DeCarb – Supporting the clean energy transition of coal-intensive EU regions

Final Report

Reference case study and SWOT analysis identifying the most advantageous growth areas in relation to the existing workforce and territorial specificities in order to create alternative to coal-driven activities

DeCarb
Interreg Europe

European Union
European Regional Development Fund

28th May, 2019

NORDJYLLAND
Jyllandsgade 1
DK–9520 Skørping
Tel. +45 9682 0400

MIDTJYLLAND
Vestergade 48 H, 2. sal
DK 8000 Århus C

SJÆLLAND
Postadresse:
A.C. Meyers Vænge 15
DK 2450 København SV

www.planenergi.dk
planenergi@planenergi.dk
CVR: 7403 8212

Table of Content

1 Executive summary 5
2 Glossary 12
3 Introduction 14
4 Present situation (Reference case) 17
4.1 Energy demand, coal consumption and efficiency potential related to coal fuel 18
4.1.1 Bulgaria – Yugoiztochen region 18
4.1.2 Denmark – Nordjylland region (example) 22
4.1.3 Germany –Lausitz-Spreewald region 25
4.1.4 Greece – Western Macedonia region 29
4.1.5 Hungary – Észak-Alföld region 33
4.1.6 Poland – Lodzkie region 36
4.1.7 Romania – South-West Oltenia region 39
4.1.8 Slovenia – Savinjska region 44
4.1.9 Spain – Extremadura region 48
4.2 Energy sources for alternative energy production 51
4.2.1 Bulgaria – Yugoiztochen region 51
4.2.2 Denmark – Nordjylland region 54
4.2.3 Germany –Lausitz-Spreewald region 60
4.2.4 Greece – Western Macedonia region 66
4.2.5 Hungary – Észak-Alföld region 71
4.2.6 Poland – Lodzkie region 75
4.2.7 Romania – South-West Oltenia region 80
4.2.8 Slovenia – Savinjska region 87
4.2.9 Spain – Extremadura region 98
4.3 Heat distribution infrastructure 102
4.3.1 Bulgaria – Yugoiztochen region 102
4.3.2 Denmark – Nordjylland region 103
4.3.3 Germany – Lausitz-Spreewald region 106
4.3.4 Greece – Western Macedonia region 108
4.3.5 Hungary – Észak-Alföld region 110
4.3.6 Poland – Lodzkie region 111
4.3.7 Romania – South-West Oltenia region 113
4.3.8 Slovenia – Savinjska region 115
4.3.9 Spain – Extremadura region 118
4.4 Workplaces connected to coal value chains 119
4.4.1 Bulgaria – Yugoiztochen region 119
4.4.2 Denmark – Nordjylland region 121
4.4.3 Germany –Lausitz-Spreewald region 124
4.4.4 Greece – Western Macedonia region 128
4.4.5 Hungary – Észak-Alföld region 132
4.4.6 Poland – Lodzkie region 134
4.4.7 Romania – South-West Oltenia region 136

