrated in towns and administrative centres. The most recent censuses in 2002 and 2011 show that the population decreased about 2%. Between the two censuses, municipalities of Lazarevac and Obrenovac show increase in population, while the municipalities of Ub, Lajkovac and Arandjelovac show decrease in the population. Statistical data from 2007 and 2017 show negative birth rate in all municipalities, therefore the increase in population of Lazarevac and Obrenovac is caused by migrations. Ub is the municipality with the greatest biological depopulation.

The share of female participating in a total population is slightly higher than the male, reaching approximately (50÷51%).

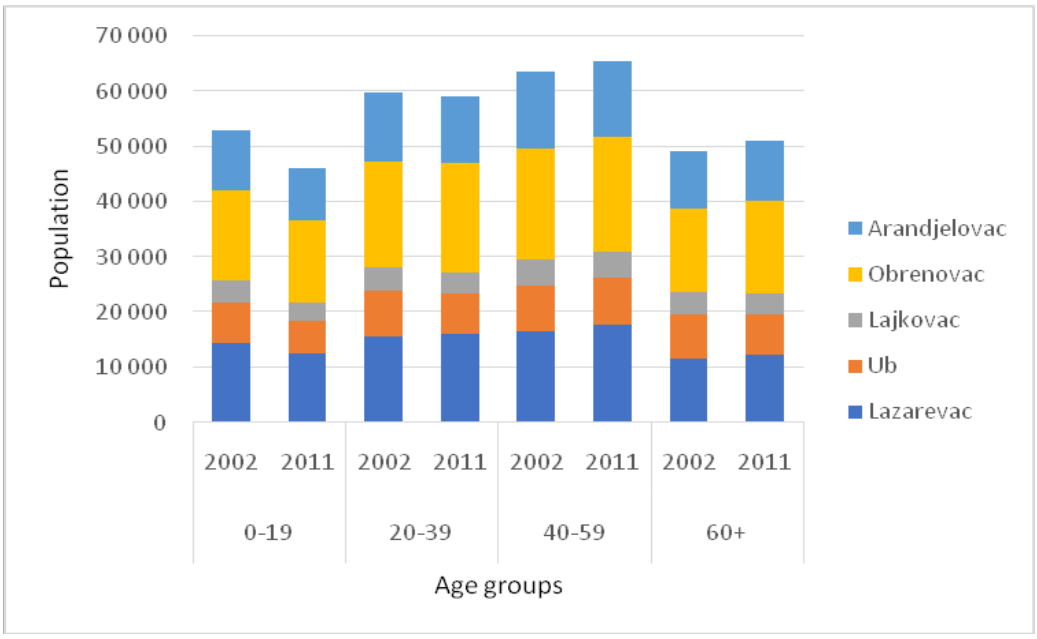


Figure 24: RS: Age structure change between 2002 / 2011 censuses (SORS, 2018a)

For 0-19 age group, in the period observed, number of residents has decreased in all municipalities, showing the low birth rate. For all other age groups, the municipalities of Lazarevac and Obrenovac show increase in population, while Ub and Lajkovac show increase in 40-59 age group and decrease in 20-39 and 60+ age group. An increase for 40-59 age group, and partially for 20-39 age group (Lazarevac and Obrenovac) show that working-age population continues to migrate to urban areas, actively seeking employment in the mining or energy sector. Arandjelovac has decrease in population in all age groups, except for 60+ age senior group, showing that after completing appropriate years of service outside the municipality, pensioners are returning to their place of residence. Globally, the population in this area is aging fast.Administrative and Institutional structure - Municipalities Lazarevac, Ub and Arandjelovac belong to NUT 2 – Sumadija and Western Serbia, while municipalities Obrenovac and Lajkovac belong to NUT 2 – Belgrade (Figure 25).

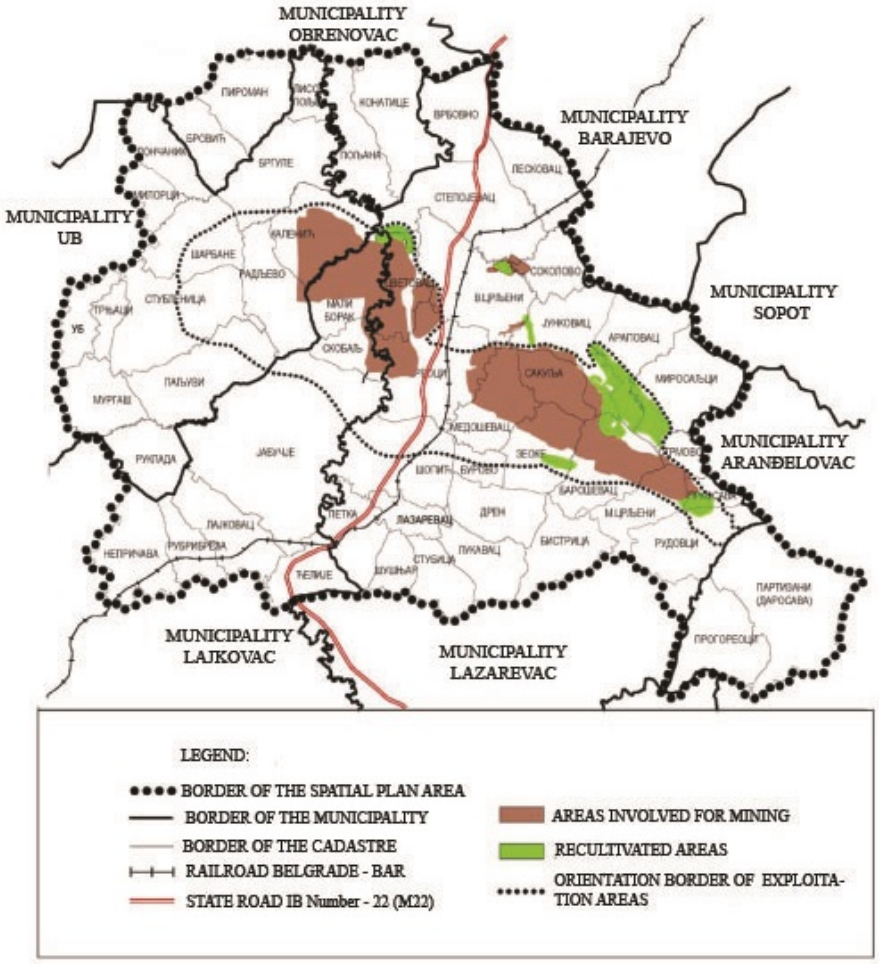


Figure 25: RS: Administrative and Institutional structure

9.1.2 Social situation

More than half of the population of the region is economically inactive (children under the age of 15, students, pensioners, unemployed man and women, as presented in Table 77. For employed population, average net salaries in Lazarevac and Lajkovac are above both national and capital city average salaries, while in Obrenovac net salaries are above national. Unemployment rate of population in the region is lower than the state's average (9.28% as per 2011 census).

The lowest salaries are in municipality of Ub, where the majority of population is employed as individual agricultural workers. Hard work in agricultural sector, low pays and the vicinity of capital city, offering more opportunities, are drives for depopulation (SORS, 2018a). Older households are engaged in agriculture, and are at risk because of the poor agricultural status as well as their age.

Table 77: RS: Employment (SORS, 2018a)

Municipality	Active population		Inactive population
	Employed	Unemployed	
Lazarevac	35.56%	6.08%	58.36%
Ub	42.79%	5.01%	52.20%
Lajkovac	42.95%	3.83%	53.22%
Obrenovac	31.25%	8.23%	60.52%
Arandjelovac	29.68%	9.58%	60.74%

Activities in the field of culture take place mainly in municipal areas. Most rural settlements have Homes of Culture, which are mostly multifunctional purposes, so they carry out sports activities, trade, health services, as well as administrative work. At the same time, these facilities (buildings) are mostly unconditional, inadequately equipped and poor quality.

Educational structure is disadvantageous (Figure 26), due to predominantly rural population, having low formal education level. The majority share of the population has completed secondary education (39.5÷56.1%). The population with higher education level is concentrated in towns (Lazarevac, Obrenovac) and economic centres (Kolubara mine, power plants, associated companies).

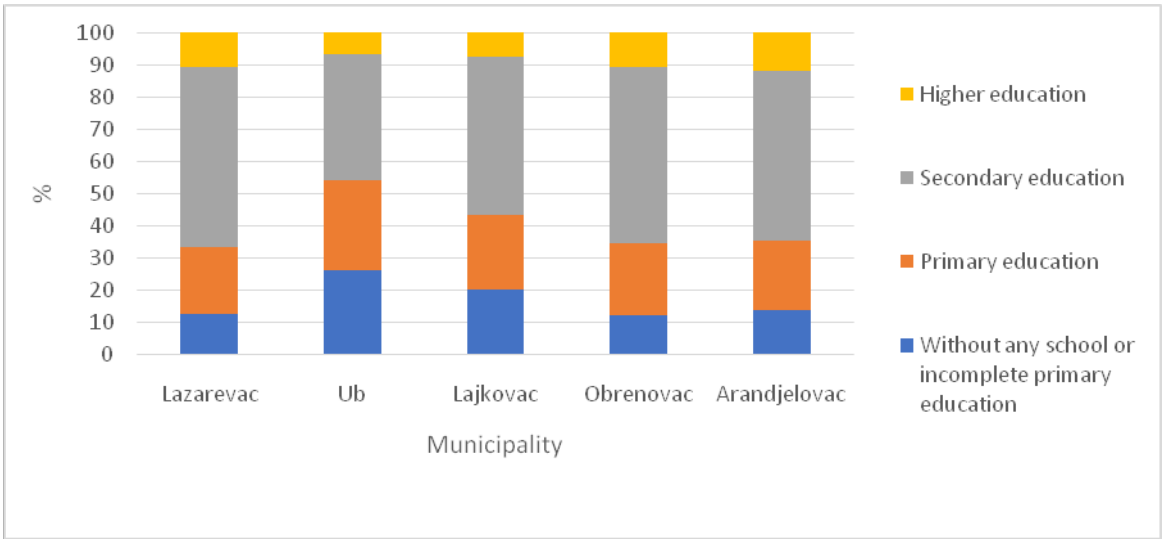


Figure 26: RS: Education structure (SORS, 2018a)

9.1.3 Economic development

The subject region is more developed than other regions of similar size in Serbia, due to two main reasons: it is within the boundaries of Belgrade city region (which itself has above-average development), and it is the area of high importance for mining-energy sector.

The participation of individual NUTS2 regions in the gross domestic product (per capita) of the Republic of Serbia is as follows: the Belgrade region takes a leading position with 39.8% (8,545 €), followed by the Region of Vojvodina with 26.2%, than the Sumadija and the Western Serbia Region with 19.8% (3,658 €) and Region of South and, finally, East Serbia with 14.1% (SORS, 2018b).

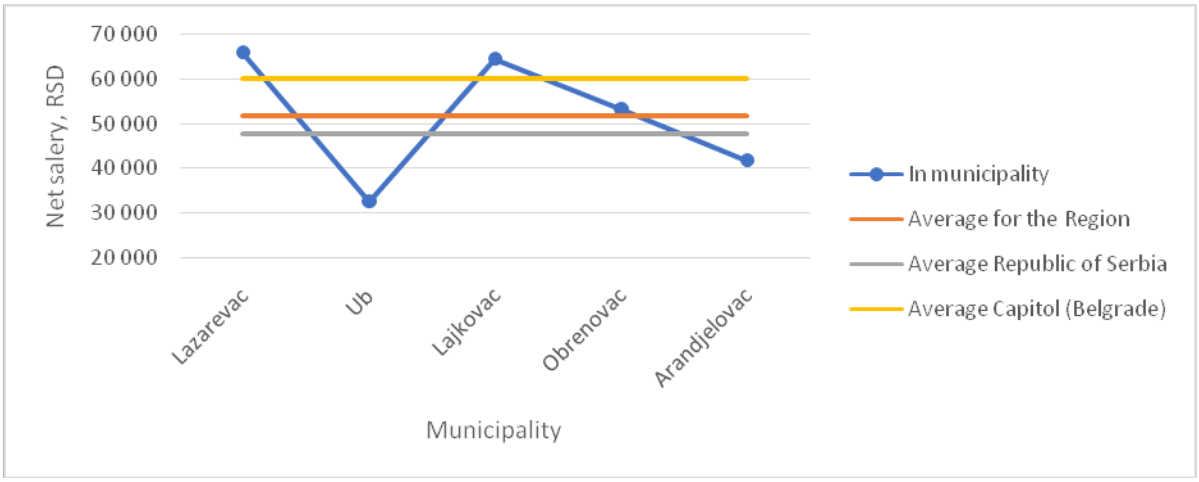


Figure 27: RS: Net monthly salary (SORS, 2018a)

Note: Average exchange rate for 2017: 1 EUR = 121.3367 RSD.

In 2016, data from the studied five municipalities shows that Mining, energy and manufacturing industry participates with 60.6% of region's income. Other activities participate in much smaller

extent – agriculture 15.8%, construction industry 12.0%, transport industry 2.8%, trade 6.0%, hotels and restaurants 1.5%, real estate activities 1.6% (Table 78).

Table 78: RS: Employment structure (SORS, 2018a)

Municipality	Mining	Manufacturing Industry	Energy sector	Construction	Trade & car repair	Transport & warehousing	Administrative sector	Education & Health &Social Sector	Individual agricultural workers	Other
	[%]									
Lazarevac	40.8	12.5	3.4	3.3	8.4	2.7	7.4	7.3	0.5	13.7
Ub	1.8	9.0	0.8	4.8	14.0	5.8	0.7	10.3	29.1	23.7
Lajkovac	37.5	15.5	0.0	4.7	8.4	3.2	0.6	11.3	4.5	14.3
Obrenovac	0.1	11.7	12.8	4.1	15.0	20.1	2.7	12.6	4.3	16.6
Arandjelovac	0.9	35.6	0.8	2.7	18.9	3.6	1.4	15	3.7	17.4

In 2017, there were about 5,756 km of public roads in the Belgrade city region, of which state roads of first order (national/transnational) were 190 km, state roads of the second order (between regions/districts/municipalities) were 460 km and the rest were local roads (within single municipality). Sumadija and the Western Serbia Region had about 18,565 km of public roads, of which state roads of first order were 1,609 km, state roads of the second order were around 3,900 km and the rest were local roads.

Railway Belgrade (Serbia) – Bar (Montenegro) runs through the region, with four rail stations – Stepojevac, Vreoci, Lazarevac and Lajkovac.

The Belgrade city has an international airport “Nikola Tesla”. In 2018, airport had 5,641,105 passengers and 20,065 tons of cargo transfer (https://en.wikipedia.org/wiki/Belgrade_Nikola_Tesla_Airport).

There is a gas network in the region, which is the densest in Belgrade. In municipalities Obrenovac, Lazarevac and Arandjelovac there is a small gas network.

All remote heating in the region is produced from gas, except in Lazarevac and Obrenovac from coal (cogeneration).

Heat network for Belgrade central municipalities is supplied with heat from several thermal heat stations located in the city. Town of Lazarevac has its own heat network, while town of Obrenovac has heat network connected to Thermal Power Plant “Nikola Tesla A”.

Through the region several electric long-distance lines are spread out. Power levels include 400, 220, 110 kV and distribution networks (35, 10 and 0,4 kV).

9.1.4 Environmental situation

Within the five considered municipalities, there are about 42,144 ha of agricultural land (71.9% of the total area). Total area under forests is 3,441 ha (5.9%) and recultivated area is about 1,020 ha (1.7%). Mining-energy sector extends to 5,663 ha (9.6%), while urbanized lands extends to 4,309 ha (7.3%), according to 2015 data (Electric Power Industry, 2019).

Environmental impact in the region is mainly due to the operation of mining and energy sectors, and related industries and activities. The main polluters or air, soil and water are open-pit mine Kolubara, coal dumps, power plants and ash and slag dumps (Spatial plan of Kolubara, 2016).

Mining process affects the soil degradation, particles and SO_x, NO_x and volatile organic compound emissions to the air. Wastewaters from pits are, in some cases, run to the Kolubara River without sedimentation and filtration. All activities carried out during coal excavations are noise polluters.

Coal dumps as well as ash and slag dumps are occasional air pollutants (due to wind). The coal can self-ignite on a dump field, during which carbon monoxide, sulphur dioxide and soot is emitted into the air. Ash and slag dumps have potential of water contamination with heavy metals, due to their migration into the lower soil levels.

Power plants are emitters of SO_x, NO_x and particles into the air. As equipment for flue gas treatment is not installed at all units and with respect of the age of the units, the pollution during some days exceeds limit values. For example, concentration of SO_2 can go up to seven times more than the limit levels, while NO_x and CO are mainly within the limit values. The particulates can go up to 40 times more than allowed. Wastewaters from power plants are oily, coaly or with high salts concentration. They are not purified and are used as transport media for fly and bottom ash to their disposal sites. Power plants in the region (TPP "Nikola Tesla A", "Nikola Tesla B", "Kolubara A" and "Morava") have emission of pollutants presented in Table 79.

In the region, there are additional pollutants, generated from industry – "Kolubara Prerada", "Kolubara Metal", "Kolubara Gasbeton", Thermal heating plant in Vreoci and "Kolubara Univerzal" in Veliki Crljeni.

Table 79: RS: Emissions of substances affecting the air quality, 2018 (Electric power industy, 2019)

Substances	Particulate matter	SO_2	$NO_x(NO_2)$	CO_2
	[t/year]			
TPP "Nikola Tesla" branch	7,533	196,898	26,993	19,341,895
"Kolubara Prerada"	80	794	123	182 809

Air pollution in the vicinity of Kolubara mine, power plants and industry in Vreoci and Veliki Crljeni have together a great impact on human health. Lung ailments (Bronchitis acuta, bronchiolitis acuta, asthma bronchial) particularly affect the children and elderly people.

The climate in the Kolubara mining region is classified as Cfb by the Köppen-Geiger system. It is mild, and generally warm and temperate. The annual average temperature is 11.8 °C, with average monthly temperatures ranging from 0.5°C in January to 21.5°C in July. There is also a great deal of rainfall, so that about 726 mm of precipitation falls annually. Precipitation is the lowest in October, with an average of 47 mm. The greatest amount of precipitation occurs in June, with an average of 84 mm. The difference in precipitation between the driest and wettest months is 37 mm.

9.2 Role of mining in the region

9.2.1 Coal sector in the region

In the mining-energy sector in Serbia, the main operator is the state-owned public enterprise Electric Power Industry of Serbia (EPS), which owns the mines in "Kolubara" region. The EPS is currently operating four active mining fields and supply four thermal power plants, three within the region, inside (Kolubara A, 5 units, 271 MW) or in the vicinity of the mines (Nikola Tesla A, 6 units, 1,745 MW, and Nikola Tesla B, 2 units 1,270 MW), and one outside the region (Morava, one unit, 125 MW). Besides surface mining and power generation, enterprises in the region include coal processing (separation and drying) and transportation (including own railway network), as well as supporting services, such as metal works, planning and design services and general services. These enterprises are operating as two separate branches of EPS, one dealing with the mining and related businesses and other with electricity generation.

At present, the mining basin (MB) "Kolubara", as a separate branch of EPS, is organised into five organizational units: "Surface mines", "Processing", "Metal", "Project" and Main office (Study on the Long Term Exploitation, 2015). Organizational unit "Surface mines" directly performs surface excavation of lignite, field testing, specialized and construction works, testing and experimental development in the field of biology, maintenance of mining equipment, auxiliary mechanization and transport operations. Organizational unit "Processing" carries out processing and refining of coal from open-pit mines "B" and "D" in order to obtain assortments needed for the supply of thermal power plants, consumer use and industry. Organizational unit

"Metal" carries out designing, production, installation, overhaul and maintenance of the mining and energy equipment, as well as rehabilitation and modernization of basic mining equipment, and production and regeneration of spare parts. Organizational unit "Project" develops specialized studies on mineral resources and reserves, mining projects conceptual solutions and investment programs, as well as bases for medium and long-term plans for the development of process and technical systems for production, processing and transportation of coal, and performs technical control of these projects. Organizational unit the Main office of MB "Kolubara" carries out activities of interest for the whole Branch.

The total production of coal and overburden in the 10 years period 2008-2017 is presented in Table 80. Coal which is excavated in Kolubara makes about 75% of total excavation in Serbia.

Table 80: RS: Production of coal and overburden in 2008-2017 (Electric Power Industry of Serbia, 2017)

Year	Coal (million tons)	Overburden (million m^3 solid mass)
2008	31	77
2009	29	64
2010	30	59
2011	31	72
2012	30	68
2013	31	69
2014	23	48
2015	29	47
2016	29	59
2017	29	66
2018	29	66

In 2017, from 29 million tonnes of produced coal, almost all is delivered to thermal power plants. Structure of delivered coal is presented in Table 81.

Table 81: RS: Delivery of coal from Kolubara in 2017

Devliery of coal	Coal [tons]	Share [%]
For thermal power plants	28,012,384	95.315
For drying	929,887	3.164
For industry	225,852	0.768
For district heating	221,033	0.752
Total	29,389,156	100.000

The data on planned and achieved coal production during the year 2018 are presented in Table 82 below.

Table 82: RS: Planned and achieved coal production

Branch		Coal production (t)			Overburden removal (m3cm)		
		Planned	Achieved	%	Planned	Achieved	%
Field B		3,200,000	1,780,161,	55.63	15,600,000	14,211,741	91.10
Field D		8,870,000	9,617,455	108.43	22,580,000	18,417,558	81.56
Field G		4,500,000	3,977,048	88.38	5,000,000	3,154,680	63.09
Tamnava – West Field		12,380,000	12,998,959	105.00	26,685,000	30,317,602	113.61
TOTAL		28,950,000	28,373,623	98.01	69,865,000	66,101,581	94.61
Kolubara Prerada (dried coal)	With dust	550,000	421,957	76.72	-	-	-
	Without dust	500,000	392,064	78.41	-	-	-

The "Nikola Tesla" power generation branch of the EPS is supplied by the coal from the open cast mines of the Kolubara basin. The branch of "Nikola Tesla" contains thermal power plants

(TPPs) “Kolubara A”, “Nikola Tesla A”, “Nikola Tesla B” and “Morava” and railway transport system to the “Nikola Tesla” A and B plants. Out of some 22 TWh of electricity is produced annually in thermal power plants of EPS, the electricity generated from coal excavated in the Kolubara basin exceeds 17 - 18 TWh, which makes about 80%. Installed power of supplied units as well as electricity production is presented within the Table 83.

Table 83: RS: Installed thermal power in the region

Power plant	Installed power, [MW]	Gross electricity production [GWh]	
		2017	2018
TPP „Nikola Tesla A“ (6 units)	1,745	8,457	8,679
TPP „Nikola Tesla B“ (2 units)	1,270	7,750	8,233
TPP „Kolubara A“ (5 units)	271	781	603
TPP „Morava“ (1 unit)	125	390	487
Total:	3,411	17,378	18,002

To produce the quantity of electrical energy in 2018, the boilers of the TPPs in the “Nikola Tesla” branch of EPS consumed the quantity of lignite mined in the Kolubara region as presented in Table 84. The quantities consumed by the boilers of TPPs “Nikola Tesla A” and “Nikola Tesla B” have been transported by the local railway system. Due to low calorific value of the coal, considerable amount of heavy fuel oil was consumed to initiate and support fires. The old units of the TPP “Kolubara A” use light oil for supporting fires.

Table 84: RS: Consumption of fuel in the TPPs of the “Nikola Tesla” branch of EPS

Organizational unit	Unit / boiler	Fuel		
		Coal	Heavy fuel oil	Oil
		t	t	t
“NIKOLA TESLA” A TPP	A1	1,503,944	3,223	
	A2	1,551,180	3,275	
	A3	3,068,025	2,078	
	A4	1,890,491	3,795	
	A5	3,030,954	2,189	
	A6	2,834,843	2,083	
“NIKOLA TESLA” B TPP	B1	6,056,628	8,693	
	B2	6,537,266	8,997	
“KOLUBARA” A TPP	K1	223,271	-	343
	K2	-	-	-
	K3	202,832	-	189
	K4	102,324	-	108
	K5	119,331	-	127
	K6	453,004	-	885
“MORAVA” TPP	A1	591,360	1,287	293
TOTAL:		28,165,453	35,620	1,945

9.2.2 Social Aspects

The MB “Kolubara” mining branch of EPS has a total of 11,880 employees. More than a half of these (6,625) are employed in the organizational unit “Surface mines” that works directly in the coal mining. The “Processing” unit has a total of 1,528 employees, the “Metal” has a total of 2,001 employees, the “Project” has a total of 87 employees, and the Main office has a total of 1,639 employees. The production process in “Kolubara´” mainly includes the employees with the third, fourth and fifth level of education. Among the employees with university degree, engineers of technical sciences - mining-geological, mechanical and electrical, are prevailing.