PlanEnergi

The report created by
PlanEnergi Nordjylland

Per Alex Sørensen
Nordjylland
Mobil +45 4058 2498
pas@planenergi.dk

Magda Kowalska
Nordjylland
Mobil +45 2266 9219
mk@planenergi.dk

Internal project ref.: 19-008

Customer
House of Energy
Boulevarden 13
9000 Aalborg
Denmark

Project
DeCarb

www.planenergi.dk
planenergi@planenergi.dk
CVR: 7403 8212

4.4.8 Slovenia – Savinjska region 139
4.4.9 Spain – Extremadura region 143
4.5 General employment pattern 145
4.5.1 Bulgaria – Yugoiztochen region 145
4.5.2 Denmark – Nordjylland region 146
4.5.3 Germany – Lausitz-Spreewald region 148
4.5.4 Greece – Western Macedonia region 150
4.5.5 Hungary – Észak-Alföld region 151
4.5.6 Poland – Lodzkie region 152
4.5.7 Romania – South-West Oltenia region 153
4.5.8 Slovenia – Savinjska region 155
4.5.9 Spain – Extremadura region 157
4.6 Educational and research capacities 158
4.6.1 Bulgaria – Yugoiztochen region 158
4.6.2 Denmark – Nordjylland region 160
4.6.3 Germany – Lausitz-Spreewald region 163
4.6.4 Greece – Western Macedonia region 165
4.6.5 Hungary – Észak-Alföld region 167
4.6.6 Poland – Lodzkie region 168
4.6.7 Romania – South-West Oltenia region 170
4.6.8 Slovenia – Savinjska region 174
4.6.9 Spain – Extremadura region 177
4.7 Innovation culture and experience in private sector178
4.7.1 Bulgaria – Yugoiztochen region 178
4.7.2 Denmark – Nordjylland region 179
4.7.3 Germany –Lausitz-Spreewald region 181
4.7.4 Greece – Western Macedonia region 184
4.7.5 Hungary – Észak-Alföld region 185
4.7.6 Poland – Lodzkie region 186
4.7.7 Romania – South-West Oltenia region 187
4.7.8 Slovenia – Savinjska region 188
4.7.9 Spain – Extremadura region 191
4.8 Political and organizational restructuring support instruments 192
4.8.1 Bulgaria – Yugoiztochen region 192
4.8.2 Denmark – Nordjylland region 193
4.8.3 Germany –Lausitz-Spreewald region 195
4.8.4 Greece – Western Macedonia region 196
4.8.5 Hungary – Észak-Alföld region 197
4.8.6 Poland – Lodzkie region 198
4.8.7 Romania – South-West Oltenia region 201
4.8.8 Slovenia – Savinjska region 202
4.8.9 Spain – Extremadura region 205
4.9 Financial support for energy conversion investments206
4.9.1 Bulgaria – Yugoiztochen region 206

4.9.2 Denmark – Nordjylland region 207
4.9.3 Germany –Lausitz-Spreewald region 208
4.9.4 Greece – Western Macedonia region 209
4.9.5 Hungary – Észak-Alföld region 210
4.9.6 Poland – Lodzkie region 211
4.9.7 Romania – South-West Oltenia region 212
4.9.8 Slovenia – Savinjska region 213
4.9.9 Spain – Extremadura region 216
5 SWOT analysis 217
5.1.1 Bulgaria – Yugoiztochen region 218
5.1.2 Denmark – Nordjylland region 220
5.1.3 Germany –Lausitz-Spreewald region 224
5.1.4 Greece – Western Macedonia region 227
5.1.5 Hungary – Észak-Alföld region 228
5.1.6 Poland – Lodzkie region 229
5.1.7 Romania – South-West Oltenia region 233
5.1.8 Slovenia – Savinjska region 235
5.1.9 Spain – Extremadura region 238
6 List of tables 239
7 List of figures 245
8 References 252

1 Executive summary

The SWOT analysis aims to determine decarbonization growth pathways in partners' territories. All nine participating partners have processed territorial evidence on the strengths, weaknesses, opportunities and threats of the clean energy transition, to identify suitable growth areas in relation to their existing workforce and specificities.

The individual findings on the reference case describing the existing situation are compiled in this master report along with a SWOT analysis, linking proposed growth trajectories with labor re-skilling needs.

- Conclusions from the reference case.

This section collates the conclusions from studies of all 9 nations which are compared using the KPI factors. These are calculated for the key parameters, as for instance, total coal consumption or electricity production using RES and are expressed a parameter divided by a thousand of citizens in the total population of the region (see 3 Introduction for the detailed formula).

The following graph shows the KPI indicators derived for heat and electricity production using coal fuel (left vertical axis) and the overall coal consumption in the region (right vertical axis). This demonstrates that the highest concentration of the coal intensive industries is in the Western Macedonia (Greece) and Savinjska region (Slovenia). These regions house all coal-fired plants and supplies electricity to the rest of the country. The coal-related KPIs in the remaining locations are below 5 GWh of coal energy production and total coal consumption per 1000 of the regional population.