The “Nikola Tesla” power generating branch of EPS (TPP “Nikola Tesla A”, TPP “Nikola Tesla B”, TPP “Kolubara A” and TPP “Morava”) employ 2,039 (2018 data). Out of total 2,288 employees in 2016, 53.9% had secondary education, 14.4% are high skilled workers, and 13.2% had university degree.

When it comes to the wide possibilities for improvement and promotion, material security and a strong sense of belonging to the collective, the loyalty of employees in PE “Elektroprivreda Srbije” is extremely high, which is shown by the fact that the majority of employees spend their working life up to the pension within the collective.

9.2.3 Economic effect

Gross value added (GVA) by activity of coal mining and electricity generation is shown in Table 85. Economical value of mining alone is almost entirely valorised on the electricity market. A small amount of (dried) coal sold on the domestic market to the industrial and residential consumers can add a negligible effect on the overall economic value of mining and electricity production. The same applies to the supporting services within the MB “Kolubara” branch and to the railway transportation of coal.

Table 85: RS: GVA by activity (in million €) (SORS, 2018b)

Name of activity	Republic of Serbia	Belgrade region	The region of Sumadija and Western Serbia	Vojvodina region	South and Eastern Serbia region
Mining, Manufacturing Industry, Electricity, Gas and Steam supply, Water supply and Wastewater treatment	7,720	1,992	1,903	2,540	1,285
Share [%]	100	26	25	32	17

Two considered statistical regions (Belgrade and Šumadija and Western Serbia) in which the Kolubara mining activities go on, encompass more than a half of the total Serbia’s GVA in considered activities. Due to lack of separate statistical data for mining and electricity generation, available data on the overall included statistical group of sectors is given.

The required continuous provision of sufficient quantities of coal and electricity/heat in the future would require considerable investments in Kolubara mine and in energy production capacities. This means that the acquiring investments for the development of the eastern and western part of the Kolubara mining basin and new power generation is a national priority. These investments will not only enable the continuity of coal/energy production but will also ensure involvement of companies and workers beyond the current engagement, which can be considered as a positive economic effect.

Specific data on wages in mining and energy production economic chain are not part of the public data. Average salaries in the region, as well as in the State, are presented in Chapter 9.1 of this report.

The land required for extending the surface mining activities is acquired by EPS through the expropriation process regulated by a special law. Exploitation of the land for mining to provide electricity is considered more feasible than for agriculture and forestry. To do it with minimum environmental impact, EPS has the obligation to exercise land remediation after exploration of coal is over in order to return the land to the original status as much as possible. Only after finishing of the remediation, the land can be returned to the State as the owner.

9.2.4 Environmental effect

The technology of lignite surface mining can seriously change the quality of the environment. In this respect, activities such as overburden removal, coal excavation, coal processing, coal transportation and burning are under a widespread environmental control system developed within the Kolubara region. The control system monitors all the operations found to have an environmental impact and compares with the national environmental standards. As the exploitation of surface mines appear to be a very significant problem in the field of conservation and environmental protection, due attention is paid on any environmental disturbance in air,

water and land and involves a comprehensive overview and definition of all potential impacts on air, water, soil, and climate, as well as on flora, fauna, landscape, etc. (Study on the Long Term, 2015, Environmental Impact report, 2011)

Table 86: RS: Dust emission factors depending on the type of activity and equipment, according to National Pollutant Inventory (Study on the Long Term, 2015)

Activity/equipment	Unit	Dust emission factor	
		Total suspended particles	Particular matter
Dragline excavator	kg/m3	0.06	0.026
Excavator on overburden	kg/t	0.025	0.012
Excavator on coal	kg/t	0.029	0.014
Belt conveyors	kg/t	0.005	0.002
Loading from the pile	kg/t	0.004	0.0017
Movement of the vehicle	kg/km	4.08	1.24
Unloading from the truck	kg/t	0.012	0.0043
Bulldozer	kg/t	17.0	4.1
Erosion by the wind	kg/ha/h	0.4	0.2

Table 86 shows data on the intensity of segregation (emissions) of dust under the influence of primary and secondary sources in mining facilities according to National Pollutant Inventory, which correspond to the natural and technological conditions on surface mines in the area of the Kolubara region.

The 2018 annual emissions of substances that can affect the air quality from the MB Kolubara branch (Organizational unit Prerada) and “Nikola Tesla” power generation branch are continuously measured. The results of measurements of air, water and soil pollution from the existing facilities are presented in Table 87 below.

Table 87: RS: Emission values for TPPs in “Nikola Tesla” branch of EPS

Thermal power plant	Particulate matter	SO_2	NOx (NO_2)	CO_2
	[t/year]	[t/year]	[t/year]	[t/year]
Nikola Tesla A	2,999	88,706	12,027	9,473,106
Nikola Tesla B	1,731	89,045	12,014	8,531,319
Kolubara A	2,733	8,118	1,726	784,316
Morava	70	11,029	1,219	553,154
MB Kolubara (Prerada)	80.39	793.55	123.25	182,809.40

Surface mining of coal, according to the characteristics of the process technology can cause changes in hydrogeological and hydrological regimes of the narrow and broad mining area, as well as the emission of hazardous substances into surface waters and ground waters. Part of the Kolubara river in the considered area, as well as its right tributaries (Lukavica, Peštan, Turija) are among the most endangered watercourses in Serbia in terms of effluent load. Furthermore, Kolubara downstream of the wastewater receivers from Lazarevac, Vreoci and Veliki Crljeni is very often (especially in low-water periods) in the “out of class” status. The quality measurement of Turia river also indicates organic pollution, as well as pollution with Cd, Pb, As, mineral oils and phenol. Downstream of the ash dump, exceedances of maximum allowable concentrations for sulphate, nitrate, and arsenic are recorded as a result of inadequate treatment of effluents from the ash dump. The Lukavica river at the exit from Lazarevac is in a very poor quality, most often in the “out of class” state, due to biological and chemical pollution of municipal wastewater and water of the municipal economy that are uncontrolled release into the sewage.

To contribute to its maximum possibility, waste water treatment plant in MB Kolubara branch Organizational unit “Prerada” reduces considerably the polluting agents before release to the recipient (Kolubara river). The data in Table 88 refer to the year 2018.

The groundwater quality data in the vicinity of the wastewater treatment plant comply with the legal standards. All measured values in 2018 were below remediation values (remediation

values of concentrations of hazardous and harmful substances and values potentially indicating significant groundwater contamination are specified by the Regulation establishing a program of systematic soil quality monitoring, indicators for assessing the risk of soil degradation and remediation programs development methodology (Official Gazette of RS No. 88/2010).The results are presented in Table 89.

Table 88: RS: Pollutant concentrations at the inlet and outlet of the treatment plant

Parameter	Concentration (mg/l)	
Pollutant	Plant inlet	Plant outlet
Suspended solids	3,550.00 – 6,200.00	71.00 – 830.00
Organic substances COD	3,740.88 – 6,657.12	211.29 – 1,512.06
Phenols	2.056 – 4.256	0.026 – 0.321
Arsenic	0.008 – 0.227	< 0.004 – 0.13

Table 89: RS: Measured and remediation concentrations of pollutants in the groundwater

Pollutant	Remediation concentration (mg/l)	Measured concentration (mg/l)
Arsenic	0.06	0,003 – 0,032
Phenols	2.00	0.001 – 0.10
Mineral oils	0.60	0.010 – 0.542

Bacteriological analysis of rural wells water carried out in 2018 indicated the presence of coliform bacteria. Occurrence of the increased ammonia, nitrite and nitrate concentrations is of faecal origin which is caused by the proximity of septic tanks and stables, not the mining-energy industry itself.

The groundwater quality monitoring at TPP Nikola Tesla A and TPP Nikola Tesla B that: arsenic concentration varies, mostly below the maximum permitted concentrations (MPCs), while lead and cadmium concentrations are above MPCs for TPP Nikola Tesla A (Lead 0.076-0.081 mg/l, limited 0.075 for remediation, cadmium is up to 0.013 mg/l, limited 0.006 mg/l for remediation, zinc concentration is above MPC for some samples 30.7 mg/l, permitted 0.8 mg/l and nitrates concentration exceeded MPCs for TPP Nikola Tesla A (62-285 mg/l, permitted 50 mg/l). Also, manganese and nitrites concentration are above MPCs while ammonia concentration varies, mostly below the MPCs.

During 2018 the testing of soil quality and the content of total and available forms of heavy metals and potentially harmful elements in soil was performed. The content of heavy metals and other toxic elements in ash and soil was within normal ranges and below remediation values for: chromium (Cr), lead (Pb), copper (Cu), zinc (Zn), cadmium (Cd), mercury (Hg), arsenic (As) and boron (B).

The impact of mining activities on the land is manifested through several types of degradation processes. On the areas where direct exploitation is carried out, the fertile soil is excavated, which distorts its structure and mixes the existing horizons. Mining technology implies coal and overburden excavation, disposal of overburden in the excavated area and transport of coal to the thermal power plant. Due to the excavation process in the excavated area there will be a depression that will be filled with the deposit of excavated overburden, which will condition the change and disturbance of the morphological and aesthetic characteristics of the existing natural environment. Also, there is the possibility of contamination of the surface layer of the land due to the deposition of dust (ash) and other substances from the air. The change or degradation of the morphological and pedological structure of the terrain and soil and the emission of hazardous matter-mineral dust into the air at a certain concentration.

Impact of mining and electricity generation in Kolubara region on human health is considerable, irrespective of the environmental protection measures taken as stipulated by the laws. The health of human population in the Region is endangered by the air, soil and water pollution from mining activities, as well as from burning coal in the boilers of power plants. The most endangered are vulnerable groups (children and elderly people), as well as those employed on or living in the close vicinity of these activities. The impact on health of their employees both the MB Kolubara branch and Nikola Tesla branch is continuously followed through regular

checking of their work abilities. From Table 90 below it is evident that the ability to work is much less within the employees on mining than on power generation, which might be taken as an indicator of health risks to which the employees are exposed.

Table 90: RS: Employees work ability in 2018

	MB Kolubara branch	Nikola Tesla branch
Number of employees	11,907	2,039
Examined	9,081 (95.11%)	1,608 (98.83%)
Able to work	5,158 (56.80%)	1,447 (89.99%)
Limited ability	3,765 (41.46%)	137 (8.52%)
Disabled	158 (1.74%)	24 (1.48%)

The coal exploitation in the Kolubara Basin results in the destruction of existing habitats or ecosystem disorders on the territory it occupies, with inseparable additional impact on the living world of the area. During exploitation of coal, microclimate regions also suffers modifications towards increasing the temperature extremes and lowering relative air humidity, which additionally reinforces the adverse effects of the newly formed surface of the land mine.

A group of amphibians and reptiles is characterized by a relatively small radius of activities with a limited ability to colonize new habitats, which makes it vulnerable when it comes to degradation of its habitat. Important anthropogenic factors affecting the reduction of amphibian populations in the field of coal mining and the environment of the mines are the destruction and fragmentation of habitats, water drainage, removal of vegetation and boundaries and the construction of a network of roads. The amphibian fauna in Serbia is particularly vulnerable to long and intense dry periods, and the disturbances of the hydrological regime accompanying the mining operations most likely affect changes in the number and composition of the herpetofauna in the vicinity of the surface mine.

Daily butterflies are recognized as important indicators of environmental quality due to their quick and sensitive response to minor changes in their habitat. The degree of change in plant communities is in direct correlation with the degree of change in populations of types of day butterflies. Destruction of meadow and forest ecosystems in a given area leads to the decrease in local populations of species of daily butterflies. The air pollution in the vicinity of the surface mine can cause negative effects on eggs and caterpillars, further reducing their number.

The primary negative impact on the bird nest and tenants fauna have direct destruction of nesting sites, as well as the reduction of food sources. Secondary impact tends to have noise, increased presence of people and other forms of harassment, which arise as a result of mining activities in the area.

The impact of habitat loss on the mammalian group is indirectly expressed through the impoverishment of the trophic base, as well as other conditions of the habitat in the area of the Kolubara basin. Small mammals reduce their number and are forced, depending on their ability, to find a new habitat in the environment. Opening of the surface mine represents a barrier for the movement of large mammals through the region, which results in the absence of these species from the exploitation area. Noise from mining activities is another factor that affects the fauna of the mammals in the immediate vicinity. The implementation of noise reduction measures that apply under environmental protection measures in the performance of mining operations can contribute to limiting this influence.

Habitats within the analysed area are of less ecological importance due to the length and degree of anthropogenic impact they are exposed to. The total biodiversity of the Kolubara Lignite Basin area is generally lower than the biodiversity of the surrounding regions. Although detailed faunistic studies of the narrow area were not carried out, potential habitats of importance for the protection and preservation of certain groups of animal organisms have not been identified here. As the areas in the immediate vicinity have a similar landscape pattern and habitat complex, new habitats during the process of exploitation of the animal species will be discovered in the surrounding area.

In this sense, the influence of the continuation of exploitation of coal in the unique area of the Kolubara basin has a definite influence on the reduction of local populations of certain species in the immediate environment, both due to the destruction of the habitat and to increased competitive relations in the settlement of alternative habitats in the environment, but with a high degree of certainty, based on all the characteristics of the living world in the given area, it can be argued that due to the mentioned mining activities in the area there will be no irreversible influence on the endangered animal species that may have been sustained in the existing area or their total populations.

The implementation of measures of biological recultivation and the formation of vegetation cover also leads to the settlement of the accompanying fauna, whose composition and number depends directly on the type of habitat that is formed and the dynamics of the development of new plant communities.

9.3 Coal mining and coal utilization policies

9.3.1 National policy

The energy sector development strategy of the Republic of Serbia up to the year 2025 with projections up to the year 2030 (Official Gazette of the Republic of Serbia, No. 101/2015) is based on the national strategic priorities in the energy sector and the frameworks of the Treaty of establishing the Energy Community, thus adapting national energy policy and legislation according to the energy and climate policy of the European Union. Strategic priorities for the energy sector development in Serbia are security of energy supply, developing the energy market and environmentally friendly energy generation.

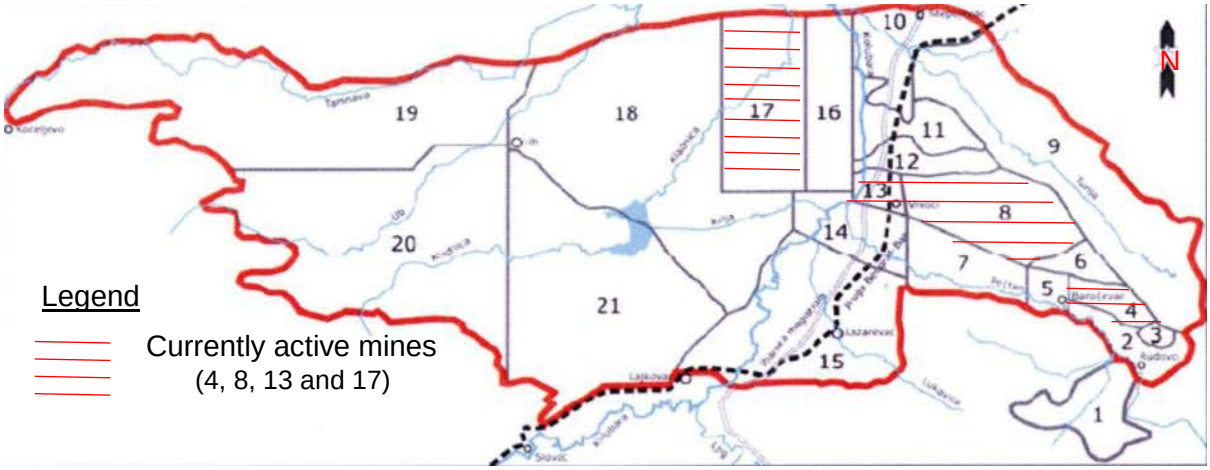
In line with the national energy policy and legislation, the Strategy envisages the transition towards sustainable energy supply through an increased energy efficiency and use of renewable energy sources, while protecting the environment and reducing the impact of energy sector on climate change. Taking into account available indigenous lignite resources, electricity production in the upcoming period will continue to be based on coal fired thermal power plants alongside with an increase of the use of local renewable energy sources. The Strategy provides for a thorough refurbishment of the existing power plants and construction of new generating capacities based on the domestic lignite with a highly efficient technology, also compatible with the highest environmental standards.

The Strategy stipulates the intensive research of coal deposits throughout the territory of Serbia to substitute the existing mines that will soon be exhausted. As a priority, the Strategy sets out the opening of new surface mines to meet the growing needs for new thermal power plants. As the existing expropriation law (Official Gazette of Republic of Serbia, No. 20/2009, 55/2013) stipulates the acquiescence of private land that can have a purpose for mining, oil and natural gas industry, power plants, distribution networks and flood control, the mining area expands towards the existing settlements, arable land and forests on the account of resettlement villages and replacement of transportation infrastructure.

To comply with the European environmental standards, the national policy of Serbia is focused on the country's goal of becoming a member of the EU. In that respect the domestic regulations are gradually harmonizing with the EU directives in this field. Additionally, all international treaties are an integral part of national regulations under the laws on ratification or with special agreements. The transposed EU directives define measures to provide an integrated approach to the prevention and control of pollution in order to achieve a high level of conservation and environmental protection. This implies that complex requirements apply both in the field of energy production technologies and on measures taken to ensure environmental protection. In line with this, the conditions for obtaining an environmental permit require the application of the best available techniques (BAT). When national environmental conditions so require, the conditions for emission limit values that are integrated with an integrated license, may be more stringent than BAT requirements. An integrated permit also determines how to use resources including coal so as to avoid harmful impact on the environment.

Coal mining and coal utilization have long been the major issues of the national policy in the energy sector of Serbia, in which the Kolubara region always played the key role. The

development of coal mining in the Kolubara region has undergone several phases according to the needs of the economic and social development of the country. Mining activities there started in 1896 with underground exploitation of coal from a dozen of pits of which the last one was closed in 1974. The next phase of development was characterized by the surface exploitation lignite starting in the eastern part of the region (the Field A was opened in 1950, the Field B in 1956, the Field D in 1961). The intensive development of lignite the Kolubara region started by opening the surface mine Tamnava - Zapad in 1995. The surface mining in Tamnava-Istok field was completed in 2007, and in 2009 a new mine, the Field Veliki Crljeni, was opened. Further expansion of coal mining is directed toward the western part of the region. Figure 28 shows the subdivision of the area of Kolubara region into 21 surface mines-the Fields.



1 Kruševica; 2 Rudovci; 3 Field A; 4 Field B, 5 Field C; 6 Baroševac; 7 Field E; 8 Field D; 9 Turija; 10 Stepojevac; 11 Veliki Crljeni; 12 Volujak-Vreoci, 13 Field G, 14 Field F, 15 Šopić-Lazarevac; 16 Tamnava East; 17 Tamnava West, 18 Radljevo, 19 Trlić; 20 Zvizdar; 21 Ruklade

Figure 28: RS: The mines (exploration fields) within the Kolubara mining region

The national energy policy is also putting an emphasis on transition towards an increased use of the renewable energy sources and provides subsidies to attract the investment in their development to gradually replace lignite-based generation. By ratifying the Treaty establishing the Energy Community ("Official Gazette of the Republic of Serbia", Number 62/06), Serbia has undertaken to implement European directives in the field of renewable energy sources and adopted National Renewable Energy Action Plan ("Official Gazette of the Republic of Serbia", No. 53/13) with a binding goal to achieve the 27% share of renewables in national gross final energy consumption by 2020. The planned share of renewables in gross final electricity consumption was 36.6%, in heating and cooling sector 30% and in transportation sector 10%. However, irrespective of high subsidies, it became apparent that the goal of 27% will hardly be achieved due to failure to build large scale hydro power plants, overestimated potential of small hydro power plants, limited quota put for solar photovoltaics and lack of interest to invest in biomass and biofuels. The lessons learned would probably help the Government to speed the transition process towards climate friendly energy within the new targets for 2030.

As a member of the UN Framework Convention on Climate Change, Serbia proclaimed the readiness to undertake the necessary measures aimed at actively fighting the climate change, which may have an impact on the use of indigenous lignite. The intended nationally determined contribution (INDC) of Serbia is the reduction of emissions of greenhouse gases by 9.8% in 2030 compared to the emissions in 1990. However, the reduction of emissions may be required to be much higher in the accession process, and Serbia is on the way to adopt the Law on climate change as the legal framework for the consecutive adoption of the proposed Low carbon strategy, Action plan for the implementation of the Strategy, and Program for the adaptation to the changed climatic conditions.

The draft proposal of the Low carbon strategy defines monitoring, reporting and verification of the emissions through the setting of conditions and the granting of permits for operators with the allowed emissions rights. The Low carbon strategy, the Action plan for the implementation of the strategy, and the Program for adaptation may considerably change the national policy

related to the continued use of the indigenous lignite for generating electricity, thus accelerating the transition towards renewables and other carbon free sources of energy and leaving a large amount of the available reserves underground. TRACER project would be of great help to the national policy makers on how to manage the energy transition in either case.

9.3.2 Regional and local policy

The Kolubara coal mining and power generation region has been and continues to be the key player in the national energy policy, which determines also the regional and local development policy. The Kolubara mining basin is the largest coal supplier for the state owned Electric Power Industry of Serbia (EPS), which is also the owner of the Kolubara mines. The reserves there amount to 2.2 billion tonnes of lignite with an average annual production of 22.6 million tonnes, primarily (about 95%) used to generate almost 20 TWh of electricity per year in four thermal power plants (14 generating units) with total installed capacity of 3.4 GWe, which provide more than a half (~ 52%) of the total electricity generated in the country.

Due to a relatively low calorific value of the mined lignite (around 7,500 kJ/kg), and an obsolete technology of power generation, the region is exposed to a threat of environmental pollution, and therefore the policy of both, the Kolubara coal basin and in the adjacent power plants, is to put massive investment in the improvement of the environmental conditions and to meet the emission standards. The environmental improvement policy in mining is aimed to improve the working conditions and reduce the impact on the local communities involved. Besides a more efficient and cleaner extraction of lignite, much better supply of lignite of the uniform quality is under development, that will lead to more stable and efficient operations of the power plants which will result in lower levels of CO_2 and other pollutants as well as reduced wear and tear and maintenance costs. The power plants are also being equipped with modern environmental protection technologies resulting in an overall environmental improvement of the Kolubara coal region, thus helping Serbia to achieve emission limits set by the recent EU Directive 2010/75 on Industrial Emissions.

A particular local policy measure is undertaken to increase the efficiency of using energy from burning Kolubara lignite by converting the largest power plant in the Region (Nikola Tesla A) to the combined heat and power generation and thus supply 800 MWt of the base-load heat to the district heating system of the capital city of Belgrade. When in operation, it will not only mean much less waste heat discharge to the overheated Sava river, but also a reduced import dependence on the natural gas along with an increase in the security of the heat supply to the largest district heating system in the country.

In spite of the environmental improvement, there are still various environmental consequences of the mining work in Kolubara complex such as gas releases (carbon monoxide, sulphur dioxide, ozone etc.), pollution of water supply and deterioration of the ground. Also, public safety is sometimes endangered by the overburden when overloaded dump field cause the collapses and landslides that destroy houses and roads in the vicinity. Due to heavy floods which devastated the whole area in May 2014, there has been a week-long interruption in lignite supply to power plants, and probably damages were much worse for those living near the mine, especially where the waters and mud mixed with pollution from the mine.

Another issue of the Kolubara coal region is the expansion of surface mining towards the human settlements. In the last decade EPS has moved hundreds of households, two complete villages and partially 10 villages. One of them (Vreoci) was even required to relocate local graveyard and more than 1,000 households. With continued expansion of mining in the region, the relocation of households became urgent and residents were under pressure to accept financial compensation and leave the territory designated for coal excavation. The value of their property was often underestimated, involving an additional dimension to the social impact of coal mining in the Region. Those and other issues make room for a variety of innovative solutions in line with the EU Platform for Coal Regions in Transition, as well as to adequately address many stakeholders involved.

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10 Ukraine, Donetsk region

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10.1 Description of the region

10.1.1 Region overview

Donetsk region is located in the south-eastern part of Ukraine. In the east, its borders partially coincide with the state borders of Ukraine. In the south the region has access to the Azov Sea. The length of the area from north to south – 240 km, from west to east - 170 km. Area – 26.5 thousand square km, or 4.4% of the country.

According to the administrative-territorial organization in Donetsk region, there are 52 cities, of which 28 are of regional significance, 24 towns of regional level, 21 urban areas, 18 districts, 131 urban-type settlements, 253 rural councils and 1,118 rural settlements. The largest cities are the regional centre - Donetsk (with a population of 927,900 people, as of 01.04.2019, according to the State Statistics Department of Donetsk region), Mariupol, Makiivka, Horlivka, Kramatorsk.

Executive power on the territory of the Donetsk region within its authority is carried out by the Donetsk Regional State Administration, a local government executive body that is part of the system of executive bodies of Ukraine.

According to the Law of Ukraine “On Local Self-Governing in Ukraine” (1997) the system of local self-government in the region includes: the territorial community; village, settlement, city council; village, town, city mayor; executive bodies of the village, settlement, city council; the elder supervisor; region and oblast councils representing the common interests of territorial communities of villages, settlements, cities; bodies of the population self-organization.

Donetsk Regional State Administration exercises the power delegated to it by the Donetsk Regional Council and is a responsible and accountable council in terms of delegated power.

Donetsk region is the largest by population region of Ukraine. There are 4.58 million people (10% of the population) of 130 nationalities. The population density is 173 people per 1 sq. km; 90.4% of the population lives in cities.

10.1.2 Social situation

The industrial specialisation of the region determines structure of the population employment. Despite decline in production in the last two decades, the largest share of the region's population is employed in the industry – 44%, of which almost 29% is employed in the mining industry and 51% in the processing industry. In transport and education, are respectively employed 10.3% and 10.1% of population. The share of the machine-building industry in the industrial output of the region is rather small – 5%, therefore, only 12.7% of the population is employed in the high and medium-tech industry, with an average of value of this index 21.2% in Ukraine.

The processes that are taking place in the manufacturing sector of Donetsk region negatively affect the state of the **labour market**. In particular, demand for labour force has decreased significantly. The number of job vacancies during 10 years decreased by almost 13 times. The number of layoffs has increased, which has led to an increase in unemployment (Figure 29). Enterprise demand for workers dropped sharply during the 2008-2009 global crisis, and subsequently continued to decline. The minimum number of vacancies was observed in 2015,

(400 people), however, in January-March 2019 the revival was observed enterprise demand for workers (2,300 persons), which exceeds the value of 2013.

The number of officially registered unemployed during the period of the world crisis of 2008-2009 increased 1.6 times and amounted to 10.1% for the economically active population of working age. During the armed conflict, the number of unemployed persons increased significantly and in 2017 it was 15.1%. In the region, it became harder to find a job: the average duration of job search by the unemployed (according to the ILO methodology) increased from 6 months in 2008 to 8 months in 2017. Main indicators of the labour market and economic activity of the population are presented in Table 91 and Table 92.

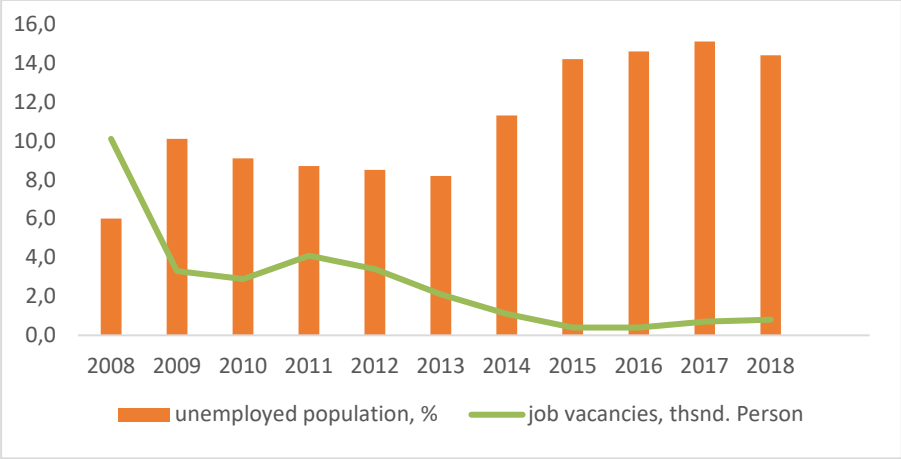

Figure 29: UA: The dynamics of the number of registered unemployed and the number of job vacancies in the Donetsk region

Table 91: UA: The main indicators of the labour market

	Employed population				Unemployed population			
	at the age of 15-70 years		working age		at the age of 15-70 years		working age	
	average, thousand people	% of the population of the relevant age group	average, thousand people	% of the population of the relevant age group	average, thousand people	% of the economically active population of the relevant age group	average, thousand people	% of the economically active population of the relevant age group
2010	1,983.7	58.3	1,834.6	67.3	182.9	8.4	182.9	9.1
2011	1,995.4	59.5	1,857.9	69.2	177.7	8.2	177.7	8.7
2012	1,985.4	60.0	1,861.2	69.4	171.8	8.0	171.8	8.5
2013	1,968.1	60.3	1,856.9	69.5	165.6	7.8	165.5	8.2
2014	1,752.4	54.2	1,697.7	63.7	216.4	11.0	216.4	11.3
2015	756.3	50.3	730.7	59.0	121.4	13.8	121.4	14.2
2016	748.4	50.0	721.6	58.5	122.9	14.1	122.9	14.6
2017	734.3	49.4	705.7	58.2	125.3	14.6	125.3	15.1
2018	741.0	50.0	714.5	59.5	120.4	14.0	120.2	14.4

Table 92: UA: Economic activity of the population by sex and place of residence in 2018

	Units	All population	Female	Male	Urban population	Rural population
Economically active population	thousand people					
at the age of 15-70 years		861.4	399.4	462.0	726.3	135.1
at the working age		834.7	385.3	449.4	702.3	132.4
Economical activity level	% of the population of the relevant age group					
at the age of 15-70 years		58.1	51.1	65.9	58.0	58.7
at the working age		69.5	62.9	76.2	69.2	71.2
Employed population	thousand people					
at the age of 15-70 years		741.0	366.1	374.9	631.7	109.3
at the working age		714.5	352.0	362.5	607.9	106.6
Employment level	% of the population of the relevant age group					
at the age of 15-70 years		50.0	46.8	53.5	50.4	47.5
at the working age		59.5	57.5	61.5	59.9	57.3
Unemployed population	thousand people					
at the age of 15-70 years		120.4	33.3	87.1	94.6	25.8
at the working age		120.2	33.3	86.9	94.4	25.8
Unemployment level	% of the economically active population of the relevant age group					
at the age of 15-70 years		14.0	8.3	18.9	13.0	19.1
at the working age		14.4	8.6	19.3	13.4	19.5

For the period from 2008 to 2018 in the Donetsk region the **number of kindergartens had decreased by 547 units** (Preschool education, 2019). Such a significant reduction is due, first of all, to the fact that official statistics from 2014 provide data without taking into account the temporarily occupied territories of the region, that is, data on such large populated cities as Donetsk, Horlivka and Makiivka are absent. Until the armed conflict there was even a slight increase in the number of pre-school establishments. This tendency is due to different factors. In the early 90's of the last century, the number of preschool age children declined. As a result of the privatization of state property, many enterprises failed to maintain social assets. As a result, kindergartens turned into office premises, and at worst they became abandoned buildings. But over the six years period (from 2008 to 2013) in the region there has been an increase in the number of preschool children by 22,000 or 18.8%, which has caused the need for new kindergartens.

The last five years have been marked by the reduction of the number of children by 3,000 people, or by 6%, and the number of pre-school establishments has decreased by 20 units.

The number of students in the **secondary schools** in the period from 2007/2008 to 2013/2014 declined more rapidly than the number of schools. In 2018/2019, the number of students in general secondary education exceeded the 2014/2015 mark. This situation coincides with the general situation in Ukraine and is related to the positive dynamics of fertility during 2008-2013. At the same time, the number of general secondary establishments of education continues a steady tendency to decrease (Secondary schools, 2019, Institutions, 2019).

In the middle of the 90’s of the last century, 142 professional and technical institutions were functioning in the region. For 18 years, 31 institutions have ceased to operate in the region. According to 2018 data, 44 institutions of professional education received students in the region. Thus, the rest remained on the temporarily uncontrolled territory of Ukraine. The number of pupils and students in professional (technical) education decreased by 23%, despite the economically justified need of the market for skilled working professions. As a result, in the Donetsk region enterprises, the number of job vacancies is 32%, and is the highest among other types of economic activity (in Ukraine as a whole - almost 30%) (Number of job vacations, 2019) while the need for skilled workers is not ensured, even in the presence of high wages.

By 2014/2015 academic years, the Donetsk region in terms of the number of institutions of **higher education** was behind only to the city of Kyiv. More than 100 thousand students studied in 73 institutions (colleges, technical schools, colleges, universities, academies, institutes). With the onset of warfare, many institutions of higher education moved to the new locations. For example, the Vasyl Stus Donetsk National University currently receives students in Vinnytsia (Vinnytsia region of Ukraine), and in its Donetsk region Kostiantynivka branch is opened. In the 2018/2019 academic year, there were 27 higher education institutions in the Donetsk region, which received almost 33 thousand students. It should be noted that over the past five years, the number of establishments has increased by 11 units, which can be explained by their gradual move from an uncontrolled area.

According to the research data, in the Donetsk region, a large proportion of graduates graduate with a junior degree, which correlates with a large proposition of jobs with low qualification requirements (ICF, 2014).

The main source of **income of the population** was and remains wages. Its share in total resources is more than a half, with pensions accounting for almost a quarter. As before, the region ranks second in the country after Kyiv by the level of wages, which exceeded the average rate in Ukraine in 2017 by 9.3%.

More than half of all total incomes of the population is spent on food, and continued to increase in 2017, the second largest, after food, – the household expenditure section: payments for housing, water, electricity, gas and other fuels, amounting to 17.5% of total spending, against 16.9% in the previous year and 9.8% in 2013. The high value of these key indicators is a proof of a low level of welfare of the population of the region (Department of Statistics of Donetsk Region, 2019).

10.1.3 Economic development

The development of the Donetsk region was determined by the historical orientation of the country's economy to expand the extensive exploitation of natural resources. As a result, **in the structure of the economy, industry remains the main sector**. Until 1990, the structure of industry in the Donetsk region was dominated by ferrous metallurgy (34.5%), the share of machine building and metal processing was 17.2%, the fuel industry accounted for 12.2%, food industry - 8.9%, light industry - 7.2%, electricity production - 5.2%, chemical and petrochemical industry - 4.8%, nonferrous metallurgy - 3.1% (Donetsk Regional Department of Statistics, 1990). Enterprises in these industries were subordinate to the USSR and produced products of the all-union specialization, that is, in the region industries were developed focused mainly on the exportation of the manufactured products outside the region.

Today Donetsk remains the region with the predominant part of mining and metallurgy that is oriented on raw materials production. The dominant sectors in terms of production are materials extraction and metallurgical industry (18.6% and 43.8%, respectively). The industrial structure of the region determines the structure of commodities exports: 81.6% refers to ferrous metals (Department of Statistics of Donetsk Region, 2018), while the share of goods with higher added value remains low.

The main role in the region's economy belongs to industries that are asset-intensive and capital-intensive. The level of depreciation of fixed assets in the region's economy in 2010 was 64.5%, which is almost 14.0% lower than in Ukraine in general. However, in industry, the degree of wear and tear of fixed assets is 10.0% higher than in Ukraine on average, and it accounts for 55.8% in the mining industry (47.8% in Ukraine as a whole), and 73.4% in the processing industry (66.8% in Ukraine in general), production and distribution of electricity, natural gas and water - 67.0% (in general in Ukraine - 60.7%) (State Statistics Service of Ukraine, 2010).

The region is characterized by larger amplitude of the fluctuations of the **gross regional product** (GRP) indicator than in Ukraine as a whole (Figure 30). This reveals its instability to the negative consequences of the world market due to the reduction in demand in the world markets for products of the metallurgical industry. Since 2014, the sharp reduction of the GRP caused the destruction of not only the economy, the normal life of the region, but also the economic ties of the Donbas, its relations with other regions and the state. A gradual increase

in the indicator occurred against the background of its critically low rates in previous years. In general, since 2014, the GRP of Donetsk region has decreased by 60.0%.

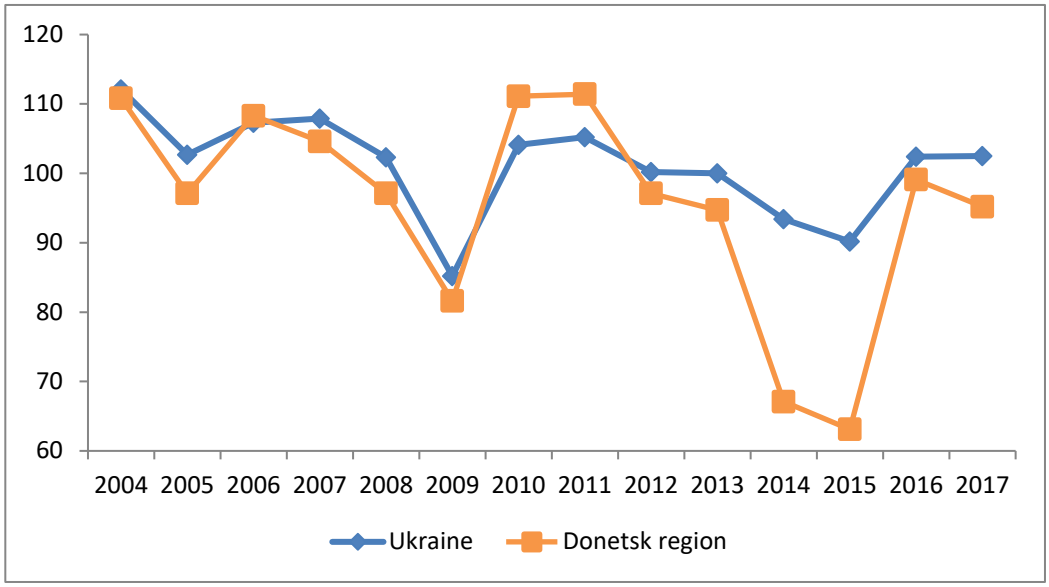

Figure 30: UA: Index of GRP physical volume (in prices of the previous year)

Innovation activities in the Donetsk region show rather ambiguous, mostly passive steps. The share of enterprises that carry out innovations has decreased significantly in comparison with year 2000 and remains almost unchanged for the last four years (Figure 31).

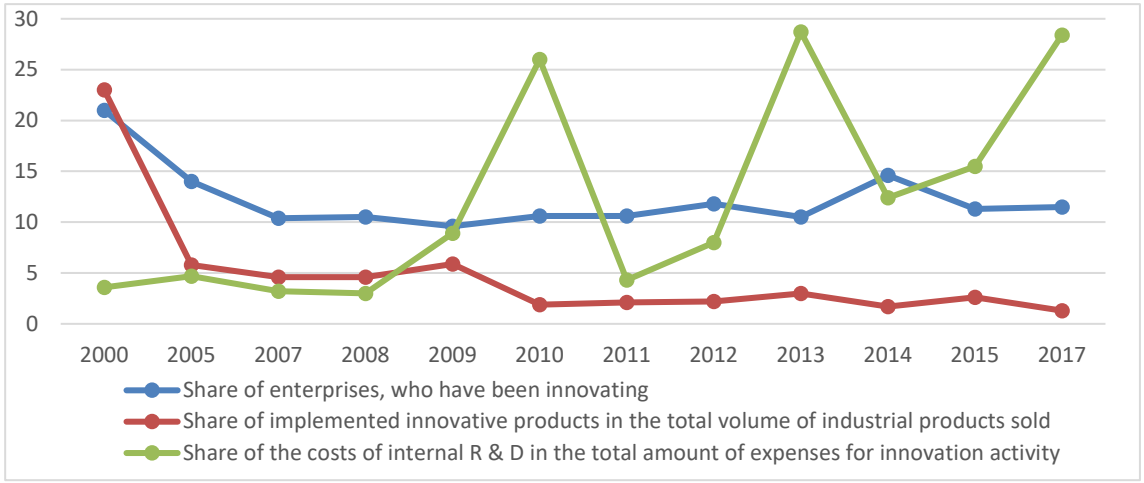

Figure 31: UA: Indicators of innovative activity in the Donetsk region

At the same time, the share of realized innovative products in 2017 did not exceed 1.3% (in year 2000 this indicator was 21.5%) and was a record low in the years of the period under study. The total expenditures of industrial enterprises for innovation activity do not have a well-defined tendency, but it can be stated that although the share of expenditures on domestic R&D in the total amount of expenditures for innovation activities increased significantly in 2010, 2013 and 2017, the expenditures for purchasing R&D products, machines, equipment and software, and other external knowledge products continue to amount for more than 60.0% (State Statistics Service of Ukraine, 2018.), which leads to degradation of innovation potential and poses a threat to innovation development of the economy of the region.

Despite the difficult economic situation, the Donetsk region remains relatively attractive for **foreign investment**. However, most investments are Ukrainian capital coming from countries with offshore jurisdictions. In the structure of foreign direct investment (FDI) from the world countries to the economy of Ukraine, more than 50% is made up of comings from Cyprus and the Netherlands. The OECD “Investment Policy Reviews: Ukraine 2016” highlights the widespread in Ukraine phenomenon of FDI round tripping (OECD, 2016), which falsifies FDI statistics, because of the reassessment of their real revenues. Significant flows of FDI are formed as a result of the repatriation of domestic capital from offshore jurisdictions. The

Donetsk region among the regions of Ukraine traditionally is the main source of direct investment: its share in the total volume of **direct investments** from regions of Ukraine to the world economies in 2016 amounted to 93.6%.

The **investment structure** is dominated by low-tech industries and industries with a low degree of technological processing (the share of investment in high- and medium-high-tech industries is only 5.4% versus 9.7% in Ukraine in general), but they are in demand on the domestic and foreign markets. Relatively stable was the investment in the production of those internally oriented industries that satisfy the vital needs of the population in the main food products (including alcohol and tobacco, which proves not in favour of a decent level of society's culture), and in the pharmaceutical industry.

At present, there are public highways of national importance with a total length of 1,865.5 km in Donetsk region, including: international - 326 km, national - 448.4 km, territorial – 1,091.1 km.

There are currently no active airports in Donetsk region. One of the largest and most modern airports in Ukraine in the city of Donetsk named after Prokofiev was destroyed in 2014-2015 during war. It is planned a new airport near Kramatorsk in Donetsk region. The closest airports to the Donetsk region are in the cities of Dnipro, Kharkiv and Zaporizhia.

The regional branch “Donetsk Railway” PJSC “Ukrzaliznytsya” includes: 5 locomotive, 6 Wagon Depot, 2 Motorwagon depot; 3 Railroad machine stations; Avdiivka Experimental plant of nonstandard equipment. The operating length of the main tracks is 1,616.7 km, including the operating length of the electrified tracks – 639 km. Deployed length of the main tracks is 2,273.1 km. Extended length of main tracks – 2,273.1 km. Full length of station tracks – 1,283.8 km, full length of access tracks - 155.2 km.

The Donetsk Region power grids are part of the United Energy System (UES) of Ukraine. Transmission of electricity is carried out by high-voltage lines from 220 to 750 kV. Power is generated generally by 6 TPPs (Kurakhivska, Slovianska, Vuhlehirska, Starobeshivska, Zuivska and Myronivska) and 1 CHP (Kramatorska). There are solar and wind power plants.

10.1.4 Environmental situation

Donetsk Region is a region with a **critical state of the environment**. Describing the state of atmospheric air in general in the Donetsk region, it is necessary to note some of its improvement and stabilization of levels of pollution. After all, many industrial enterprises do not work. However, the situation in some cities remains tense. In general, in the region, 186.8 kg of harmful substances from stationary sources emitted to the atmosphere per one person, which is 3 times higher than the national average (Environment of Ukraine, 2017).

For example, in one of the largest cities in the region - Mariupol, in March 2018 there was an increase in the average monthly concentration in terms of units per capita: nitrogen dioxide 1.5 times, phenol 2.0 times and formaldehyde 2.6 times.

The area is one of the least secured with water resources. Per inhabitant, here falls five times less water than the average in Ukraine. At the same time, the main consumers of water are industrial enterprises, not residents.

The rate of total discharge of polluted returnable water into surface water objects is decreasing, which is a general trend in Ukraine, but remains one of the highest among other regions – 200 million cubic meters, which is one fifth of the total Ukrainian indicator.

As a result of the intensive development of mining and processing (mainly in the metallurgical industry), huge areas of accumulation of industrial waste were formed in the region. While occupying less than 4.5% of the territory of Ukraine, Donetsk region dispose 28.0% of I-III class waste (extremely hazardous (Class I), highly hazardous (II class), moderately hazardous) and 6.1% of class IV (low dangerous) waste (Regions of Ukraine, 2018).

The largest share (62.4%) in the total waste disposal generated at enterprises attributed to mining waste and mining quarries in the extraction and enrichment of ores and mineral raw materials, 11.8% are wastes containing metals and their compounds, 3.2 % - waste from industrial and municipal wastewater treatment, 1.6% - non-metallic wastes and their

compounds, 1.5% - waste from dedusting plants and installations (Department of Statistics of Donetsk Region, 2013).

10.2 Role of coal mining in the region

10.2.1 Historical and current mining volumes, coal demand, technologies

The record for national coal mining in Ukraine was 1976, when it produced 218 million tons of coal in natural calculus, or 173 million tons in oil equivalent (Coal Industry of the USSR, 1977).

Even before 2014, Ukraine was one of the twelve largest coal mining countries in the world – during the period of 2001-2013 national coal companies were producing about 80 million tons of ordinary coal annually. But since 2014, due to warfare in the East of Ukraine, there has been a significant reduction in coal production – 39.7 million tons in 2015, which is 38.8% less than in 2014, and in the next 2016, 2017 and 2018 years: 40.9; 34.9; 33.3 million tons – that is no more than 18.6 million toe. (Energy Industry of Ukraine, 2016, 2017).

According to the plans of the former USSR, due to low profitability and low quality of Ukrainian coal for energy purposes (primarily high sulphur content), it was envisaged that the coal mining in the Donbass (Styrikovich M.A., 1986.) would be almost completely curtailed with the import of coal from the Russian Kuzbass and with the application of the regime of so-called “gas pause” (extended natural gas consumption), but the course of history fundamentally changed plans, and domestic mines remained the main supplier of fuels to the national energy and metallurgy.

Currently, the life service time of the average mine is 53 years; mining works physically descended up to the depth of 696 m, on average, (against 554 m in 1976); the network of coal workings is 56 km per mine, on average. Complex mining and geological conditions and the aging of the mines have led to deterioration of the economic performance of domestic coal mining enterprises, and neither attempt at their substantial technical re-equipment, in particular the change of generations of equipment, has provided significant improvements, although instead of obsolete structures, a large number came to the mines of new types of complexes, tunnel combines and transport facilities.

According to the data from 2016-2017, the demand for coal in Ukraine amounted to 86.1 and 81.9 million tons per year, respectively.

Due to a significant reduction in coal production and the loss of the anthracite production mine stock, which remained on the territory uncontrolled by the Ukrainian government, the economy of Ukraine was forced to apply for the extension of import of the resource. This practice existed until 2014 - mainly for the needs of the coking and metallurgy industries, 8-10 million tons were imported annually, mainly from the Russian Federation, but volumes of foreign supply increased substantially in recent years. Thus, in 2016, Ukraine received 12.6 million tons of coal cost about $ 1.5 billion. According to the State Fiscal Service, imports of coal from the Russian Federation amounted to 906.3 million dollars, from US $212.1 million, from Canada - $94.4 million, from other countries - $254.3 million. In 2017, the volume of coal imported into Ukraine amounted to 10.2 million tons, which cost $2.2 billion, and the Russian Federation (about half) and the United States (about a third) were the largest suppliers (Energy industry in Ukraine: summary, 2016).