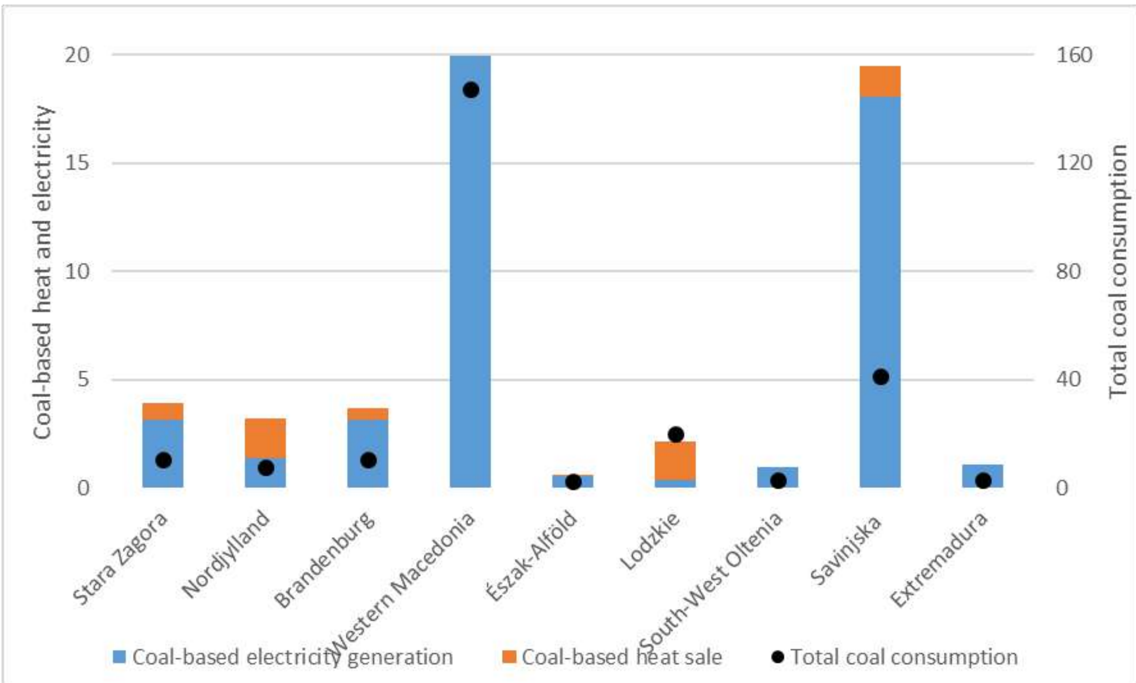


Figure 1 Comparison of coal-fueled energy production (left vertical axis) and total coal consumption (right vertical axis) among the regions, (GWh/1000 of population).

The next two graphs illustrate the proportions of renewable energy production per 1000 of citizens along with a detailed breakdown by energy source. The common feature for all regions is the key utilization of a biomass and renewable waste for RES heat supply. This values peaks in particularly for the Nordjylland and Savinjska region. The heat supply using renewables in Stara Zagora is negligible as below 0.1 GWh/1000 of population. The heat production is also insignificant in the Extemadura region, however this refers to the total heat production, not only renewable one. The RES energy production breakdown for South-West Oltenia has not been available.