Since the peak of the development of the Ukrainian coal industry, significant changes have occurred in both the coke and the energy sector, and in the regional aspect (Starychenko L.L., Cherevatskyi D.Yu., 2013).

While in 1976 coking coal accounted for 63% of coal production, then in 2011 this proportion was 44%, while the output of power coal decreased from 134 to 57 million tons.

In the seventies of the last century, three regions (Donetsk, Luhansk and Dnipropetrovsk) provided almost 88% of the national coal production, and 97% in 2011, due to the reduction of coal production in the Lviv-Volyn Basin and the collapse of brown coal production (in

Kirovograd, Cherkassy areas). The contribution of the mines in Donetsk region became less: there were 49, and became 44.

After 2014, the situation with mining in the regional context has changed dramatically. Thus, in 2015, the mines of Donetsk region provided extraction of 14.4 million tons of coal (-44.9% relative to 2014). Indicators of 2016: Donetsk region mines extracted 15.6 million tons of coal.

Coal mining in Donetsk region located on the territory controlled by the Ukrainian authorities in 2017 amounted to 11.4 million tons, and in 2018 - 11.1 million tons. At the same time, in 2018 the volume of coking coal production amounted to 5.6 million tons, which is 10.8% less than in 2017; 5.5 million tons of power coals were extracted, which is 21.1% more than in 2017.

At the same time, the state coal mining enterprises of the region produced 2 million tons of coal, which is 29.4% less than in 2017. The volume of coking coal production amounted to 0.56 million tons, which is 39.9% less than a year earlier. 1.4 mln. tons of power coal have been extracted, which is 24.2% less than in 2017. LLC DTEK Dobropilliavuhillia extracted 2.8 million tonnes of coal in 2017, while in 2018 they reached 4.1 million tonnes, which is 48.6% more (Forward to energy independence, 2018)

The technology used in the mines of the Donetsk region is quite up-to-date. In 2018 in total 24 fully mechanised complexes (16 at the SE and 8 at private enterprises) worked in the region, the average load of the second working at the state enterprises (SE) was 251 tons per day, at PJSC MM (mine management) “Pokrovske”- 2,273 tons/day, at LLC“DTEK Dobropilliavuhillia”- 1,541 tons/day.

At the same time, the average monthly productivity of labour in the seventies was much higher - 43 ton/person than now - 21 ton/person, despite rather primitive technical means of that time. A large number of workings (4.5 mining face per mine), equipped with a cheap mechanization equipment, ensured the ability to maintain high productivity of enterprises (611 thousand ton/year). The annual production capacity of the mine (an average of 630 thousand tons) was almost completely mastered.

The widespread implementation of heavy type mechanized complexes caused an increase in the ash content of coal extracted, as a result of grabbing of the lateral rocks. In 1976, the ash content at mine amounted for 23-25%; while in 2006 it reached 38-40%.

Lack of investment resources in the 1990s led to a deep crisis in the coal industry. Negative dynamics could not be mitigated by means of intensification of production, adopted at the beginning of the XXI century. Thus, in 2006, the average mine operated 1.88 ± 0.25 working, which produced 563 ± 69 thousand tons of coal per year. The average industry index for operating the production capacity was less than 0.5. Modernization of equipment did not give the expected increment in the load per working. The index has increased to 571 ± 90 ton/day, in comparison with 444 ± 21 ton/day observed at using the thirty years old technique. At the same time, the introduction of new complexes took place along with the increase in the thickness of the developed layers – the average dynamic thickness in 2006 was 1.31 ± 0.25 m, whereas in 1976 it was 1.13 ± 0.03 m.

The current (2018) labour productivity of the coal mining worker in the region amounted to 30.1 tons. At the same time, it amounted to 9.7 tons at state enterprises, and 63.8 tons at PJSC “MM Pokrovske”, and 54.1 tons at DTEK LLC “Dobropilliavuhillia”.

Plans for mining coal at state mines (on the territory controlled by the Government of Ukraine) in Donetsk region can be seen from Table 93 (Ministry of Energy and Coal Industry of Ukraine, 2019).

Table 93: UA: The plan for coal mining at the Donetsk region mines of the Ministry of Energy and Coal Industry of Ukraine for 2019

Entity	Coal brand DSTU 3472:2015		Coal production, ths. ton year 2019	Ash, %	Mass share, %		Volatiles (daf), %	Heat value, kcal/kg	
					Sulphur	Wet			
	Coke	Power	projected	operative	avrg.	avrg.	%	HHV	LHV
MINISTRY OF ENERGY AND COAL INDUSTRY OF UKRAINE			4,880	41.3	2.5	7.7	38.8	8,281	4,016
including:									
power station coal		Bit.	4,640	41.6	2.5	7.6	39.1	8,266	3,987
coke	Met.		240	35.7	3.4	8.2	31.9	8,587	4,582
Donetsk region			2,495	41.6	2.3	7.6	38.9	8,311	3,983
									including:
power		Bit.	2,255	42.2	2.1	7.5	39.7	8,281	3,919
coke	Met.		240	35.7	3.4	8.2	31.9	8,587	4,582
SE "MINE AFTER NAME M.S. SURGAYA"		Bit.	655	33.4	0.8	6.3	37	8,459	4,817
SE "MM PIVDENNODONBASSKE № 1"		Bit.	410	48	1.4	8.2	42	8,309	3,417
SE "MYRNOGRADVUHILLIA"			590	44.9	2.2	6.8	36.9	8,399	3,757
Rodynska		Bit.		35.7	3	11.7	34.2	8,388	4,279
Centralna		Bit.	30	34.5	2.8	7.8	36.8	8,352	4,575
Kapitalna		Bit.	520	46.3	2	6.6	36.5	8,410	3,655
mine 5/6		Bit.	40	35.1	4	8.1	41.7	8,286	4,471
SE "SELIDIVVUHILLIA"			600	45.1	4.1	9.1	43.8	7,952	3,440
Kurakhivske		Bit.	145	45.9	4	10.5	46.3	7,778	3,239
1 -3 Novogradivska		Bit.	100	48.3	4.2	7.9	41.8	7,820	3,182
Kotliarevska		Bit.	255	44.1	4	8.7	42.2	8,093	3,603
Ukraina		Bit.	100	43.5	4.2	9.2	46	7,979	3,574
SE "TORETSKVUHILLIA"			240	35.7	3.4	8.2	31.9	8,587	4,582
Centralna	Met.		168	36.5	3	8.5	30.5	8,604	4,506
Toretska	Met.		72	33.8	4.3	7.6	35.2	8,547	4,759

[Bit. – bituminous coal, Met. - metallurgical coal]

One of the main consumers of coal in Ukraine are the large electricity producers – coal thermal power plants (TPP) and heat and power plants (CHP). The total number of coal-fired TPPs is 14, and large coal-fired CHPs – 8. Of these, 6 TPPs are located in the Donetsk region (Kurakhivska – installed electric capacity of 1,470 MW, Slovianska – 880 MW, Vuhlehirska – 1,200 MW, Starobeshivska – 2,010 MW, Zuivska – 1,200 MW and Myronivska – 115 MW) and 1 CHP (Kramatorska).

At the moment, after the commencement of hostilities in eastern Ukraine, 2 TTPs (Zuivska TPP and Starobeshivska TPP9 are located in the temporarily occupied territory. The supply of fuel to the power plants in 2018 is given in Table 94 (The state of accumulation, 2019).

Table 94: UA: Structure of fuel supply for TPP and CHP in 2018.

	Output, mln. kWh	Specific consumption of coal equivalent for electricity production, g/kWh	Coal (ths. t)		Gas (mln. m3)	HFO (thsnd. t)
			Supply total	LHV, kcal/kg	Supply total	Supply total
Sum-total TPP & CHPP, of which	55,051	383	26,792	5,106	4,868	72.2
Anthracite+Lean coal	9,408	312	4,680		380	1.1
Bituminous coal	45,643	327	22,111		4,488	32.6
Slovianska TPP	2,232	418	1,055	5,950	8.5	
Vuhlehirska TPP	4,241	369	2,130	5,485	30	2.1
Kurakhivska TPP	6,621	393	4,185	4,388	13	19.5
Kramatorska CHP	206	441	127	5,800	44	
Myronivska TPP			250	4,300		

Anthracite was the main rank of coal that was extracted in the mines of the Donetsk region. 7 of 14 TPPs of Ukraine were designed for combustion of such coal (2 of them in the Donetsk region). At the moment, most of the mines that produced anthracite and close to it by characteristics the lean coal are located in temporarily occupied territories.

10.2.2 Social aspects

The coal industry in Ukraine, like in many countries of the world, is not a highly attractive industry for employment. Miner's work is difficult physically and dangerous for the worker's life and health. This determines the high price and complexity of the recruitment of labour resources. A well-known pre-revolutionary (1917) researcher, V. Den, in his monography “Coal and iron-making industry” (1912) concluded on the situation of coal miners in the 70-90’s of the nineteenth century: “In the meantime, our situation is much worse than that of in the West. First of all, our salary is much lower.” However, he added, “it is scarcely that there any industrial centre in Russia, not excluding the capitals of the Empire, which would have that high wages" (Dyakonova I.A., 1999).

The picture did not change: in 2012, the miners of the Ukrainian Metinvest in Krasnodon received 12 times less than the miners of the same Metinvest from the coal province in the Appalachians (11 thousand dollars per person per year, compared to 132 thousand dollars) (The salary, 2019), but significantly more than workers in other domestic industries.

In 1976, there were 237 administrative units of the mine fund (338 technical units) operating in Ukraine, with 476 thousand people of industrial and production personnel, of which 405 thousand people worked in the mining industry. Under today’s state in Ukraine, the industry employs 290 thousand people, including 217 thousand working in extraction.

In Donetsk region (except for the territory non-controlled by the government), in the year 2018, there were 6 state-owned enterprises (SE MM Pivdennodonbaske No. 1, “ine named after M.S. Surgaya”, “Myrnohradvuhillia”, “Krasnolymanska”, “Selidivvuhillia”, “Toretskvuhillia”); and privately owned companies, the most powerful of which are PJSC “MM Pokrovske”, LLC “DTEK Dobropilliavuhillia”, Mine “Bilozerska”, LLC Mine “Krasnolymanska”, and others.

The average number of employees in the region in 2018 was 34,630 people, in particular, 21,074 at state enterprises; 6,847 employees at PJSC MM “Pokrovske”; 6,709 at LLC “DTEK Dobropilliavuhillia”. According to the estimates of the regional state statistics authority in Donetsk, the region's population is estimated to about 4.160 million by March 1, 2019, of which 8 people from each thousand inhabitants of the Donetsk region controlled by the Government are miners, of which 4 persons are employed at the state enterprises. Among the staff (382,000 at the end of 2018) almost 90 of each thousands of workers are miners, or work at the auxiliary enterprises of the coal industry. But if we consider the situation in miner's cities, this figure is much higher due to the territorial crowding of miners. The population density, for example, of a small (10,000 inhabitants) city of Bilitske, which is close to the mine with the same name, is

4.95 thousand people/km^2, almost as in the German Ruhr, which serves as a typical example of the old industrial territories, whereas Dobropillia district, where the specified settlement is located, has a population density only 17 people/km^2.

The state sector of the coal industry of the Donetsk region (the territory under the jurisdiction of the Government of Ukraine) is presented by the mine management “Pivdennodonbaske” No. 1, the mine “Pivdennodonbaska” No. 3, Mine after name of M.S. Surgaya, State Enterprise "Selidivvuhillia" (4 mines), State Enterprise "Myrnogradvugillya" (4 mines), State Enterprise "Toretskvugillya" (3 mines).

As of March 1, 2019, the employees at these state coal mines amounted to 17,795 people, in particular: "Selidivvugillya" – 6,465 (36.3%), "Myrnohradvuhillia" – 3,970 (22.3%); "Toretskvuhillia" – 2,468 (13.9%); "Pivdennodonbaska" No. 1 – 2,482 (13.9%), "Pivdennodonbaska" No. 3 – 2,470 (13.9%).

At the beginning of 2019, at the state mines of the Donetsk region of 17,800 registered workers 5,526 were pensioners, which is 31% of the total number of employees; 9,736 people are underground workers (54.7% of the total personnel), of which 2,854 (29.3%) are persons of retirement age; 5,026 persons (28.2%) are employees at the surface, of which 1,704 (33.9%) – pensioners; 2,852 persons (14.5%) make up the corps of engineering and technical personnel (ETP), 842 persons of the latter (29.5%) are of retirement age. The total number of employees includes 454 representatives (2.6%) of non-producing personnel, among which 126 (27.8%) are pensioners.

With probability of 0.95 it can be concluded that the average mine in the Donetsk region has a staff of 1,369 ± 460 employees, among them - underground workers 749 ± 271 persons, in particular 220 ± 80 - pensioners; maintenance workers on the mine surface - 387 ± 146 persons, and those of a retirement age are 131 ± 84 persons; the engineering and technical staff - 199 ± 59 persons, respectively 65 ± 17 - pensioners; non-industrial group - 35 ± 14 persons, including 10 ± 4 pensioners.

The specifics of employees by categories are as follows, in %:

- underground workers 51.4 ± 4.6;
- coal mining workers serving the technological surface complex – 29.0 ± 3.5;
- engineering and technical personnel (ETP) – 17.0 ± 2.9;
- non-industrial group – 2.6 ± 0.6.

The share of pensioners among these groups is more than a third: underground workers – 32.6 ± 5.7%; workers occupied on a mine surface – 36.8 ± 5.2%; ETP – 34.4 ± 6.3%; non-industrial group – 30.1 ± 0.6%

The abnormally high number of pensioners among the groups of workers is usually inherent in those mines whose production activity is coming to an end.

The number of women in state mining enterprises, which according to the specifics of labour is predominantly male, is 5,086 persons (28.6%), almost every third employee is a woman. Young people aged 18 to 35 years old working at Donetsk mines – 4,522 persons, which is 25.4% in the structure of personnel, of which 714 are women (15.8%). People aged 36 to 50 – 5,568 persons (48.0%), including 2,937 women (52.7% in this age category); workers over the age of 51 – 4,717 persons (26.1%), of which 1,968 (41.7%) are female.

The workers at the average mine in the Donetsk region, with a probability of 0.95, are 348 ± 133 persons of the first age category, i.e. young people, of which 55 ± 26 are women; the middle age group are presented by 658 ± 250 persons, of which 184 ± 77 are women; the third group – mostly pensioners – 363 ± 125 persons (151 ± 50 female).

Similarly, in relative terms, percentages: the first group - 22.5 ± 4.0%, of which women of the same age group from the total number of employees - 4.2 ± 1.6%; the second group – 46.5 ± 4.4%, women - 13.8 ± 2.5%; the third group – 31.9 ± 5.9%, women – 13.8 ± 3.3% (Cherevatskyi D.Yu., Gudinov D.V., Kobysh I.V., 2019).

10.2.3 Economic effect

Under curtailment of domestic coal supplies, the domestic electricity market has undergone significant changes. In March 2016, the National Commission for State Regulation of Energy and Utilities (NERCU) adopted methodology for determining the wholesale price of electricity to stimulate imports of anthracite from the US and South Africa. The essence of the methodology, called "Rotterdam +", is the coincidence of the price of coal for TPP to the cost of coal in the ports of the Netherlands (index IP 2), plus the cost of its delivery to Ukraine, including the cost of transhipment in ports. The forecast wholesale electricity market price (WEMP) according to the Rotterdam + method should be determined by the average price of coal in the European market over the past 12 months.

Cumulative profitability curves provided in Figure 32, demonstrate the growth of the economic efficiency of the operation of electricity generating companies under the influence of increased tariffs for electricity (Cherevatskyi D.Yu., Cheilyah D.D., Kocheshkova I.N., 2018).

The diagram shown in Figure 33 provides the cumulative profitability curves for the period 2015-2017of coal production at state enterprises of the Donetsk region (see Table 93), which supply fuel to the TPPs.

Implementation of the Rotterdam + formula in the coal industry has somewhat improved the economic situation at the mines of the public sector, but not as much as in the thermal power industry. Coal enterprises subordinated to the Ministry of Energy and Coal Industry of Ukraine remained profoundly unprofitable.

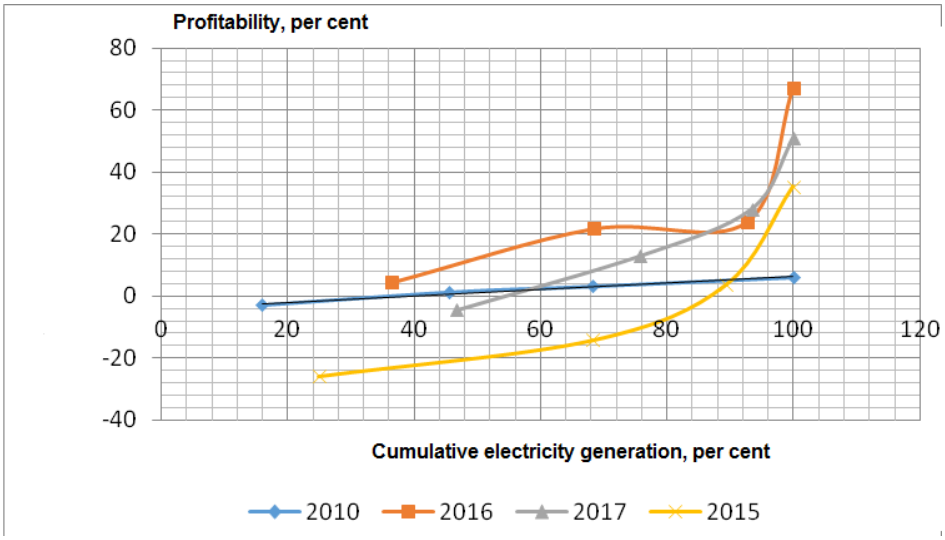

Figure 32: UA: Profitability of electricity generating companies

The situation with regard to state enterprises of the Donetsk region practically did not change, and in 2018 the coefficient of profitability (the ratio of price to cost) in general was 0.48.

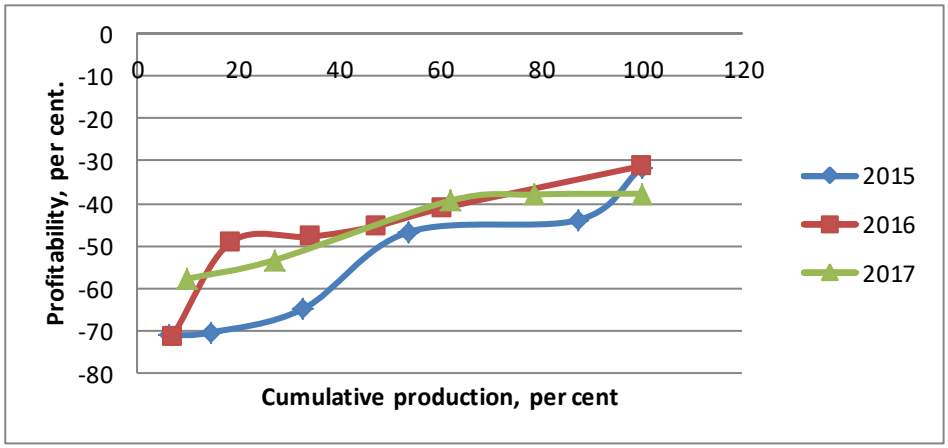

Figure 33: UA: Profitability of the state owned coal enterprises of Donetsk region

At the same time, on the MM “Pivdenodonbasske” No. 1, it raised to 0.88; at "Mine after name M.S.Surgaya" – 0.64; "Myrnohradvuhillia" – 0.42; "Selidivvuhillia" – 0.46; "Toretskvuhillia" – 0.58.

This unprofitableness is natural: coal mining in Ukraine, as a business, is unprofitable, and on most Donbass mines it is unprofitable, due to unfavourable mining and geological conditions, weariness of the mine fund, lack of investment in its modernization. In 2006, this ratio of the price of coal to cost, even without subtraction of private companies, of the average Ukrainian mine was 0.66 ± 0.07. In the world, coal deposits in such conditions as in Ukraine, are not being developed. The mine "Shakhtarska Hlyboka" in the Donbass has reached the geodetic mark of "minus 1,546 m", and is the deepest coal mine on Earth. There are several mines in the Donetsk region of Ukraine that carry out mining operations at a depth of more than 1,200 m.

Losses of state-owned coal mining enterprises are so deep that they are not able to pay even for consumed electricity. Mutual non-payments of coal mines and power generating companies acquired the character of a chronic default and became a national phenomenon. In 2018, the mines under the Ukrainian government control consumed 1.033 billion kWh of electricity costing 2.158 billion UAH, of which only 14% (308.6 million UAH) were paid. Since 2014, the debt of mines is 9.11 billion UAH (Cherevatskyi D.Yu., Kotlyarenko D.V., Stilbyi A.V., 2019).

The average salary in the Donetsk region in April 2019 amounted to 12,134 hryvnias. The nominal salary in April 2019 exceeded the average in Ukraine (UAH 10,269) by 18.2%. As before, the region ranked second in the country (the highest salary level in April was in Kyiv – 15,876 UAH, the lowest - in the Kherson region, where it amounted to 7,695 UAH). In terms of the average wage in April 2019, the most highly paid among the main types of economic activity were employees of enterprises producing coke and oil products (19,309 UAH), metallurgy complex (16,967 UAH), coal industry (14,308 UAH), engineering (12,739 UAH). The average salary of miners during this period was 24,415 UAH.

10.2.4 Environmental effect

The large gas-saturation of the rock masses necessitates the use of powerful ventilation systems. Ukraine, on the resources of coal mine methane ranks fourth in the world. It is about 12-13 trillion m^3 of gas. This is both wealth and at the same times a risk factor for devastating catastrophes. In order to avoid methane explosions, it is necessary to constantly feed the air in the mine in such a way that the concentration of methane does not exceed 0.75%. Therefore, over a year at Pokrovske mine, which is the flagship of the Ukrainian coal industry, over 23 million tons of air is to be pumped through underground production. In 2011, the mine extracted about 7 million tons of coal, which is three times less than air used. The main ventilation systems in Ukraine demand for about 21% of the total electricity used in the coal industry. The requirements of intensive ventilation determine the high cost of underground economy.

The "Pivdennodonbaska No 1" mine is an enterprise with not very large for Donbass tidal water (total flow rate is 107 m^3/h), but during the year it produces about 937,000 tons of mine water.

The coal production capacity is 1,200,000 tons per year or is approximately 0.8 tons of water per ton of coal extraction. In 2015, mining in the mine (but not water) decreased to 690 thousand tons of coal, hence the ratio deteriorated to 1.4 tons of highly mineralized mine water per ton of coal. By power capacities, the mine dewatering plants in Ukraine far outstrip the lifting installations. If electricity consumption by mine pumps is almost 20% of the total in the coal industry, then for lifting units, which, in addition to coal produce the breed is only 10%.

With mine water coming out of a mine with an average mineralization of 3.6 g/l, about 2.7 million tons of salt per year is placed on the surface, which increases the mineralization of surface waters and groundwater.

The mass closure of mines without proper engineering work led to the bogging and salinization of soils within the settlements, damage to buildings, roads and other infrastructure, intensive corrosion of underground engineering networks, supporting metal structures and the destruction of reinforced concrete foundations (D. Kazanskyi, A. Nekrasov, O. Savitskyi and others, 2017).

Thin coals layers determine the volumes of the empty rock which discharge to the surface. The rock production from excavation and repair workings are stored here, in the dumps of the mine, and the waste of the enrichment - in the dumps and tailings of the concentrating factories. For Ukraine, the output of the breed at the mine is 110-150 m^3 per 1 thousand tons of coal mined for the year, which is about 0.6 tons per ton of coal (0.4 tons/ton – in the factory and 0.2 tons/ton – according to mine).

Thus, on the whole, in the amount of 1 ton of mined minerals on the surface, more than 5 tons of liquid, gaseous and solid waste materials are raised (Amosha A.I., Zaloznova Yu.S., Cherevatskyi D.Yu., 2017).

For 200 years of coal mining in the Donbas there were about a thousand mines. As a result of their work on the surface were 11 billion tons of related rocks, and in the bowels of the destruction of rock masses with a subsidence of the surface on 2-5 m in areas of thousands of square kilometres - annually 1,000 km^2, according to experts of the coal industry.

With a large number of heaps, only within Donetsk there are 138 waste heaps occupying more than 1,000 hectares (2.6%) of the urban area (Soldak M.A., 2012). Every year, from the surface of the average rock heap, about 400 tons of dust that contains a large amount of toxic compounds is blown out and 8 tons of salts are washed out, which is dangerous for the health of the population of the miner's regions.

A significant environmental problem is the release of methane. Annual methane emissions from the mines of Donetsk and Luhansk regions, according to conservative estimates in the early 2000s, amounted to 5.5 billion m^3 per year. Given the greenhouse potential of methane, which is 21 times higher than carbon dioxide potential, it amounts to 33.8 million tons of CO_2 per year or about 9% of national greenhouse gas emissions (relative to 2013 levels). The current volumes of methane emissions from open and closed mines are actually unknown but are likely to be larger than expected, which is why detailed assessment and implementation of measures to reduce emissions and utilization of coal mine methane are necessary.

According to the category of mines in the Donetsk region for the specific gas content and their production indicators, methane emissions can be estimated only by state enterprises in 2018 at a volume of at least 36 million cubic meters per year. Actually, methane in the mine layers is 80-95%, the rest – ethane, propane, nitrogen and carbon dioxide (UN, 2010).

Thus, it can be assumed that only the state mines in the Donetsk region produce a negative greenhouse effect equivalent to 715 million cubic meters of CO_2 per year.

Regarding mines in the non-state sector of the coal industry that extracted about 6 million tons of coal in 2018 and has a high methane emanations, their annually impact on the environment – 123 million cubic meters of methane – can be estimated at 2,500 million cubic meters of dioxide carbon. On the territory controlled by the Government of Ukraine, the enterprises of the coal industry of the Donetsk region generally emit at an equivalent of 3,200 million cubic meters of the CO_2 per year.

According to the Main Department of Statistics in Donetsk region, the emissions of pollutants into the air by stationary sources for 2018 amounted to 790,200 tons (31.5% of the total emissions in Ukraine) and on 0.7% more than in 2017 year (see Table 95), excluding the territory where the state authorities temporarily do not exercise their powers.

Table 95: UA: The dynamics of pollutants emissions into ambient air in 2018 and two previous ones

Indicators	2016	2017	2018
Emission of pollutants into the air from stationary sources, ths. tons	981.4	784.8	790.2
Emission of pollutants into the air from stationary sources per km^2, t	37.0	29.6	29.8
Emission of pollutants into the air from stationary sources per capita, kg	230.7	185.9	188.9

Describing the state of the atmospheric air in general in the Donetsk region, it is necessary to note some of its improvement and stabilization of levels of pollution during 2012-2015, because many industrial enterprises have reduced their capacity, and some generally stopped working.

During 2016 there is an increase in emissions of pollutants in the atmosphere in relation to previous years due to increased capacity of enterprises, moral aging and physical deterioration of dust-cleaning equipment. The reduction in emissions in 2017 is due to the lack of information on the territory, uncontrolled by the Ukrainian authorities. In 2018, there is a slight increase in emissions in relation to 2017, due to the increase in capacity of industrial enterprises and the transition from natural gas to alternative fuels (in particular, the coal of various types). The major industries in Donetsk region with the highest emissions are listed in Table 96.

Table 96: UA: Total emissions of pollutants into the air by types of economic activity

No	Types of economic activity	Emissions volumes by region	
		ths. t	% of total
Total		790	100
1	By types of economic activity, including:		
1.1.	Extractive industries and the development of quarries	150	18.9
1.2.	Processing industry, including:	333	42.1
1.2.1	Production of coke and coke products	12.5	1.6
1.2.2	Metallurgical production	316	40.02
1.3.	Supply of electricity, gas, steam and air conditioning, including	302	38.3
1.3.1	Electricity production	290	36.71
1.4.	Transport, warehousing, postal and courier activities, including:	0.901	0.1
1.4.1	Ground and pipeline transport	0.418	0.05

10.3 Coal production and policy of use of coal

10.3.1 National policy

The first regulatory act for the restructuring of the coal industry of independent Ukraine is the Decree of the President of Ukraine "On the restructuring of the coal industry", signed on February 7, 1996.The main transformations in the field of restructuring of the coal industry were the creation of state-owned enterprises that were part of the management sector within a month. It was supposed that objects of social infrastructure of enterprises are subject to separation and transferred to communal property. The solution to the crisis in the industry was to recognize the coal industry (coal mining enterprises) as requiring state support, as well as to channel large amounts of state funds to state enterprises of the coal industry to increase coal production. In fact, since the entry into force of this Decree, the history of subsidizing the existence of coal enterprises began, which led to deterioration of affairs not only in mines that could not be self-managed, but also at successful enterprises.

In September 2001 a system document was adopted - "Ukrainian Coal" Program, which was to be implemented in 2001-2010. In the Description of the Program, the coal industry was recognized as a strategic one, but noted problems related to the low investment attractiveness

of this industry, lack of real mechanisms privatization, imbalance in the cost of production of coal and procurement prices, lack of funds for the maintenance of the social sphere. Compared to the previous Decree, the Program's objectives were "the transfer of social infrastructure to communal property", "the elimination of unpredictable coal mining and coal processing enterprises". The main advantage of the Program is a very detailed description of the tasks that should be carried out for the social sphere of liquidated coal mining enterprises, starting with the system of social security for workers who were released in connection with the closure of "overcoming the factors of the depression of the mining regions." However, the sector's expected reform in accordance with the Program did not take place. The Ministry of Coal Industry did not envisage denationalization of separate entities, but integral complexes. Based on state-owned holding companies and individual mines, 21 state-owned companies were created. The balance of these campaigns included both cost-effective and unprofitable enterprises that were identified by the Program before liquidation. The program announced the privatization process and the denationalization of mines were not implemented to the specified extent. As a result of the systematic lack of financing of the Program's activities, the coal industry was unable to achieve the necessary technical and technological and economic levels, while production coal volumes even decreased to 78 million tons in 2005. Due to insufficient volumes of capital investments in the coal industry, Ukraine had the oldest mine in the CIS countries fund, and its accelerated aging has led to the formation of a negative balance of production capacities. Reducing their volume has become a constant trend. The system of state financing of profitable and unprofitable enterprises has become an additional contribution to the aging process of mine equipment and is by no means a way out of the situation.

In July 2005, the Cabinet of Ministers of Ukraine adopted the "Energy Concept of Ukraine for the period up to 2030", which aimed to "ensure the organization and development of the coal industry in order to maximally meet the needs of the state in fuel and energy resources at the expense of economically justified increase in the volume of own coal production". Once again, privatization on a competitive basis of investment-attractive and unprofitable enterprises was determined as a priority. The three stages of the Concept were calculated for the period from 2006 to 2030 and were mainly based on the expected growth of coal production in each of the specified periods. Unfortunately, within the limits of the strategy, the detail overview of the state of mines undergoing restructuring, which are subject to closure, have been avoided.

Since 2017 Ukraine has been implementing the Energy Strategy of Ukraine for the period up to 2035 "Security, Energy Efficiency, Competitiveness", which is a document outlining strategic guidelines for the development of the fuel and energy complex of Ukraine for the period up to 2035 (Cabinet Ministers, 2017).

Implementation of the Energy Strategy is envisaged in three main stages:

STAGE 1 - Energy Sector Reformation (by 2020),

STAGE 2 - Optimization and Innovative Development of Energy Infrastructure (by 2025),

STAGE 3 - Ensuring Sustainable Development (by 2035).

At the first stage it is planned to create complete natural gas and electricity markets in accordance with the EU energy legislation. Also, at this stage it is planned to complete Ukraine's integration into the ENTSO-G, as well as to carry out most of the measures to integrate the Ukrainian Energy System into the ENTSO-E networks.

Reforming energy companies in accordance with Ukraine's obligations under the Treaty establishing the Energy Community, increasing natural gas production, reducing the energy intensity of GDP and further developing the RES (renewable energy sources).

A coal market will be created. The restructuring of the coal industry will be accompanied by a set of measures to mitigate the social and environmental consequences of the elimination/conservation of coal mines and the social rehabilitation of the closure of the mines according to best European practices.

In the field of environmental protection, compliance with high environmental standards of production, transportation, transformation and consumption of energy must be ensured; financing of investment projects in the framework of the National plan for reducing emissions

from large combustion plants in accordance with the legislation of Ukraine and obligations to the Energy Community should be implemented.

The first stage is expected to achieve radical progress in the RES by increasing their share of final consumption to 11% (8% of total primary energy supply) due to the implementation of a stable and predictable policy in the field of promoting the RES development and in the field of investment attraction.

The second stage of the implementation of the Energy Strategy will be focused on the work of the new market environment and the actual integration of the Ukrainian Power System with the Energy Networks of Europe, which will significantly influence the justification of the choice of objects for reconstruction or new construction in the energy sector and energy efficiency.

The objectives of this stage are the introduction of mechanisms for attracting investments for the implementation of the program for replacing the capacities that are to be decommissioned, the new energy infrastructure.

The second stage should include the following actions:

- integration of the Ukrainian Integrated Power System with the ENTSO-E continental European networks in operating mode;
- realization of investment projects within the framework of the National emission reduction plan from large combustion plants;
- the formation of local heat supply systems based on economically feasible consideration of the potential of local fuels, supply logistics, regional and national energy infrastructure;
- attracting private investment.

At this stage, intensive investment in the RES sector, development of distributed generation is planned, in particular, the development and implementation of the Smart Grids implementation plan and the creation of an extensive infrastructure for the development of electric transport.

The third stage of the Energy Strategy is aimed at the innovative development of the energy sector and the construction of a new generation. Investing in new generating capacities to replace capacities that are to be decommissioned. The choice of generation type will depend on the forecast price conditions for fuel and the intensity of development of each type of generation, which will increase the level of competition between them; from the introduction of smart technologies to equalize consumption peaks.

In the field of energy efficiency and environmental protection it is envisaged introduction of construction of passive house standards, achievement of targets for SO2, NOx and dust emission reduction in accordance with the National emission reduction plan for large combustion plants and the introduction of a system for trade in quotas for GHG emissions in Ukraine.

The coal sector in this period should achieve competitive and transparent operating conditions. The RES will develop at the most dynamic pace compared to other types of generation, which will increase their share in the structure of total primary energy supply (TPES) to 25%.

In 2015, according to the State Statistics Service of Ukraine, the structure of the TPES was characterized by a high share of natural gas of 28.9%, (26.1 million tons of oil equivalent). The share of nuclear power was 25.5% (23.0 million tons of oil equivalent); coal – 30.4% (27.3 million tons of oil equivalent); crude oil and petroleum products – 11.6% (10.5 million tons of oil equivalent); biomass (biomass, fuel and waste) – 2.3% (2.1 million tons of oil equivalent); HPP – 0.5% (0.5 million tons of oil equivalent); thermal energy (thermal energy of the environment and secondary resources of technogenic origin) – 0.5% (0.5 million tons of oil equivalent) and wind and solar power plants together – 0.1% (0.1 million tons of oil equivalent). The total share of all RES was 3.6 million tons, or only 4%.

In Ukraine, the current level of pollutant emissions exceeds the EU standards by an average of 7-80 times depending on their type. It is planned to comply with the requirements of Directive 2010/75/EU on SO_2 and dust emissions by the end of 2028, NOx emissions by the end of 2033.

Concerning the development of the coal sector, the following key goals of the state are set at the first stage of the implementation of the Energy strategy:

- optimization of the structure of coal mining and other state enterprises of the coal industry, improvement of economic and technical indicators of activity, reduction and elimination of regulation and subsidizing operating activities of coal mining and coal processing enterprises;
- development of the necessary infrastructure to strengthen Ukraine's ability to provide export-import operations with coal products.

The main measures for the implementation of strategic goals in the coal sector:

- reorganization of coal mining and other state enterprises of the coal industry and subordination to their single legal entity;
- exemption from non-core assets;
- restructuring of the sector, preparation of prospective state mines for privatization, liquidation / preservation of loss-making state mines;
- the transition to a self-sufficient extraction with the reorientation of state support for labor protection, protection of the environment and restructuring of the coal industry;
- ensuring the development of own coal production.

The measures for the closure/conservation of loss-making state mines will be completed by 2025, a plan for mitigating social and environmental impacts will be adopted for each facility. Within the framework of this work, it is planned to take into account (with the assistance of large-scale international assistance) the best world experience in mitigating social consequences, which includes, in particular, initial benefits, advisory assistance for discharged personnel, vocational training and retraining.

It is planned to expand the use of all types of renewable energy, which will become one of the tools for guaranteeing the energy security of the state. In the short and medium horizons (by 2025), the Energy Strategy of Ukraine predicts an increase in the share of renewable energy to 12% of the TPES and at least 25% by 2035.

10.3.2 Regional and local policy

In general, the restructuring processes in the coal industry in Donetsk Oblast were in line with those in the Ukrainian coal industry, which were supposed to contribute to the improvement of the economic situation in the industry, but in fact it caused an increase in crisis phenomena.

By the Resolution of the Cabinet of Ministers of Ukraine of March 28, 1997, No. 280 "On the Process of Structural Restructuring of the Coal Industry", a program for the closure of unpredictable mines and sections was launched. In general, the program should have closed the 81 coal enterprises with total industrial coal reserves of more than 1 billion tons. The estimated cost of the program was about 2 billion UAH (approximately $ 1 billion). However, from a large number of projects for the closure of mines under the documents 2004-2011, no more than 30 mines were closed (with the implementation of environmental and social measures). As of January 1, 2007, there were 125 mines in the stage of liquidation; as of January 1, 2013 - 103 mines.

Financing the work was not uniform. At the same time, the amount of funding was not determined by the closure program of mines, but on the contrary, the program "fit" for allocated budget funds.

Of the large number of mine closure projects in Donetsk region, as evidenced by the Decree "On Approval of the Act of the State Reception Commission on the Acceptance of Performed Liquidation Works", only 12 mines were actually closed. K.I. Pochenkova, No.2 "Torezke"; "Donetsk" and No.43 "Torezko"; "Red October"; "Sverdlovskaya"; "Cossack"; "Svitopolskaya"; named after RV Menzhinsky; named after A.B. Batov and "Removskaya"; "Butovka-Donetsk" . Unfortunately, only the "Kozatska", "Donetsk" and No.43 mines contain information on the progress of the project. For example, work on the "Kozatska" Mine began on December 20, 1999, ended in 2009, with an estimated spending of 21,542,000 UAH, in fact spent 20,282,000

UAH. Costs for "Donetsk" and No.43 mines were also lower than planned. The mine of Donetsk was closed in October 2000, the works were completed in December 2006, mine No.43 - from December 2002 to December 2006.

The desire to close the mines in Ukraine according to European norms - "from black to green" – leads to an increase in the cost and slowing down of the restructuring process. The time-stretched closure of each individual mine in the face of a shortage of budget funds requires a constant increase in estimated resources, which, in most of the facilities, is lacking in either full-fledged social activities (in particular, the creation of new jobs) or environmental measures. The problem of restructuring the domestic coal industry is complicated by the fact that there are still many mine-candidates for closure (at least 30), whose stay in operation significantly increases the loss-making industry.

The international experience of radical and fleeting liquidation of loss-making mines (Great Britain, Russia) cannot serve as a model for Ukraine because of the financial insolvency of the economy. The experience of Germany is more acceptable – relatively slow but consistent and steady closure of loss-making mines (not excluding their preventive modernization).

Accordingly, the strategy of coal industry restructuring in Ukraine needs to be adjusted with a wider application of mine conservation (Kocheshkova I.M., Cheilyakh D.D., Cherevatskyi D.Yu., 2013).

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11 United Kingdom, Wales

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11.1 Description of the region

11.1.1 Region overview

Location & area

Wales is one of four nations in the United Kingdom (UK). Wales includes the NUTS-2 territorial units West Wales & the Valleys (UKL1) and East Wales (UKL2). It lies in the West of the United Kingdom, covers 20,780 km^2 ground surface and is bordered with England on Wales' Eastern side. This border is the only land border with nation regions in the rest of the United Kingdom (Figure 34).

The other nations and regions in the UK are Scotland and Northern Ireland. The Irish Sea separates Wales to the West from Ireland, which is composed of the Member State of Ireland and the Northern Ireland UK region. Scotland is located in the North of the UK.

Wales has a total area of 20,780 km^2 (8,023 sq miles) of which 80% is devoted to agriculture; measures 274 km (170 miles) from north to south, and 96km (60 miles) from east to west at its shortest points; has over 1,200 km (750 miles) of coastline; has 3 National Parks, 3 areas of Outstanding Natural Beauty, 41 Blue Flag beaches and 6 UNESCO World Heritage sites. It is largely mountainous, with its highest peaks in the north and central areas, including Snowdon, its highest summit.

There are 12 NUTS-3 regions, which include one or more of the 22 Welsh local authorities

West Wales and the Valleys NUTS Code: UKL1 including; Isle of Anglesey (UKL11), Gwynedd (UKL12), Conwy and Denbighshire (UKL13) South West Wales (UKL14). Central Valleys (UKL15). Gwent Valleys (UKL16). Bridgend and Neath Port Talbot [NPT] (UKL17) and Swansea (UKL18).

East Wales NUTS Code: UKL2 includes the NUTS3 areas of Monmouthshire and Newport (UKL21). Cardiff and the Vale of Glamorgan (UKL22), Flintshire and Wrexham (UKL23) and Powys (UKL24).

In 2019 there were a total of 8 licensed coal extraction sites in Wales, with 5 of those sites located in Neath Port Talbot (NPT). However, most licenced sites are not in production. The single large scale operational mine in Wales still selling coal in early 2019 was in NPT. NPT also hosts Wales' main coal consumption business, the Indian owned TATA steel works.

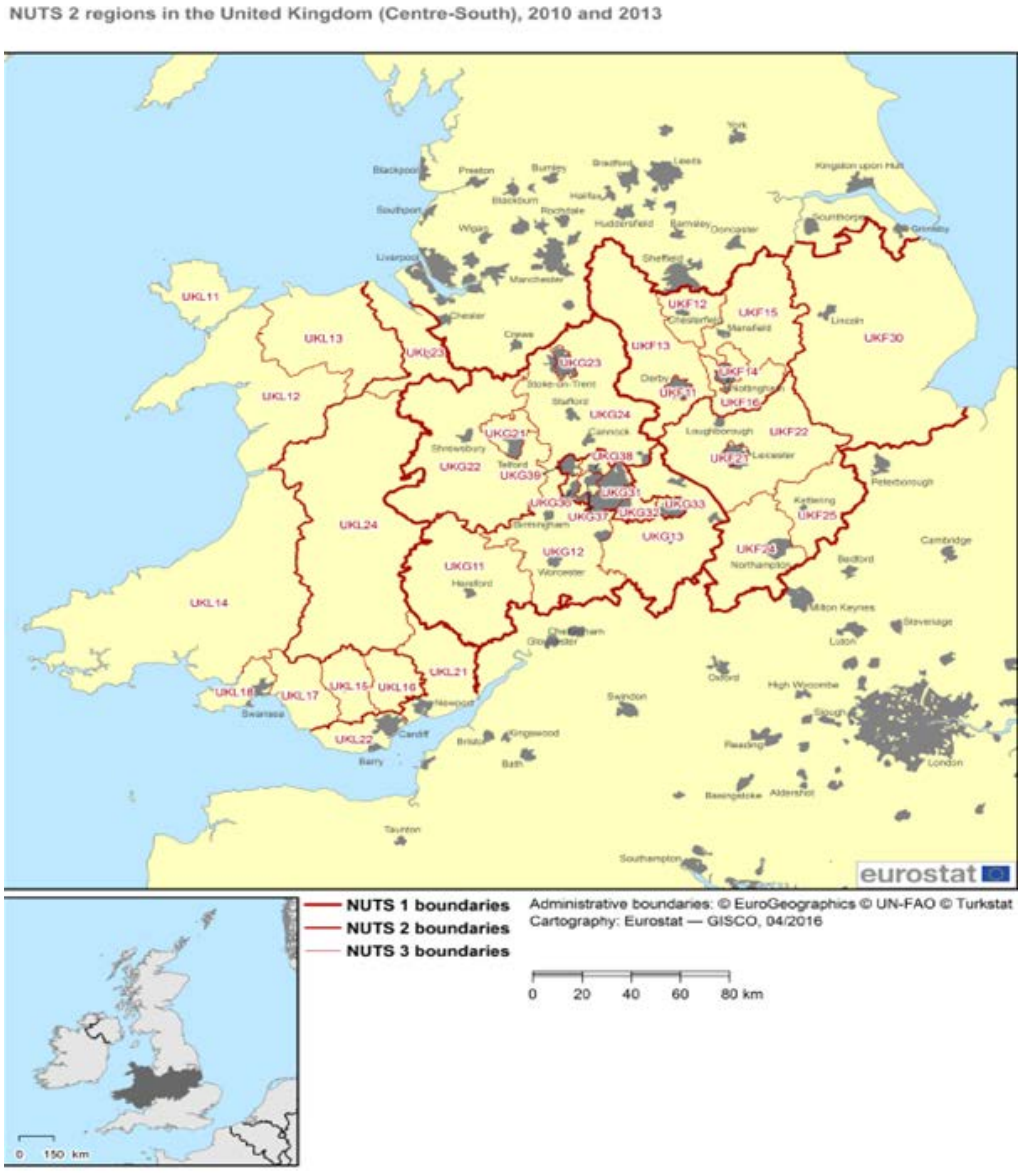

Figure 34: UK: Administrative structure of the NUTS-3 *Local Authorities UKL 11-16 and UKL 21-24* within the Wales region in the United Kingdom

Data source: Eurostats NUTS map UK

Administrative and institutional structure

Wales' constitutional body is the National Assembly of Wales (NAfW). The electorate in Wales elects political members both to the UK House of Commons - Members of Parliament (MPs) - and to the NAfW- Assembly Members (AMs). The UK Government has devolved legal competencies to the NAfW and to Ministers of the Welsh Government, who are selected from the 60 elected members represented in NAfW. The house, the "Senedd", was established in 1999 following the referendum for a Welsh national parliament, held in 1997. Since 1997 the Welsh Labour Party has been in government, apart from a coalition period, when Welsh Labour shared power with Plaid Cymru, the party promoting Welsh independence.

The powers of the Welsh Assembly have been set out in successive Acts. The Government of Wales Act 2006 identified specific legislative powers that were devolved to the NAfW. The Wales Act 2017 introduced a model where the Welsh Assembly would have control of all matters apart from specific powers which were "reserved" to the UK government. The Welsh Government was granted borrowing powers in the Wales Act 2017.

Welsh Government receives a block grant from the UK Government on an approximate per capita basis of UK population (5%) to provide services in devolved areas, including health,

education and economic interventions. Limited tax raising functions were introduced in the Wales Act 2017, for example in relation to mineral aggregates and house sale duty fees. Wales has no taxation functions for coal.

The capital city for Wales is Cardiff in South East Wales and Welsh Government offices and functions are dispersed in towns and cities throughout the country.

Wales is divided into 22 “County” or Local Authority areas for local government purposes. The elected councils of these areas are responsible for the provision of local government services, including education, social services, environmental protection, and most roads. Within each local authority are a number of elected community councils, to which responsibility for specific aspects of the application of local policy may be devolved. The 22 local government areas are divided within the 12 NUTS-3 regions. NUTS 3 regions can therefore include more than one “local authority”.

The UK Government is supporting regional development through the introduction of “city deals”, responsible for driving future economic activity by creating “city regions” over 10-15 years. City deals require capital investment by the UK Government, Welsh Government, local authorities and other partners. There are four such regions within Wales, with the *Cardiff City Region* and *Swansea City Region* the most advanced. The *North Wales Economic Ambition Board* has agreed a similar development deal in North Wales, and Mid Wales will potentially be the final deal region in Wales. The Welsh city deals, with borders to England in the East, acknowledge the economic relationships with English Counties.

Demographics

Wales has a population of 3.1 million people living in 1.3 million households: 1 in 21 of the UK population live in Wales. Hence the UK awards an annual budget to Welsh Government of 5% of the UK Government’s total spending.