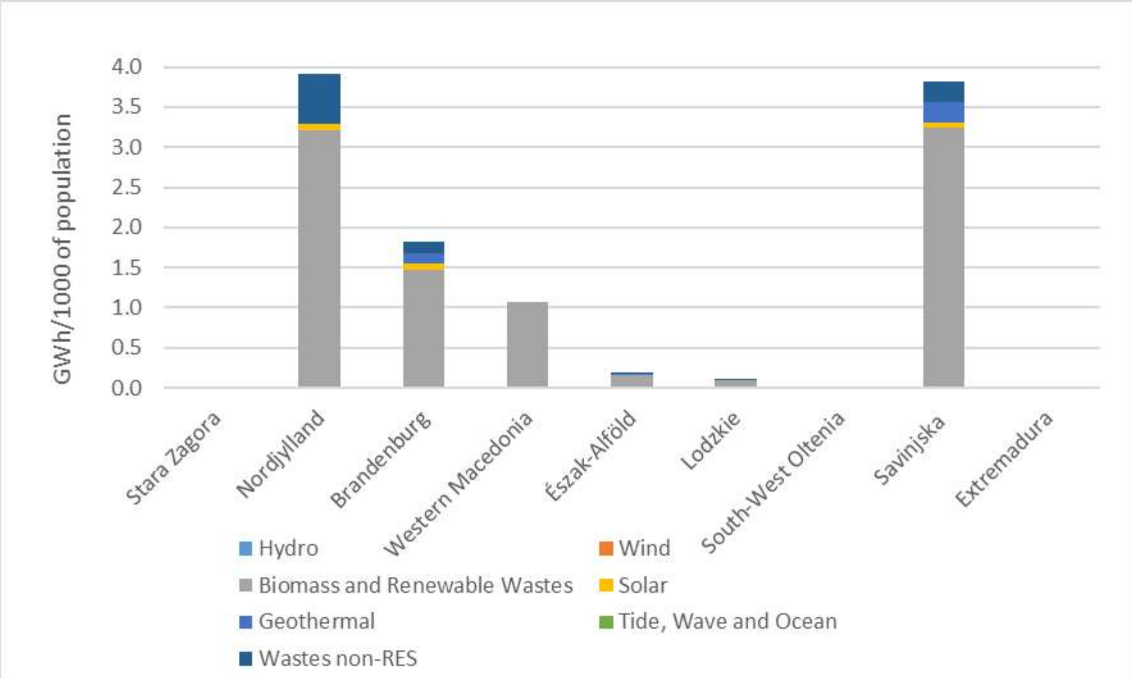


Figure 2 Comparison of heat production using renewable energy among the regions, (GWh/1000 of population).

The highest ratio of RES electricity production per 1000 of citizens is indicated for Extremadura, Nordjylland and Észak-Alföld. The Spanish region relies on combination of solar and wind power, while north part of Denmark is almost entirely dependent on wind energy. The Hungarian region shows a great contribution of hydro power, supplemented with wind and solar energy.

The lowest utilization of renewable sources for electricity production is demonstrated for Bulgarian (Stara Zagora) and Polish (Lodzkie) regions. In this case, the total annual electricity production from RES is below 0.5 GWh per 1000 of population.

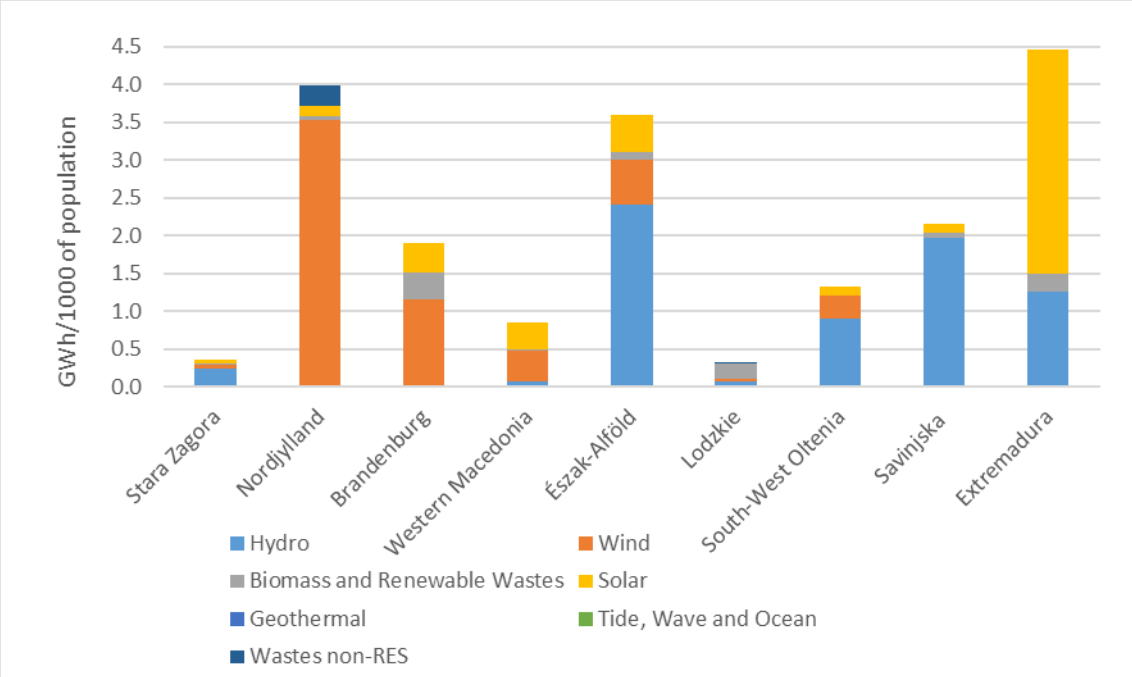


Figure 3 Comparison of electricity production using renewable energy among the regions, (GWh/1000 of population).