The population density for Wales is 151 persons per square kilometre. Life expectancy for Wales, is 78 years for males and 82 years for females. Life expectancy for Wales in 2015-17 was male 78 years and female 82 years. In West Wales and the Valleys, life expectancy ranged from 76-80 for males and 81-84 for females. In East Wales the range is from 78-80 for males and 81-84 for females.

Education in Wales is devolved from the UK. In Wales 80 per cent of 16-18 year olds in Wales were engaged in some kind of education or training (full or part-time) in 2017. In 2018, 23 per cent of those aged 18-24 in Wales were qualified to NQF level 4 or above (higher education or equivalent). Working age adults aged 35-49 were nearly twice as likely (45 per cent) to hold a higher education qualification (or equivalent).

The 1990s was the last decade where there was significant employment in coal mining in the UK (Data from UK Department for Business, Energy and Industrial Strategy). As many of the workforce previously involved in mining will now be retired or deceased, the impact on reduced life expectancy is less apparent.

Wales has the second highest unemployment rate of the four UK countries. In the year ending March 2019 unemployment in Wales was 4.5%, falling to 3.8% in the period March to May 2019. The Annual Population Survey estimates that 24% of adults aged 16-64 are Equality Act core or work limiting disabled in the year ending March 2019. This is the highest proportion of the four UK countries.

In the year ending March 2019 the unemployment rate East Wales, which includes the Welsh capital, Cardiff, had an unemployment rate of 3.6%. The unemployment rate in West Wales and the Valleys NUTS 2 area was 5%. The local authority of Neath Port Talbot, the remaining authority with both coal mining and steel production, is in West Wales and the Valleys, had an unemployment rate of 3%, lower than in East Wales. The major employer in Neath Port Talbot is the TATA owned steel furnace manufacturing plant.

Average (median) gross weekly earnings (£) in 2018 in Wales was £509. In West Wales and Valleys, the range was £446 – 587 and in East Wales the range was £476 – 553. Median earnings for individual local authorities within each NUT3 region will vary depending on the local economy.

There is uneven geographic distribution of the job opportunities in Wales. Between 2001 and 2017, Cardiff had the largest absolute increase in workplace employment (up 54,000 or 30 per cent) of the 22 local authorities in Wales.

The proportion of the population aged 16-64 has generally increased since 1996 in the UK, Wales, West Wales and the Valleys, and East Wales. During this period, the employment rate for East Wales has been above the rate of both Wales as a whole and West Wales and the Valleys, and generally close to the rate for the UK. (Figure 35)

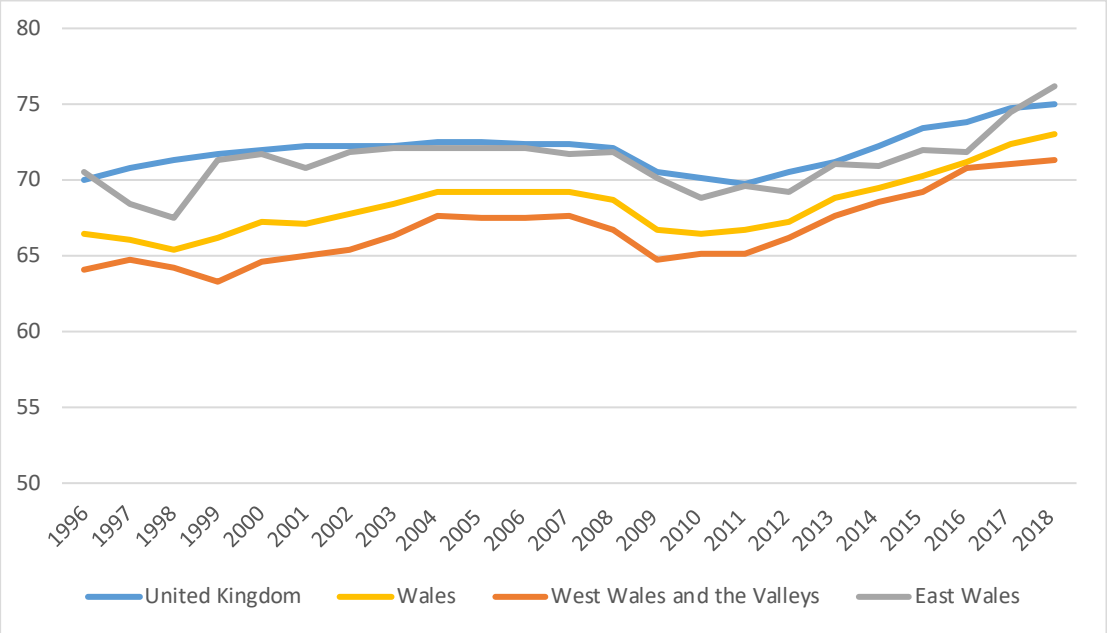

Figure 35: UK: Employment rate by area, 1996 to 2018

Source: Welsh Government analysis of the Annual Population Survey

One of the main challenges to economic prosperity is the rugged topography of the coal mining "Valleys", making east/west links between the valleys challenging.

Some of the local authorities with the lowest gross value added (GVA) per head in Wales are the local authorities containing coalfields, such as Blaenau Gwent, Caerphilly, Neath Port Talbot, Merthyr Tydfil, Rhondda Cynon Taf and Torfaen (Figure 37).

In 2017, gross value added (GVA) per head in Wales was £19,899 per head. This was the lowest of the four UK countries and 72.9 per cent of the UK figure (StatsWales).

Landscape

The geology of Wales is complex and varied: all geological periods from the late Precambrian to the Jurassic are represented in outcrops, whilst younger sedimentary rocks occur beneath the seas immediately off the Welsh coast. The effects of two mountain-building episodes have left their mark in the faulting and folding of much of the Palaeozoic rock sequence. Superficial deposits and landforms created during the present Quaternary period (2.6 million years) by water and ice are also plentiful and contribute to a remarkably diverse landscape of mountains, hills and coastal plains.

Wales' modern character derives in substantial part from the exploitation of its diverse mineral wealth; slate in Snowdonia, coal in the South Wales Valleys and metal ores in Anglesey and mid Wales (Howells 2007).

11.1.2 Social situation

The Wales region is recognised as a nation within the United Kingdom of Great Britain and is a union more than three centuries old. Wales has a distinct economy within the UK based on 80% agricultural land and also a concentration of heavy industry and power generation, located in the now redundant coal fields region. Coal supplies to sustain the steel and power sectors are now largely imported.

The language of Wales is Welsh and is widely spoken in addition to English. The English language is part of the legacy of the coal extraction period in 1920 to 1990s. The demand for coal for ships and the ongoing industrial revolution of the 18th century attracted a large workforce from outside Wales. This immigration to Wales to work in the coal industry and subsequent energy intensive businesses introduced new aspects like language, religious practice and traditions from English life. Education is conducted through the medium of both Welsh and English as part of a legal commitment to treat both languages equally.

The harsh conditions experienced working coal underground and the close remote ex-coal communities are in part responsible for the unionisation of workers to seek collective bargaining with the employers to demand improved conditions. The political history of Wales since coal has been exploited has remained largely Labour (socialist) in the UK Parliament with Welsh Ministers of Parliament representing constituents in the United Kingdom. Labour has been dominant in elected bodies like the NAfW since 1999 and have members across regional and local elected councils.

Religion in Wales is distinct in the UK in its non-conformist religious movements that choose to separate from long-established religious teachings. The last great non-conformist revival ended before the First World War. Language and non-conformist religion is broadly acknowledged as connected in Wales.

The 2016-based national population projections from the Office for National Statistics (ONS) suggest that Wales' population is projected to increase over the next 20 years, by around 4% in the period 2019 to 2039. While natural change (births minus deaths) is projected to contribute to population growth up until 2027, it is projected that migration (from both within and outside of the UK) will be the only factor contributing to population growth in the period 2028 to 2039.

According to Census data for Wales, around 40 per cent of inward international migration in 2011 was from EU countries. The latest data UK Migration Statistics Quarterly Report tells us that in 2017, inward international migration to Wales was approximately 23,000, with around 5,000 from the European Union and around 16,000 from non-European Union countries. However, these are approximate estimates.

The UK's exit from the European Union could lead to more controlled migration in the future and a subsequently lower population growth rate. The economic demands for inward migration are likely to remain however, so immigration is still likely to continue to some extent.

Over the next 20 years, the proportion of over 65s in Wales is set to increase from 20.4 per cent in 2016 to 26.3 per cent of the entire population. The population aged over 75 in Wales is also projected to increase from 9.1% of the population in 2016 to 13.6% in 2036. The number of young people (aged under 16) is projected to increase up to 2023 and then fall slightly accounting for around 17.1% of the population in 2036.

Life expectancy increases in Wales look set to continue, although there is a lot of uncertainty around the extent of increase.

The number of households in Wales is projected to grow faster than the overall population. This would lead to smaller household sizes.

Fuel poverty: a household is regarded as being in fuel poverty if they are unable to keep their home warm at a reasonable cost. In Wales, this is measured as any household that would have to spend more than 10% of their income on maintaining a satisfactory heating regime.

Fuel poverty estimates for Wales in 2018 recorded that 155,000 households in Wales were living in fuel poverty, equivalent to 12% of households. This included 32,000 households that were living in severe fuel poverty, equivalent to 2% of households.

Estimates in 2018 stated that 130,000 vulnerable households in Wales were living in fuel poverty, equivalent to 11% of vulnerable households. In addition, 19,000 vulnerable households were living in severe fuel poverty, equivalent to 2% of vulnerable households. (Fuel poverty estimates for Wales).

It is challenging to establish the social impact of the coal industry in Wales. The productive period of coal production was two or three decades in the past. Comparing historic location of collieries and the areas presently described as deprived gives no definitive evidence of impact. Nevertheless, the transition since the mines closed is likely to be strongly related to the economy and wealth of those regions.

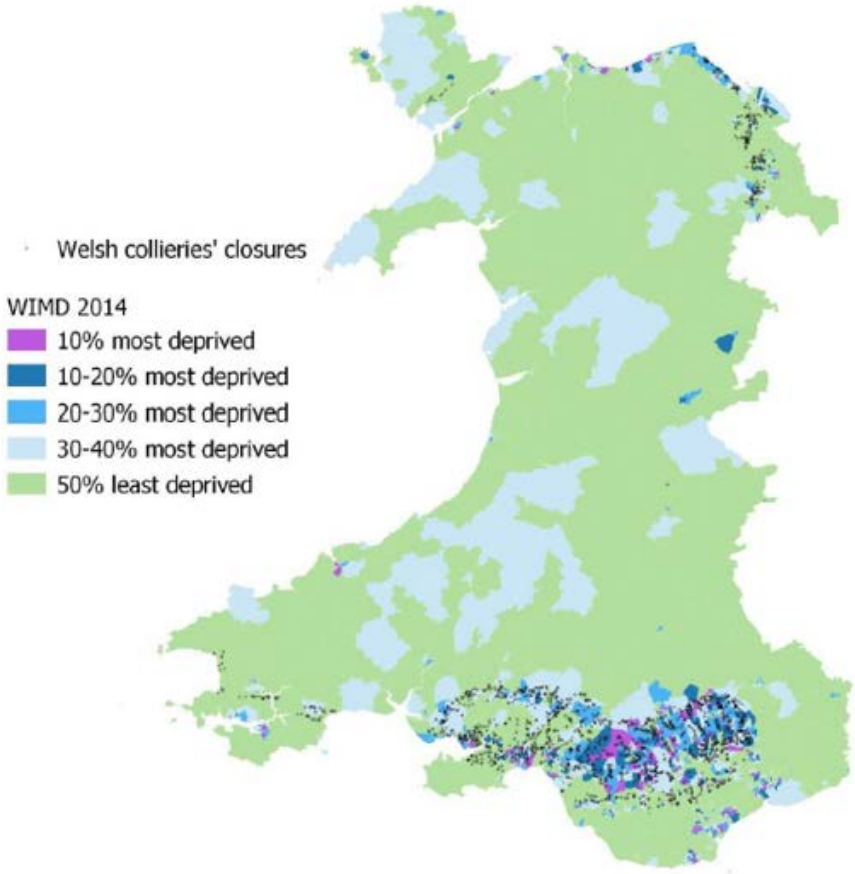

Figure 36: UK: Welsh collieries' closures

Data source: Case study: Welsh coal-exit – A policy package for regional economic regeneration.

Deprivation is defined as the lack of access to opportunities and resources. The Welsh Index of Multiple Deprivation was developed to measure small area relative deprivation in Wales, considering employment, income, education, health, community safety, physical environment, access to services and housing.

11.1.3 Economic development

The "National policy" which determined coal mining and use during the high coal output period in Wales were policies of the UK Government. Following a referendum vote in Wales, the UK Parliament passed the Government of Wales Act 1998. The Act established the National Assembly as a corporate body – with the executive (the government) and the legislature (the Assembly itself) operating as one. The first elections to the Assembly were held in 1999.

Generally, Wales' current and former mining communities (like Neath Port Talbot and Methyr Tydfil), tend to have lower GVA per head than Cardiff (the capital of Wales). GVA per head in 2017 was £16,222 per head for Neath Port Talbot, and £ 16,313 per head in Merthyr Tydfil. This is compared with Cardiff's GVA per head of £30,629 per head. (Figure 37).

The past under-investment in the coal regions of Wales is in part responsible for the relative deprivation today compared to other UK areas, though regions in England in the North and South West with a heritage of coal, tin, and clay mining have also received European funding, like Wales, to improve conditions. In Wales the European Commission has actively participated in the development of the West Wales and the Valleys region by co-financing the Objective 1 programme for the area during 2000-2006. Wales continues to receive support via European programme investment, which aim to add value to wider programmes, so that together they

can support sustainable jobs and growth in the West Wales and the Valleys region of Wales and contribute to the delivery of the Europe 2020 targets for smart, sustainable and inclusive growth.

The European Regional Development Funds (ERDF) investment in Wales aims to focus on specific structural weaknesses as well as targeting specific growth opportunities. There is a particular focus on providing the right conditions for the private sector to invest across Wales, building on the area's specific strengths. This includes increased research funding (including business expenditure) coming into Wales and increased commercialisation of research by Welsh Small and Medium Enterprises (SME).

The SME sector is responsible for high levels of self-employment and providing work in Wales. Therefore, the European funds since 2000 have been directed at increased research funding coming into Wales and increased commercialisation of research by Welsh SMEs. As a key employer the increased birth rate of SMEs means access to finance for SMEs is a driver for higher employment.

Of the 257,500 Small and Medium sized Enterprises, SME (0-249 employees) in Wales, over 95.5% are in the micro business category. While the total count of micro businesses and their employment increased by 2% and 1.6% respectively from 2017 to 2018, their turnover declined by 20% over the same period. Micro businesses' turnover dropped from £20bn in 2017 to £16bn in 2018 (Economic Intelligence Wales Quarterly report March 2019).

Wales' investment and specialisation in energy opportunities to reduce dependency on fossil fuels includes:

- Welsh Government's €100m commitment to develop marine energy in Wales;
- increasing investment for community renewable energy schemes;
- improved energy efficiency of households facing severe fuel poverty.

In Wales, the Welsh Government has invested more than £240 million since 2011 to improve the energy efficiency of more than 45,000 homes of those on low incomes or living in the most disadvantaged areas of Wales. The Welsh Government is investing a further £104 million in the Warm Homes programme for the period 2017-2021, improving up to 25,000 homes and leveraging up to £24 million of EU funding (The UK's draft National Energy and Climate Plan 2019).

The legacy of coal mining, which originally attracted and built dedicated communities to serve a concentration of industries, which are now closed, created infrastructure to transport coal to the ships in docks on the South Coast. The transport infrastructure for workers and families was less important when communities had high employment and the community was self-sufficient. European funds are now focused on improving and connecting citizens in those communities to locations with the higher GVA locations. The virtual internet network (Figure 39) and physical multi-modal public transport networks are necessary to improve travel times, improve public transport connections to employment centres and enhanced ICT networks.

The European programmes have targeted research and increased commercialisation of research by SMEs. The R&D expenditure in Wales as a percentage of gross domestic product (GDP) remains low.

The *Welsh European Funding Office 2014-2020 ERDF East Wales OPERATIONAL PROGRAMME* reported lower levels of R&D investment across Wales with fewer world-class institutions and specialisation clusters, fewer R&D intensive businesses, but also the potential for more RD&I to be carried out in Wales by those multi-national R&D intensive businesses with a Welsh presence.

Infrastructure

The main highway travelling along the coalfields East to West Wales is the motorway M4 (Figure 38). The main rail line follows the same route. The aim for Wales' metro system in East Wales is to connect communities in the Valleys located North of the M4. There are plans to improve the M4 and electrify the rail network (passenger and freight) westward and complete a multi-modal metro, which require billions of pounds in capital investment. The need for co-

investment from the UK, Welsh Government and also private sector in these transport schemes to connect people and businesses, to employment and improved trading capacity, will demand borrowing.

The final dedicated “coal train” stopped in 2017. This supplied thermal coal from *Ffos-y-Fran* mine to the *Aberthaw Power Station* owned by German company RWE. No Welsh domestic coal has replaced this supply.

The one Welsh licensed mine in operation, and those on “care and maintenance” if re-started, will rely on traffic movements on minor and major road networks.

The seaports (Figure 38) to receive imported coal are located south of the M4 motorway. The ports include Trust Ports and the majority are operated by Associated British Ports. The Welsh sectors importing coal for steel or cement will have access to quayside terminals located near their furnace operations.

The main airport located near Cardiff hosts domestic and international flight routes and is a major British Airways centre for Maintence, Repair and Overhaul. The airport includes carriers for national (UK) distribution services. The airport is owned by the Welsh Government.

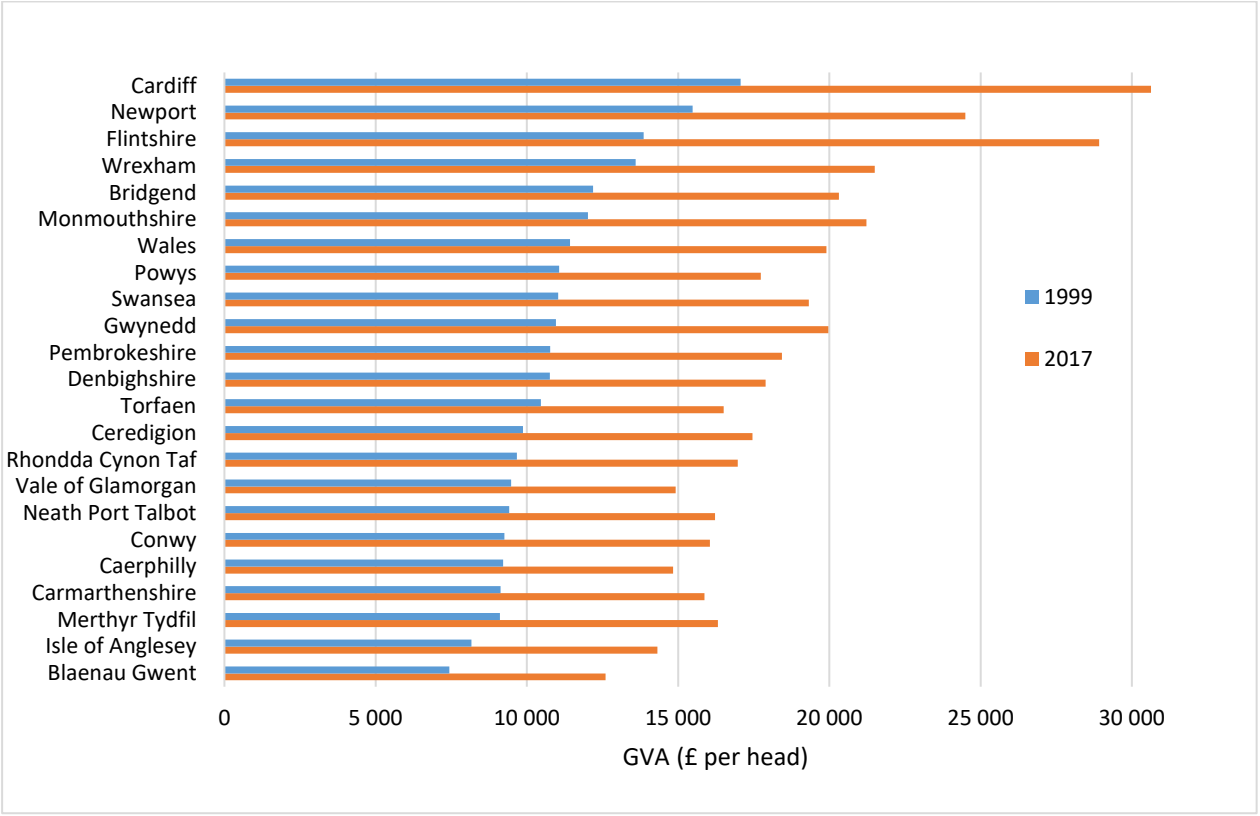

Figure 37: Gross Value Added (GVA) per head in 1999 and 2017 by local authorities in Wales

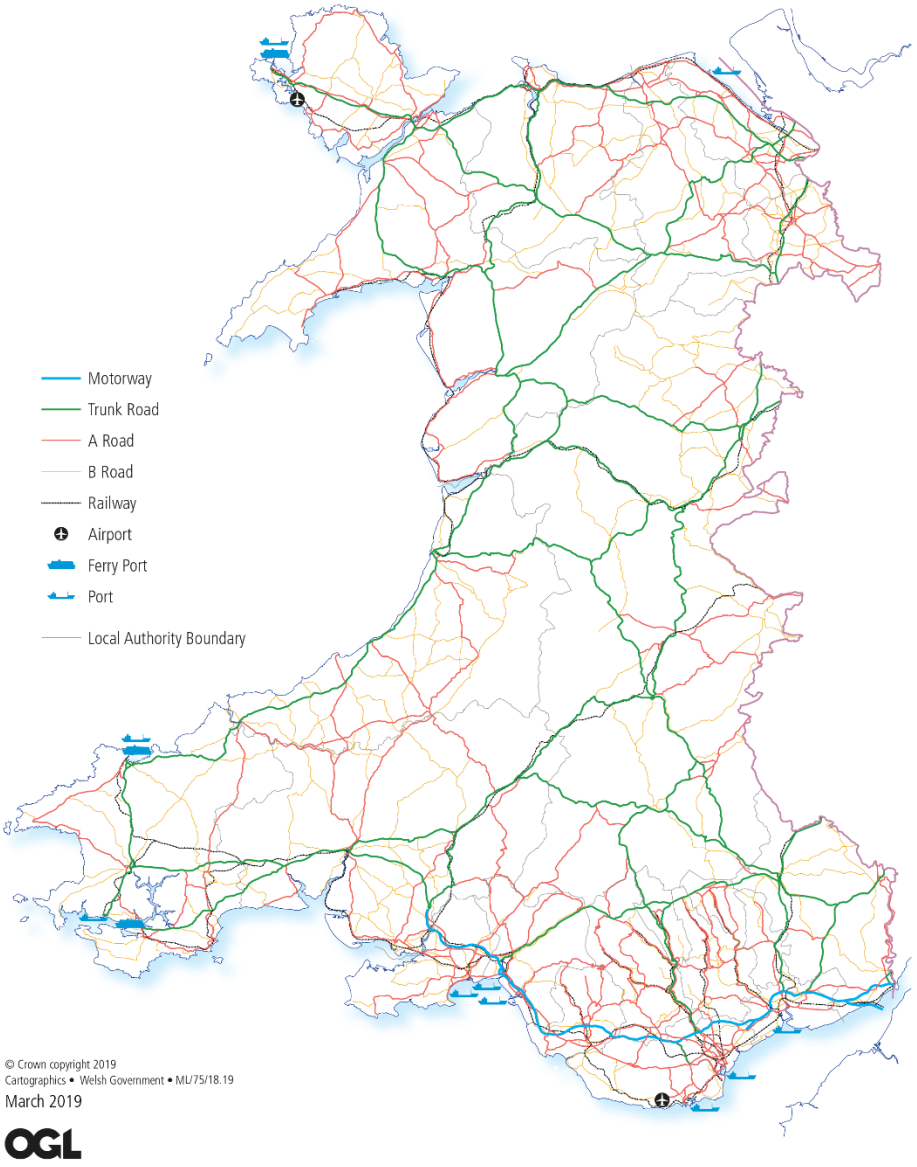

Figure 38: UK: Transport Infrastructure in Wales

Source: Ordnance Survey

There are three motorways in Wales; these are the A48(M), M4 and the M48.

The three most important ports in Wales meet specialised shipping needs:

- Milford Haven handles mainly crude oil, oil products and liquefied natural gas;
- Port Talbot imports iron ore and coal mostly for the adjacent steelworks;
- Holyhead is the main port for freight and sea passenger transport with the Irish Republic.

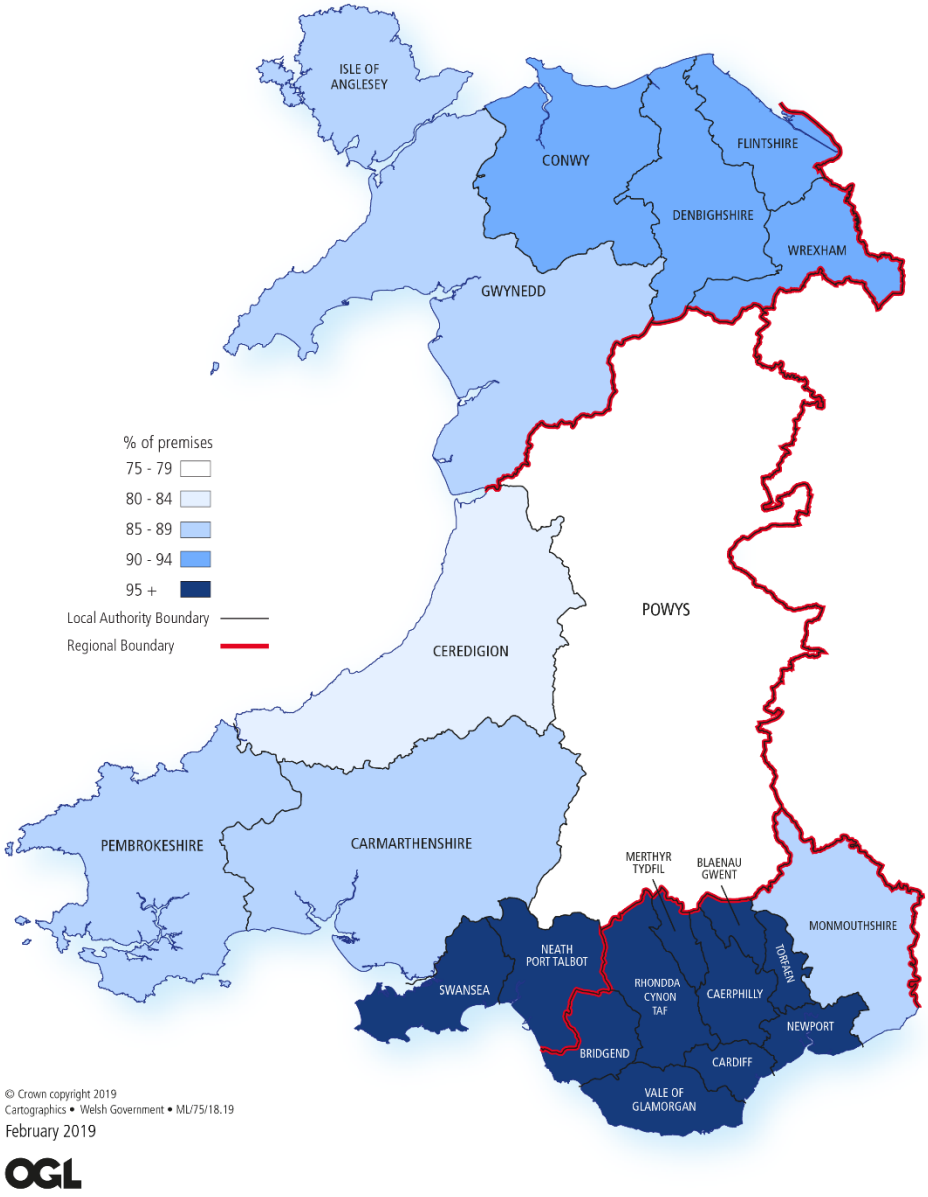

Figure 39: UK: Digital Infrastructure Percentage of homes and businesses with superfast or ultrafast broadband availability by local authority, September 2018

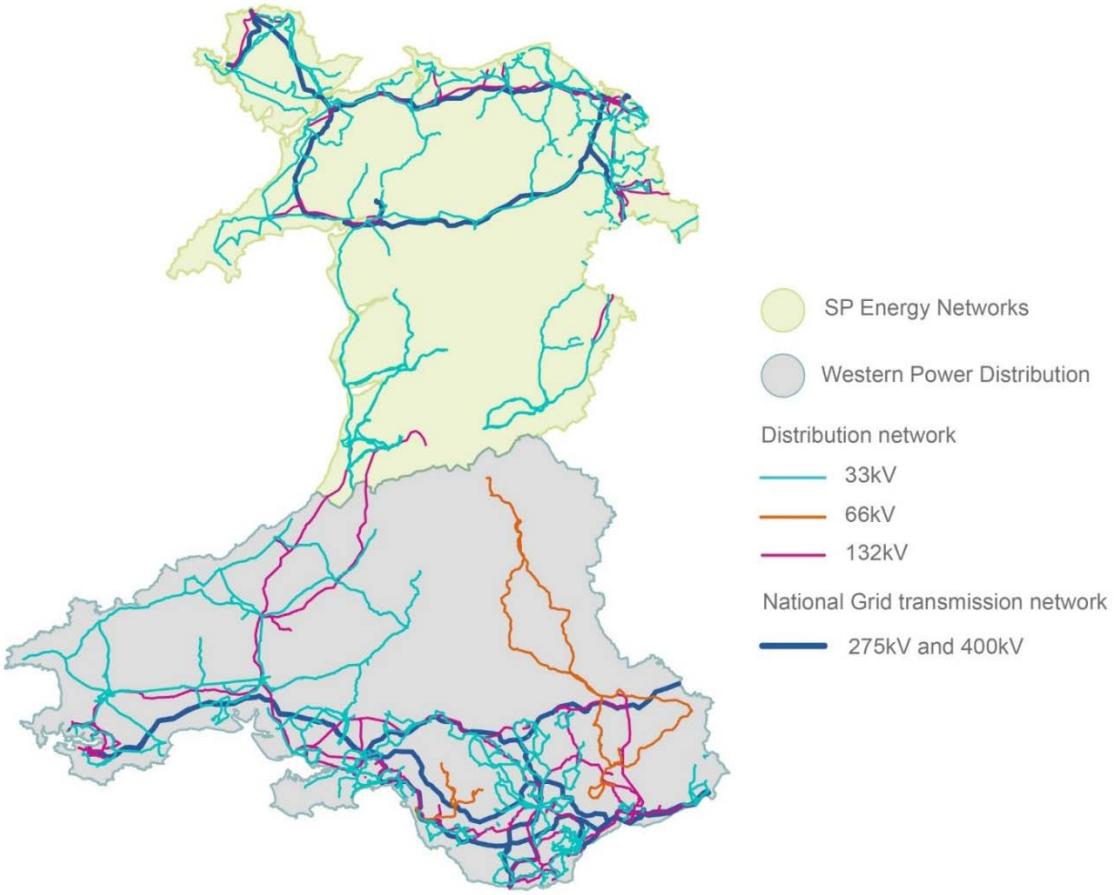

Figure 40: UK: Wales' Electricity Network

Credit: MyCarto

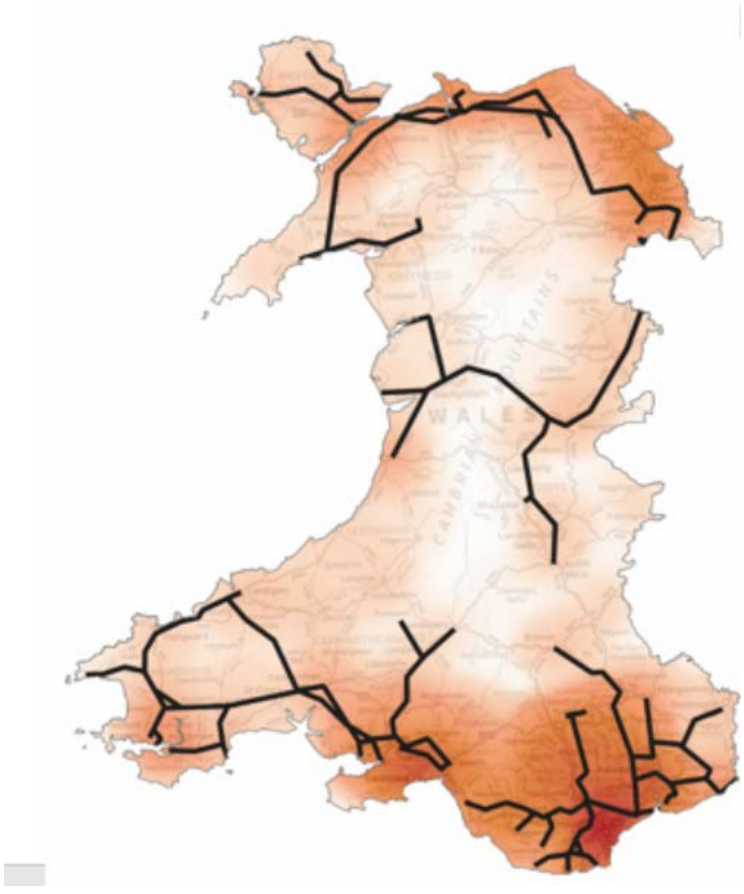

Figure 41: UK: Wales' Gas networks and Housing density

11.1.4 Environmental situation

Wales has a total area of 20,736 km^2 (8,023 sq miles) of which 80% is devoted to agriculture.

Wales' Workplace employment by Welsh local areas and broad industry shows that in 2017 employment in the agriculture and forestry and fishing industry was 40,500. The production industry has an employment level of 164,500. The *Wholesale, retail, transport, hotel and food* industries is far greater with a workplace employment level of 331,500 and the largest industry is *Public administration, defence, education and health* with a workplace employment level of 422,400. The high employment industries are therefore in concentrated areas and the land use does not sustain the majority of the workforce. The location of UK Government main central agencies for UK Government Tax, Intellectual Patents, Vehicle Registration and UK Government Statistics increase employment in the Public Administration sector.

Geography South Wales Coalfield

A major geological feature of the Upper Carboniferous rocks in south Wales is the south Wales coalfield. The rocks comprising this important area were laid down during the later Carboniferous. This sedimentary succession includes a sequence with a thickness of more than 1,800 m (5,906 ft) in the west. The coal measures were laid down on a low-lying waterlogged plain with peat mires immediately south of an ancient and persistent geological feature known as the Wales-London-Brabant High. Burial converted the peat deposits to thinner coal seams. Later earth movements distorted the coal-bearing strata, and the difficulty of mining led to premature closure of many mines on economic grounds, especially in Pembrokeshire where seams were squeezed completely out of shape (Data at August 2019, data source: Wikipedia).

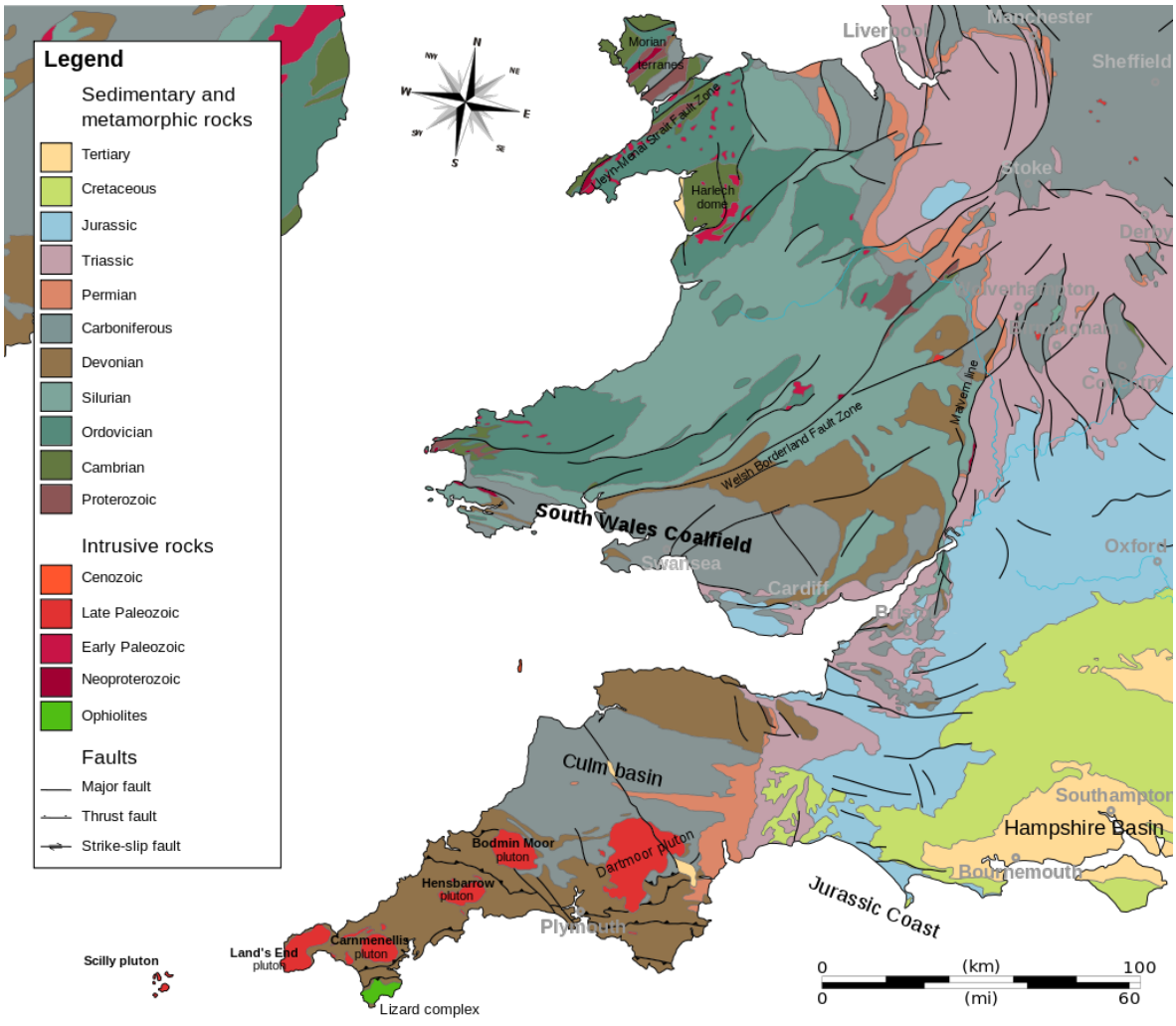

Figure 42: UK: Geologic map of Wales and south-west England Map

Source: British Geological Survey; 2005

Coal deposits in Wales are located in the UKL1 & 2 region. The South Wales Coalfield covers an area of approximately 2,000 km^2 measuring roughly 90 km from east to west and 27 km from north to south. It also extends offshore in Swansea Bay and Carmarthen Bay. The coalfield was extensively mined, principally over the last 200 years, with a peak production of approximately 57 million tons in 1913. The majority of the productive coals are found in the Lower and Middle Coal Measures formations. The coal is thickest in the western and south western parts of the coalfield, thinning to the east. The rank within the South Wales Coalfield ranges from high volatile bituminous coal in the south and east to anthracite in the north-west (Jones et al., 2004) (Welsh Government: A Study of Potential Unconventional Gas Resource in Wales 2013).

The geography of the South Wales coalfield is described in the International Institute of Sustainable Development (IISD) report in 2017. The South Wales coalfield is an elongated basin, with a rim of millstone grit and carboniferous limestone with an up-fold in the centre which brought coal deposits comparatively near the surface. Deep north-south valleys cut through these formations providing access to coal seams through their sides and deep vertical shafts, producing bituminous coal in the east, high-grade steam coal in the central coalfield, and anthracite in the west. Faults in coal seams were numerous throughout the geological formations. Mining communities were -and remain - tucked into the floors of these inaccessible valleys around the pit heads, precisely reflecting the pattern of mining activity.

The South Wales coalfield is synonymous with the term “the Valleys” but care needs to be taken in using this term because it would be convenient to regard the coalfield as a homogeneous area.

The southern mouths of the valleys are closer to the coastal strip and the key ports of Port Talbot, Swansea, Cardiff and Newport and benefited accordingly. The most isolated and inaccessible northern reaches of the Valleys, are known as the “Heads of the Valleys”.

11.2 Role of coal mining in the region

11.2.1 Coal sector in the region

The coal industry of south and north-eastern Wales first reached truly large proportions in the late eighteenth and early nineteenth centuries feeding the fuel-hungry iron and copper industries. However, by the mid-nineteenth century the great steam-coal trade of south Wales was beginning to dwarf even this. Coal exported principally from Cardiff was fuelling huge international steamship fleets and the Cardiff Coal Exchange determined the world price for such coal. Production peaked in 1913, at which time it had one of the largest outputs of any coalfield in the world.

Well over 2,000 collieries are thought to have operated in Wales. The industry was at the heart of the industrial revolution in Wales. Coalmining has been a significant activity in its own right and for its integral role in other key Welsh industries.

Coalmining was a mainstay of the Welsh economy from the eighteenth century onwards, both as a direct wealth creator and as the supplier of fuel to other industries. At its peak around 1914 coalmining in Wales employed a quarter of a million people: one in four adult males in the country as a whole, and three in four in the Valleys (Hughes 1994).

The decline in demand for Welsh coal began before the scientific community identified fossil fuel combustion as a significant contributor responsible for climate change. The UK Government under Prime Minister Thatcher introduced a wide programme of public assets disposal. The Case study: Welsh coal-exit – A policy package for regional economic regeneration (A. Marques 2019 indicates the UK policy was not founded on ambitions to decarbonize and address climate change. During the period when coal mining was a significant supplier of fuel for power, the coal sector required financial subsidies to compete in energy markets. Also, financial intervention to prepare for a UK Government policy to reduce state ownership of the coal industry.

“The short-term response of the UK government to the abrupt loss of employment from coal mine closures in the 1980-1990s, recognizing the serious socio-economic impacts of pit

closures and the concentration of redundancies in particular localities, consisted of subsidies to sustain the coal mining industry until privatization, thus enabling phasing of mine-closures, and a package of measures to assist coal mining communities, including welfare payments (UK DTI, 1993)."

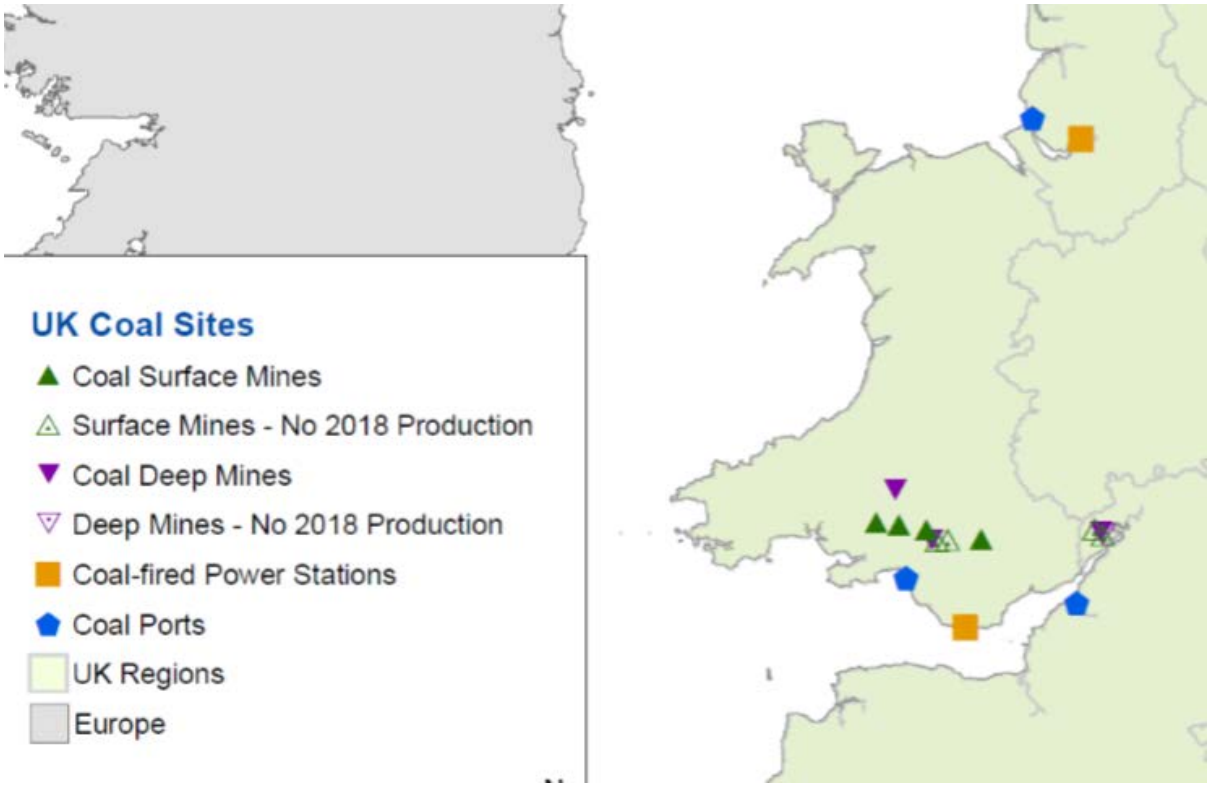

Figure 43: UK: Wales & England coal production sites & ports 2018. In 2019 production at Surface Mine, East Pit

Wales' coal mines licensed in 2019

In Wales in 2019 the licensed sites producing coal are limited to Celtic Energy's East Pit producing coal. The volume extracted was reported at 450,000 mt in 2018. The additional 7 licenced sites are on a "Care and maintenance" regime. The majority of mines in Wales were deep hard-coal mines, not open/surface extraction, though the planning applications for new mines include deep and surface mining.

The Welsh annual coal output peaked at 60.3 million tons by 1913, and employment peaked at 290 thousand miners at the end of the First World War.

Employment in coal mining during the 2015 – 2018 period is at estimated 400 persons.

Table 97: UK: Wales coal output millions tonnes & employment 2016 - 2018

	2016	Staff	2017	Staff	2018	Staff
Deep Mine	0.01	6	0.00	4	0.01	90
Surface Mine	2.4	415	1.2	294	1.0	280
Total	2.4	421	1.2	298	1.0	350

National Statistics Digest of UK Energy Statistics

The last 3 decades have seen a consistent demand for opencast coal but the deep mines have almost ceased. The opencast mines in Wales in 1997 extracted 1,753,000 tonnes and this declined to 1,210,000 tonnes in 2005. Deep mines in Wales in 1997 produced 756,000 tonnes and in 2004 extracted 431,000 tonnes (Taylor et al 2006).

The final coal-fired electricity generation plant in Wales is Aberthaw 1.56 MW power station. There are no coal heat plants in operation. Aberthaw will be supplied from imported coal or stocks held since Ffos-y-Fran mine stopped the coal train service in 2017.

The coal imports for individual power stations and steelmakers are not recorded. During 2019 Aberthaw was operating at a capacity factor of just 3 percent before the announced closure in March 2020. With the loss of 180 jobs in the direct operation of the plant.