The following graph illustrate the comparison of number of employees hired directly in the coal industry (mines, power plants) and in the correlated sectors (intra and inter regional jobs) between the regions. The highest ratio of the professional market allocated to the coal-related sector is present in Stara Zagora and Wester Macedonia. The largest dependence on jobs in the coal mining and coal-fired power plants exceeding 10 employees per 1000 of population is indicated for Stara Zagora, Western Macedonia and South-West Oltenia.

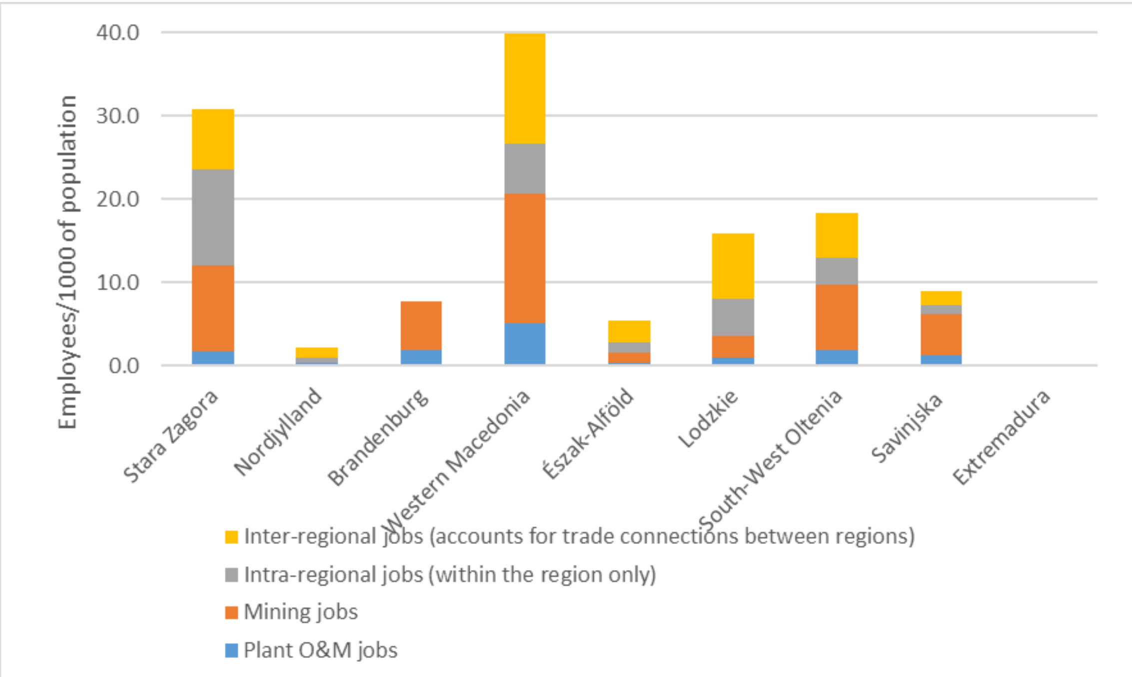


Figure 4 Comparison of work positions in the coal industry among the regions, (GWh/1000 of population).

- Conclusions from the SWOT analysis.

Stara Zagora

The region perceives their strengths in the existing national economic development plan that follows the EU RES policy and historically accomplished ecological projects that can prove the ability of the country to undertake the coal sector transformation.

The weak sides include low efficient wind generators developed locally and lack of alternative renewable sources. This also includes a high investment cost for the 'green' technologies and insufficient internal financial resources for realization of projects for renewables. The R&D in the energy sector is also limited.

The region sees the opportunities in building combined plans with a high-efficiency, low-capacity facilities, using new technologies, which are environmentally friendly.

The potential threats include legislative uncertainty in the legal framework and long-term policies and lack of investments and business initiatives in the sector.

Nordjylland

The strengths of the region in the phasing out coal-intensive sector, include the large wind and solar energy resources and excess heat from industry that along with the well-developed DH system could replace the remaining coal-based energy supplies.

The private sector historically proved to quickly adapt to the changing market when many employees in ship building, cement and chemical industry retrained to work within production of wind power equipment, biogas, solar thermal, large scale heat pumps, control systems.

The weakness is that existing coal fired plant that is being decommissioned in the next decade is one of the most efficient in the world or the challenge of storing renewable energy.

The region sees its opportunity in becoming a forerunner in demonstrating how the coal based heat and electricity (Nordjyllandsværket coal plant) can be replaced with a new smart, hybrid energy system with electricity from wind and solar and heat from industrial production (excess heat), thermal storages, solar thermal, heat pumps using different heat sources and also geothermal heat.

The threats include cheap CCS technologies that might be more economical attractive than transition to RES or that boundary conditions for district heating can be changed making individual systems more attractive and thus reduce the total flexibility in the energy system.

Lausitz-Spreewald

The region perceives their strengths in the large potential of wind, solar and geothermal energy that could replace the coal-based heat and electricity production. The liabilities after the final phase-out of coal mining in Germany) will be funded by a very well financed program by German Government which ensure financial security for the transformation. The region also aleradt developed multiple strategies for transition of Lauisitz-Spreewald to RES in the heating and electricity sector which is very good backed up by politicians.

The weak sides of the region include limited DH infrastructure that would enable quick integration of dispersed RES plants. The key issue is also the cost of coal-based heat and electricity which is still the cheapest source of energy.

Lausitz-Spreewald state can, however, take advantage of decarbonization trends in the energy sector and develop new industrial value chains through the expansion of renewable energies, the large-scale production of hydrogen, the refurbishment of energy buildings and the energy-optimized urban and rural transformation. Additionally, the post-mining sites can become redeveloped and converted into a solar energy park.

The new proposal of the government coal commission aiming at phasing-put coal intensive industries entirely by 2038 may face delays in order to maintain the energy security which is a potential threat to the coal transition.

Western Macedonia

The region anticipates its strengths in the research capacities, renewable sources potential and a great importance of the region for the whole nation.

The main weakness is the high dependence of the local economy on the lignite industry activities and fur industry, against other economic activities. This also include a high unemployment rate and lack of foreign investments.

The potential opportunities include empowerment of policies towards to new economic activities (green economy, use of RES, social economy, agriculture of high productivity etc.) and possibilities to reuse the post operational lignite industry installations, by integrating them into the new economic and social reality.

The region anticipates some threats in the coal-phasing out process which is continuation of the environmental degradation of the area and in compliance with European and national commitments regarding the reduction of carbon dioxide pollutants. Moreover, a delay in adopting innovations and new technologies by SMEs could entail a loss of markets in Greece and abroad.

Észak-Alföld

No SWOT analysis provided.

Lodzkie

Lodzkie region is one of the best developing voivodships in the country in the field of renewable energy sources RES. The region has a large potential of biomass, geothermal waters and wind which is it's a definite strength. Moreover, the region has a large educational and research capacity which is a strong point of the Lodzkie Voivodeship. Besides that fact, Poland has legislation to promote the transition from coal-based energy to clean energy, such as : Clean Air, Energy Policy of Poland until 2030.

Among key weaknesses is the high rate of job loss in the coal industry which involve up to 20,000 work places. The other issue is the current share of energy from renewable sources which in the total amount of energy produced in the region is only 2 %. In the region and the whole country there is insufficient ecological awareness of the society is a general obstacle to the introduction of various environmental programs, e.g. related to the replacement of coal-fired furnaces with gas-fired furnaces for individual customers.

Lodzkie Region is perceived as a moderate innovator at the medium level with progressive dynamics of innovation growth. This gives it an opportunity to develop further and become a precursor in the country in highly progressive transformation from the coal. There is opportunity for expanding geothermal installations that already have been successfully built.

The anticipated threat is in the SMEs that do not fully use the financial support of ROP WL in the implementation of innovations.

South-West Oltenia

The region is rich in mineral resources. The cost coal extraction increases unlike to the quality of coal and the extraction techniques. This may be a trigger point for incentivizing renewable and low carbon energy. Moreover, the local work forces have a great availability of re-training and skills development programs.

The key weaknesses include insufficient green spaces in the cities of the region and the high dependence on the coal-based heat and electricity. This is mostly due to great ratio of large industrial units with obsolete and energy-intensive technology that are present in the industry.

The region sees opportunities in developing the service sector to create new jobs. It could utilize EU funds through operational programs. This also includes a possibility of implementing modern methane capture technologies from coal and methane emissions from the exploited fields or degassing coal.

The main threat for the coal transition is increasing the unemployment rate following the privatization of large enterprises and industrial restructuring;

Savinjska

Among the strengths of the region is very well-developed DH and DC system, low unemployment rate and highly skilled workforce capacities.