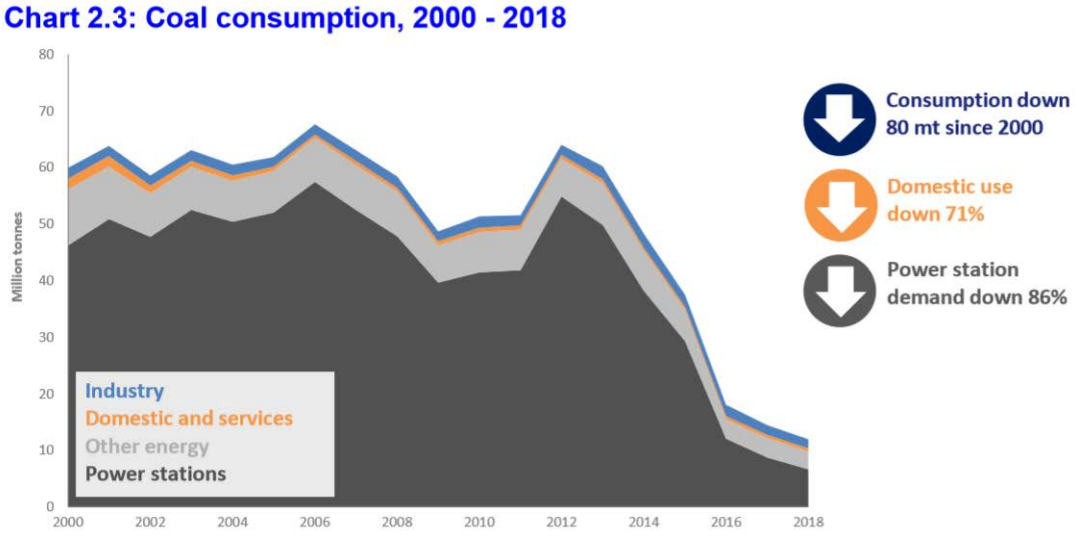

Figure 44: UK: Coal consumption

Source: National Statistics Digest of UK Energy Statistics (DUKES): solid fuels and derived gases

Cardiff Business School's study The Economic Impact of Tata Steel in Wales illustrated that since 2011 Tata's steel works was the most economically important private sector company in Wales. For every employee within Tata, another 1.2 jobs are supported throughout Wales, together totalling almost 18,000 full time equivalent jobs.

The company supports £3.2bn of output and £1.6bn of value added in Wales, as well as contributing to the development of much needed innovation and R&D activities in the region.

11.2.2 Social aspects

Due to the very low number of coal extraction and processing jobs in Wales there is no specific coal-related quantitative data to provide a description of social aspects. Related businesses, in and outside the region consuming Welsh and imported coal, supplies coke and pulverized coal to steel works and coal for milling in the cement sector.

11.2.3 Economic effect

General economic performance of the region

Wales' GVA per head in 2011 was £16,658 per head and £19,899 in 2017. In England, UK the values were £23,402 per head and £28,096 per head in the same periods. Neath Port Talbot was £12,918 and £16,222 per head. There is general economic weakness today in mining communities. However the peak in mining in Wales was a century earlier. Some of the other local authorities in Wales without past coal-related industries also have lower GVA per head values than the UK.

Importance of the mining and generation sector

In Wales in 2019 there is one operational mine providing significant quantities of coal to industry. There remains a very small group of "independent" mines producing hundreds of tonnes without large machinery. The German energy company RWE owns the last coal-fired power station in Wales and ceased purchasing coal from mines in Wales in 2017. Thereafter the coal was imported from overseas to supply Aberthaw power station. This power station will close in March 2020.

The economic effect from direct and indirect coal operations in Wales in 2019 is too low to estimate the value added to the region or economy. The licensed sites in Wales with existing planning permission have applied to extract volumes in 100,000's per annum during the next few years.

Figure 37 provided £ GVA per head values. The values provided for the local authorities of Neath Port Talbot and Merthyr Tydfil are almost half the Cardiff local authority (capital of Wales) £ GVA per head. These two local authorities may benefit from gaining employment provided by the steel industry in Wales with approximately 4000 construction (containing manufacturing) jobs in Neath Port Talbot and 1,300 in Methyr Tydfil.

Mining licenses and land reclamation

The administration of the coal sector is managed by the Coal Authority for the UK. The Coal Act 1994 established the Coal Authorities responsibilities.

Coal functions in the Wales Act 2017 extends to Ministers of the Welsh Government a “veto” on new operations and extensions, not extant licenses which were awarded before the Wales Act powers were introduced in 2017.

The Coal Authority is directed principally by the UK Government’s policies. Welsh Minister’s policies are in agreement with the UK regarding, for example, Underground Coal Gasification and closure of unabated coal-fired power station by 2025. However, Wales does not support coal extraction for energy or unconventional ‘fracking’ intervention techniques to extract coal bed methane. The UK Government has the opposite strategy to develop the industry in the English regions. The Coal Authority will determine coal extraction licenses in Wales and England, but the Welsh Government will use its power of veto to seek to keep coal in the ground.

Individual mine applications require planning consent from the Local Authority e.g Neath Port Talbot County Borough Council. These Council institutions are the Local Planning Authority, LPA and also the Minerals Planning Authority, MPA responsible for granting planning permission and setting restoration terms when the mine closes.

The Welsh Government published Planning Policy Wales Edition 10 in 2018. Ministers have also issued Direction Notices to the Chief Planning Officers for local Planning regions.

The guidance and Direction Notice together set out new requirements for local planning authorities to refer.

Coal related planning applications to the Welsh Ministers, to enable them to decide whether they will “call-in” (review) the application for their determination. The Welsh Minister’s direction instructs the LPA that, where a local planning authority does not propose to refuse an application for coal and petroleum development, the authority must notify the Welsh Ministers.

The remediation of land for coal producing sites is agreed between the coal license holder and the Mineral Planning Authority. The term "Mineral Planning Authority" is that given to any of the authorities with responsibility for planning control over mineral working to local authority and national park authorities in Wales.

The Welsh Government’s report *Research into the failure to restore opencast coal sites in south Wales* was published in 2014. The liabilities associated with coal restoration remain and hence the key conclusions are important. The report states “Bonding and other mechanisms to secure restoration have been applied in a variety of different ways. For some sites, monies accrued to date fall short of the financial liabilities associated with restoration and aftercare to the agreed planning conditions. Sites which are operated by Special Purpose Vehicles pose additional challenges in terms of restoration risk.”

In 2016 guidance was produced by the UK’s Coal Authority, Best Practice Guide on Restoration Liability Assessments for Surface Coal Mines on behalf of the Welsh Government.

Energy Administration organisations, Research and Pricing in UK and Wales

The policy responsibilities shared between Wales and the United Kingdom Government’s are explained in 10.3

Licencing and investment

Approval decisions for large scale planning infrastructure investment like power grids and ownership of coal and coal licensing, onshore and offshore coal fields, remain a reserved

responsibility to the UK Government. Planning decisions for energy generation <350MW and associated development has been transferred to Welsh Government in 2019.

Research and innovation

Public funded energy research is awarded via applications to UK institutions. Existing organisations, for example, Green Steel (Sustain) or new research establishments like Cardiff's UK Geoenergy Observatory are located in Wales to further UK research.

European institutional funding has contributed directly towards both Welsh programmes and also European funding for UK programmes. Awards have been towards research and structural investment within Wales as part of the UK. European Structural Funds in Wales are administered by the Welsh European Funding Office (WEFO).

Economic intervention

UK Government functions transferred from the UK to Wales in 2005 *includes the Welsh Industrial Development Advisory Board*, WIDAB. The Board recommendations are made to the [Welsh Government] Minister for Economy, Science and Transport in relation to financial assistance to industry.

Trade representation

The trade bodies or membership associations representing industry like Coal Importers and The International Steel Trade Association, are Headquartered in England and with Branches in Wales.

Energy contracts & pricing

The process to award long-term contracts for energy generation, supplying to the gas or electric National (UK) Grid operators, is managed and the supply contracts agreed between operators and the UK Government.

The process of setting guaranteed forward purchase prices and payment of incentives to produce energy e.g in technologies with lower carbon intensity than fossil fuels, is managed by the Department of Business, Energy and Industrial Strategy (BEIS) which is a UK Government Department.

The setting of rates and implementation of mandatory tariffs on industry and households to pay for energy 'innovation' and renewables subsidies are managed at the UK level.

Carbon taxation, coal commission payments and Value Added Tax

Taxation on carbon emissions and administration of the European Union Emissions Trading Scheme is managed by the EU Member State which is the United Kingdom.

The Value Added Tax, VAT applied to industrial and domestic household heating and energy which varies between generation sources is the responsibility of the UK Treasury.

The coal "taxation" or royalty fee charged per tonne is approx. €0.20.

Implementation of the Industrial Emissions Directive (which relates to pollution control) within the UK is devolved to the Welsh Government.

Environmental Regulation

Regulations reserved to the UK Government, for example, include Health and Safety, electricity and heat supply, consumer regulation and energy pricing. These roles are not devolved to Wales.

Natural Resources Wales (NRW) is a Welsh Government sponsored body, which became operational from 1 April 2013, when it took over the management of the natural resources of Wales. It was formed from a merger of the Countryside Council for Wales, Environment Agency Wales, and the Forestry Commission Wales.

NRW is the principal adviser to Welsh Government, and adviser to industry and the wider public and voluntary sector, and communicator about issues relating to the environment and its natural resources. The land of the Welsh Government's estate including woodlands is managed by NRW.

NRW is the regulator and protects people and the environment including marine, forest and waste industries, and prosecuting those who breach the regulation.

NRW holds roles and responsibilities like an “environment agency” in Wales including, for example, enforcement of Industrial Emissions Directive requirements.

11.2.4 Environmental effect

The large scale extraction of coal in Wales during the 20th century used mostly deep mining techniques to extract reserves. Following the run-down of deep mining since the Second World War, particularly through the 1980s and 1990s, the opencast operations in South Wales have become the source of the majority of coal worked in the area, with the bigger sites containing about 10 million tonnes, and having depths of excavation as great as 200 m.

Operators of private opencast sites were required to put in place a bond against restoration of the site. The beneficiary of that bond was the Minerals Planning Authority. However, no restoration bonds were required of the new operator nor were restoration bonds applied to sites obtaining planning permission (or extensions to permissions) during the decade following privatisation in 1995. Sites and site extensions obtaining planning permission since 2005 have been the subject of various types of restoration bond and with varying amount of monies accrued (Roderick, E and Griffiths, D.G. 2014).

The findings in the report identifies environmental risk due to mining because coal mine operators face short contacts, price variations and restrictions in coal fuel markets. The effect is “The lack, or inadequacy, of bond protection, coupled with other commercial pressures may at times contribute to a situation where full compliance with planning conditions and successful restoration may not be achieved”. The report concludes that “there needs to be a degree of balance and pragmatism in the setting and management of bonds and also in what constitutes acceptable restoration.” The lesson is: privatization of coal and shifting decision-making and financial responsibility, from the State to lower regional government, in TRACER regions needs to consider liabilities in the decades ahead.

Coal domestic extraction & coal demand

Wales has one single coal mine extracting a few hundred thousand tonnes per annum and no domestic-supplied coal-fired power station. Imported coal supplies the last electricity plant. Non-power industries consuming Welsh coal are steel and cement.

Power station fuel

The remaining coal to electricity plant ceased consumption of domestic coal in 2017 as a result of operator changing sourcing to international suppliers. The UK and Welsh Government is to cease unabated coal-fired power stations by 2025.

Steel

In 2019 the extraction of coal for steel in Wales is below 500,000 mtpa. The total consumption of coal in Wales’ steel industry is estimated at approx. 1.2 million mtpa.

Port Talbot Steelworks is the largest integrated steel plant in the UK and one of the largest in Europe, employing circa 3,900 people. A further 2,500 persons are employed in the supply chain, for example, in galvanising, coating, panels for buildings, packaging and strip steel.

The plant produces approximately 3.8 million tonnes of steel annually using the Blast Furnace/Basic Oxygen Furnace (BF-BOF) method where iron ore is reduced through a chemical process, using primary raw materials including iron ore and coke.

Steelmaking is an energy intensive operation. The World Steel Association has estimated that energy constitutes on average around 20% of the cost of steel production, with energy consumption at an integrated site such as Port Talbot being around 50% coal, 35% electricity, 5% natural gas and 5% other gases. For an Electric Arc Furnace (EAF) the figures are approximately 75% electricity and 25% gas.

In the past 40 years the steel sector has achieved a 40% reduction in energy consumption per tonne of steel produced. The EAF steel manufacture has lower emissions but requires high

volumes of scrap steel supply and energy from electricity. This is produced by fossil fuel sources like gas or nuclear power.

On average, a Blast Furnace integrated plant uses 1,400 kg of iron ore, 800 kg coal, 300 kg limestone and 120 kg of steel scrap to produce 1000 kg of crude steel.

Tata's integrated steel works at Port Talbot is a large source of greenhouse gas emissions. In 2017 the site's greenhouse gas emissions as reported through the EU Emissions Trading System were 6.55 million tonnes, or 16% of Wales' total emissions.

11.3 Coal mining and coal utilization policies

11.3.1 National policy

The "National policy" which determined coal mining and utilization, during the high coal output period in Wales, were policies of the UK Government and not Wales' policies. Following a referendum vote in Wales, the UK Parliament passed the Government of Wales Act 1998. The Act established the National Assembly as a corporate body – with the executive (the government) and the legislature (the Assembly itself) operating as one. The first elections to the Assembly were held in 1999.

The UK National Energy and Climate Plan (NECP) is the framework by which EU Member States are required to set out their integrated climate and energy objectives, targets, policies and measures. Within the UK, energy policy responsibility is largely reserved to the UK Government, with some exceptions.

The Welsh Government has responsibility for climate policy and environmental pollution and emissions reduction policy. The Environment Act Wales sets a long term target of reducing our emissions in Wales by 95% by 2050 and requires us to set interim targets and carbon budgets.

The UK Committee on Climate Change (CCC) the Welsh Government's statutory advisors, have provided their advice on the setting of the targets. Within the CCC's recommended pathway, the level of electricity generation is focused on fossil fuel gas plants, and must reduce substantially in Wales before 2030 and 2050. The emissions from Aberthaw power station, the final coal-fired plant in Wales, have reduced substantially in recent years. The demand for imported power station coal fuel has therefore fallen (Figure 42). Aberthaw will close in March 2020.

The environmental impact, of the main domestic coal consumer in Wales, with a demand for approx. 500,000 mtpa and 700,000 mtpa imported coal, is TATA's Port Talbot Steel Works.

The potential for a merger with steel companies like ThyssenKrupp or rationalization within the TATA group's plants outside the UK, will mean the upstream demand for coal may decide the direction, time and speed of coal's transition in Wales.

The London School of Economics (LSE) report "*Is the UK doing enough to prepare for the last days of coal and the eventual phase-out of oil and gas?*" in 2019, describes the impact of UK coal transition policies. The report stated "Job losses caused by the closure of coal-fired power stations have a profound impact on regional communities" and considers "A lack of foresight, planning and policy frameworks at the national level have caused past failure in transitions away from coal." The national policies referred to are at the UK level. Future transition policies in coal import sectors and alternative fuels like gas will be determined by both Welsh and UK Minister's policies.

The LSE report identified measures to mitigate the impact of closures "Running concurrently with the phasing out of fossil fuels, a clear domestic (UK, Wales) policy on energy workforce transitions is urgently needed. The scale of the challenge in the UK is considerably less than in countries such as Poland, Germany and South Africa – but this should not warrant complacency."

In December 2016 the Welsh Government announced a series of major investments as part of an ongoing programme of support to secure the long-term future of TATA's steel works in Wales. The Welsh Government made available a total of £4m of grants for the financial year

2016-17. The grant scheme *Welsh Government Skills Support for Tata Steel* was intended to support learning designed to improve professional and technical skills relevant both to the steel industry and wider employment market.

11.3.2 Regional and local policy

Lessons learnt & current policies

This section will consider policies since 1999 and the establishment of the National Assembly.

Lessons Learned

An independent report *The End of Coal Mining in South Wales: Lessons learned from industrial transformation* May 2017 (Merrill and Kitson) is a useful statement of lessons for transition. These include: "the need to develop a comprehensive response that includes measures that generate economic activity, improve infrastructure, maintain social cohesion and establish effective institutions to implement the response."

The Welsh Government's Programme for Government's 2016-2021 is *Taking Wales Forward* which sets out how the Government will deliver more and better jobs, improve public services and build a connected and sustainable Wales.

Prosperity for All is the strategy that places the key commitments of Taking Wales Forward in a long-term context and sets out how they fit with the work of the wider Welsh public service to lay the foundations for achieving prosperity.

The National Policy *Planning Policy Wales* (in March 2018) provides direction to the Local Authority and stated that proposals for opencast or deep mine coal should be environmentally acceptable or can be made so by planning conditions or obligations, and there must be no lasting environmental damage.

The Environment (Wales) Act 2016 sets a target for Wales to reducing greenhouse gas emissions by at least 80% from their pre-1990 levels in 2050. The Act also establishes a rigorous and comprehensive statutory process in establishing the level of the interim emissions targets and carbon budgets.

In response to the latest evidence from the Intergovernmental Panel on Climate Change, Welsh Government has received advice from the UK Committee on Climate Change on how meeting the goals in the Paris Agreement might affect Wales' long-term legislative targets. Welsh Government has accepted the Committee's recommendation for a 95% reduction in Wales and intends to legislate to this effect in 2020.

In April 2019 the National Assembly became the first Parliament in the world to vote in favour of the declaration of a climate emergency. Welsh Government has also declared an ambition to reach net-zero by 2050 and will work with the UKCCC and other stakeholders to understand how this could be achieved.

In March 2019 Welsh Government published Prosperity for All: A Low Carbon Wales – the first delivery plan for decarbonisation in Wales. This contains detailed sector-by-sector emissions profiles and 100 policies and proposals to achieve a low-carbon Wales. The plan raises the level of ambition to meet the challenge of climate change to secure maximum benefits for the wellbeing of Wales through the transition to a low carbon economy. The plan includes proposals to develop policy on the combustion of fuels for power and fossil fuel extraction, including new coal developments.

Welsh Government is responsible for preparing the plan to meet the second carbon budget for 2021-26. This plan must take into account the Minister's declaration of the climate emergency and the increases to carbon targets.

Ambitious targets for energy generation in Wales mean there is a target for 70 percent of electricity consumption in Wales to be met by renewable sources by 2030. In 2017, 48% of Wales' electricity consumption was met by renewables generation, a five percentage point increase on 2016.

Welsh Government has also set a target for at least 1 Gigawatt of renewable electricity and heat capacity to be locally owned by 2030, and an aspiration for all new energy projects to have an element of local ownership by 2020. This is to retain economic benefit from the transition to a low carbon economy.

Welsh national planning policy and guidance facilitates the delivery of energy and climate change policies, including Welsh, UK, European and international targets. Welsh Government is currently developing the National Development Framework (NDF) which will set the overall spatial direction for large-scale renewable energy. The NDF consultation will be published in August 2019.

Decarbonisation has been identified as a key theme for the NDF. The NDF adopts the three region model and starts to establish the requirement for regional land use planning in these regions. The Welsh Government has challenging targets for the provision of renewable energy and the NDF must complement cross governmental work to deliver on this.

The policies at the local level, which direct investment and industrial activity, are published in the Local Authority's policies and integrated within the Local Development Plans. These plans are at NUTS 3 level or smaller Council regions.

Following a coal mine application in 2018, to Neath Port Talbot's Local Planning Authority (LPA), the Authority report highlighted "The Wales' Well-being of Future Generations Act requires LPA's to think long term and balance the need to address current issues with the long term needs of Wales". The Planning decision concluded the 2018 mine application was "an opportunity to think long term about the economic prospects of the local community and to develop a strategy for planning for the closure of existing sources of supply."

Wales' new Planning policies for fossil fuel and coal

In December 2018 the Planning Policy Wales Edition 10 was published. The Energy Minerals section 5.10.1 set the Welsh Government position. "The demand for energy minerals has been largely based on power generation. The Welsh Government has set climate change targets for the reduction of greenhouse gas emissions and promoting decarbonisation."

Wales will close the last remaining coal-fired power station in March 2020. At the UK level coal powered generation is being phased out. This means moving away from the extraction of fossil fuel for use in energy generation. In Planning Policy Wales set an energy hierarchy and says that the extraction of minerals for the purpose of generating energy is undesirable as it is the most carbon intensive form of production.

The purpose of this hierarchy is to encourage lower carbon generation proposals to come forward and to discourage proposals supported by the extraction of fossil fuels.

The Local Planning Authority's CEO for Planning are instructed, since December 2018 "where a local planning authority does not propose to refuse an application for coal and petroleum development, the authority must notify the Welsh Ministers."

The Welsh Minister's new competency for approving coal licences ("it shall have effect only if the Welsh Ministers notify the Authority that they approve the authorization") requires the development of Welsh Government's policy position in relation to domestic coal extraction. An evidence review of the impact of coal extraction in Wales was commissioned in 2019. A policy position is expected in 2020.

Prosperity for All – A Low Carbon Wales is Welsh Government's approach to the reduction of fossil fuels, and Planning Policy Wales sets out the current approach to new coal developments. Welsh Government's approach is to address climate change within the existing devolved powers to Wales and also sets ambitions to influence the UK Government to develop policies which will impact Wales.

Fossil fuels are placed at the bottom of the planning energy hierarchy, which emphasises that the drivers for planning choices are decarbonisation and addressing climate change. However, coal mining is still continuing in Wales, providing coal for a range of purposes including steelmaking, domestic heating which includes low quantities of concessionary (life time benefit) coal for ex-miners.

The Welsh Government has set climate change targets for the reduction of greenhouse gas emissions and promoting decarbonisation. The continued extraction of all fossil fuels, including shale gas, coal bed methane and underground coal gasification, are not compatible with those targets.

Present policies aim to balance a rapid transition to the clean energy industries that are replacing coal, in a way that preserves and protects the places where people live and work.

Any license issued by the Coal Authority for additional coal extraction will not take effect without the approval of the Welsh Ministers. Any decisions on new licenses will be made on the basis of both the climate emergency and the principles enshrined in the Wellbeing of Future Generations Act, of delivering a prosperous low carbon Wales.

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Chart 2.3 [UK] Coal Consumption

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12 Conclusions

This report outlined the current situation and policy intentions in 9 European coal-intensive regions facing the challenge of transition towards low-carbon economy.

Coal mining and coal utilization play very different role across regions. The volumes in the Polish and German regions are the largest, while the ones in the Romanian and UK regions – the lowest.

In most regions, the coal-related businesses take a serious share of the employment and gross value added (GVA), especially in the Bulgarian, Greek, and Serbian regions. In many regions, however, both the sectoral employment and GVA are going down. The most striking examples are Germany and Romania, where the jobs in coal mining decreased 10 times for one or two decades. The reduction is attributed to both the diminishing coal production and utilization, on one hand, and increasing mechanization and rationalization.

The current employment in the sector consists predominantly of old people, especially in the mines approaching their end-of-life. The education level is low. Nevertheless, as a general rule, the salaries are much higher than the region and country average. The male employees are much more than the females.

In the majority of the countries, the coal regions are more developed than the country average in terms of economic indicators and infrastructure.

Coal mining and burning cause serious environmental and health problems in all regions. In most cases, however, a positive trend is observed, either due to the reduction of coal activities, or due to the introduction of advanced pollution control technologies. Despite that general trend, the land damaged by coal mining increases in some regions, due to untimely recovery.

All target countries, except for Ukraine, are obliged to contribute to the 2030 and 2050 EU targets for emission reduction, renewable energy, and energy efficiency and these obligations are currently part of the national energy strategies and / or National Energy and Climate Plans.

The nine countries have different vision and priorities regarding coal sector, only some of which are in line with their “green” declarations and commitments. Wales will close the last remaining coal-fired power station in 2020. Germany, Romania, Greece, and the Czech Republic have committed to substantially reduce and / or eliminate coal mining and use, although coal will continue to play an important role in the next two decades. Germany, Romania, and Greece have already significantly decreased their coal volumes. Germany decided to phase-out coal until 2038. Romania plans to reduce its use so that by 2030 only 20.5% of its electricity originates from coal. Greece intends to phase out all lignite power generation by 2028, and the Czech Republic to decommission the old coal-fired plants until 2025 and after that to continue the decrease of coal use until 2040.

In Bulgaria, Poland, Serbia, and Ukraine, on the other hand, coal mining and utilization remains a priority in the long term. In Bulgaria lignite mining and utilization is planned to continue at least until 2050, although the quantities decrease over time. In Poland, in 2030, 60% of the electricity is expected to come from coal and there are no plans for its role after 2030. In Serbia and Ukraine, the indigenous coal resources will continue to be a pillar of the electricity system in the next decades.

In relation to their future intentions about coal, some countries are much more advanced in planning the regional transition towards carbon-free economy - improvement of the local environment, re-skilling of the workforce, stimulation of new start-ups, etc. For example, in Wales and Germany there is much clarity what need to be done, based on their past experience (lessons learned) and long-standing discussions. On the other hand, in Bulgaria, Serbia, and Ukraine no concrete plans to ensure sustainable transition have been reported. Most countries have indicated potential public financial sources to support some aspects of the regional transition, but the financing is still not arranged.

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