The region's weaknesses are the limitations to the exploitation of some types of renewable energy sources such as landscape conditions and difficulties with obtaining all necessary legal permissions or lack of funds. There is also no overarching framework defining restructuring support instruments for coal-fired energy producers neither on the regional or national level.

The potential opportunities are perceived in increasing effort on the exploitation of renewable energy sources (primarily wood biomass and solar energy) and developing of new innovative energy services. This also include possibility to reuse of out of operation coal mining industry installations after the lignite mine closure and redesigning post-mining landscapes in the future.

The issue of phasing out coal in Slovenia is controversial in the sense that feasible alternatives that could realistically substitute the energy source without having a profound impact on the economy and moreover an economically viable energy supply to households and industry. There is a risk of higher energy import dependence due to phasing out coal. Another threat is a loss of workplaces directly or indirectly linked to the coal value chains that would primarily have consequences on local level.

Extremadura

The key strength of the region is lack of either coal excavation sector or coal fired plants.

Although, the main report indicates some coal activity in the region, this is only a result of the extrapolation of national figures to the regional level using the population factor. Lack of the specific data sources, however, can mislead the actual picture for Extremadura, which is entirely free of any coal-intensive industry.

Extremadura has still space for further development of renewable and low-carbon energy, since, it has a very good potential of solar, biomass and hydro energy. There is also a strong SMEs cluster with a number of companies specialized in renewable technologies at regional and national level.

The region’s weaknesses include high rate of unemployment and difficulties to implement district heating, due to lack of experience and limited hours of heating needed. Alternative renewable energy sources as geothermal energy are rather negligible.

The further expansion of RES creates opportunities for new jobs in the construction sector. The energy local ‘know-how’ and experience with the renewable systems will facilitate the further development of low carbon system.

There are no threats in the region related to the coal-based energy production, as there is no such production in Extremadura.

2 Glossary

Agricultural residues – cereal straw, grain maize, rice straw, sugar beet leaves, citrus pruning, olive pruning and pits, vineyard pruning.

Bachelor level – programs designed to provide intermediate academic and professional knowledge, skills and competences leading to a first degree or equivalent qualification.

CHP – Combined Heat and Power

DH – District Heating

Doctoral level – programs designed primarily to lead to an advanced research qualification, usually concluding with the submission and defense of a substantive dissertation.

Forest residues - broad-leaved forest, coniferous forest, mixed forest, natural grassland, moors and heathland, sclerophyllous vegetation, transitional woodland shrub.

HFD – Heat-Flow Density

KPIs – Key Performance Indicators

Livestock effluents - production of solid and liquid residues from breeding of the following livestock: pig, cattle, poultry.

Master level – programs designed to provide advanced academic and professional knowledge, skills and competences leading to a second degree or equivalent qualification.

SME – Medium-size enterprises

Mtoe – mega tone of oil equivalent

Municipal solid waste - households waste and economic activities waste excluding recyclable waste (paper, cardboard and wood waste), food, vegetal waste and used frying oil.

n.a. – not applicable

NUTS - Nomenclature of territorial units for statistics – a hierarchical system for dividing up the economic territory of the EU

NUTS 1: major socio-economic regions

NUTS 2: basic regions for the application of regional policies

NUTS 3: small regions for specific diagnoses

R&D – Research and Development

RES – renewable energy sources

Short-cycle tertiary education – programs practically-based, occupationally-specific and prepare for labor market but also can provide a pathway to other tertiary programs.

Vocational education – education that prepares people to work in various jobs, such as a trade, a craft, or as a technician.

3 Introduction

The report summarizes the key findings for individual studies of all 9 nations. This includes an overall picture of the reference case and the main conclusions of the SWOT analysis. The reference case provides an overview of the current energy sector, its performance and favorable factors that would facilitate the coal energy transition. The conclusions drawn in this task will enable to complete the subsequent SWOT analysis. The investigated areas along the justification on how they apply to the decarbonization strategy are listed below:

1. energy consumption and its proportion sourced from coal - to identify the magnitude of coal fuel dependence in the region,

2. the proportion of renewable energy resources in the energy production and the potential of the remaining ‘green’ fuel resources to produce low-carbon heat and electricity - to understand the availability and potential of utilizing the alternative energy sources in the region,

3. district heating potential to supply efficient heating - to assess the feasibility of incorporating alternative energy generation plants into the existing transmission infrastructure,

4. workplaces connected to coal value chains in the region - to identify the proportion of the population in the region directly dependent on the coal industry,

5. present pattern of general employment structure in the region - to define the local capacities for the coal conversion process that create opportunities for new job positions,

6. regional educational and research capacities - to provide in-formation on the potential future capacities of educating the workforce that could take part in and after the coal conversion process,

7. regional innovation and transition culture and experiences in the public and private sector - to explain the overall tendencies and typical behavior of the institutions and companies in the face of diametrical changes in the energy strategy.

8. regional innovation and transition culture from the political and organizational perspective – to identify what are the current regulations, programs and schemes related to coal conversion and implementation of carbon emission mitigating measures,

9. financial support for undertaking energy conversion investments - to identify the regional / national funding options for the potential investment into for example energy conservation in buildings, renewable energy generation and efficient energy supply.

The subsequent SWOT study summarizes the key strengths, weaknesses, opportunities and threats of the clean energy transition. It is based on the conclusions made when describing the present situation in the earlier section.

The breakdown of the regions investigated for this study is collated in the following table.

Initials	Country	Partner	NUTS level	NUTS number	Region
BG	Bulgaria	Stara Zagora Regional Economic Development Agency	nuts2	BG41 (Stara Zagora BG344)	Yugozapaden
DK	Denmark	House of Energy	nuts2	DK050	Nordjylland
DE	Germany	Ministry for Economic Affairs and Energy, State of Brandenburg	nuts3	DE406 Dahme-Spreewald DE407 Elbe-Elster DE40b Oberspreewald-Lausitz DE402 Cottbus, Kreisfreie Stadt DE40g Spree-Neiße	Brandenburg: Lausitz-Spreewald
EL	Greece	Regional Association of Local Governments of Western Macedonia	nuts2	EL53	Western Macedonia (Dytiki Makedonia)
HU	Hungary	ENEREA Eszak-Alfold Regional Energy Agency Nonprofit Ltd.	nuts2	HU32	Észak-Alföld
PL	Poland	Marshal Office of Lodzkie Region	nuts2	PL71	Łódzkie
RO	Romania	South-West Oltenia Regional Development Agency	nuts3	RO411 Dolj RO 412 Gorj RO 413 Mehedinți RO 414 Olt RO 415 Vâlcea	South-West Oltenia
SL	Slovenia	Energy Agency of Savinjska, Saleska and Koroska Region	nuts3	SI034	Savinjska
ES	Spain	Extremadura Energy Agency	nuts2	ES43	Extremadura

Table 1 Coal-intensive regions investigated in the SWOT study.

The following chapter presents the findings for the reference case organized by the topic. This means the present situation for all nine regions is described as area by area. This structure enables to make an easier comparison of the energy sector between the countries.

4 Present situation (Reference case)

This section presents the findings for the region regarding the existing energy sector and aspects directly related to the coal industry. This begins with the basic overview of the energy consumption and production using coal and RES technologies. This is followed by the key facts about human resources, education and research capacities with the particular focus on the coal and low-carbon energy segments.

The chapter is concluded with political and organizational attitude and readiness for the energy conversion actions and is concentrated on the programs, schemes and incentives supporting the energy efficiency investments and employment transformation to suit the changing working environment.

The analysis is performed using one of two types of data sources. The first one is the local data which are issued for the particular region by local authorities **(specific data)** and the second is the standardized data that have been produced for all European countries and are widely available **(general data).** The general data source usually contains the figures representing the entire country. In order to apply them in the regional description, these need to be scaled down. The ratio that allows the most adequate conversion especially in respect to energy usage and employment characteristic is the proportion between the population in the region and the total population in the country. This should be calculated according to the formula (example values are for Nordjylland in Denmark):

$$Population\ ratio = \frac{Population\ in\ a\ region}{Population\ in\ a\ country} = \frac{587{,}335}{5{,}748{,}769} = 10.2\%$$

This estimate may not always be accurate, hence the local data sources – if available – have been chosen with a priority. If the local data are not sufficient or not present, then the general figures and the population scaling factor were used instead.

The most important parameters have been standardized using key performance indicators (KPIs) This enables to compare the findings of all nine regions in Europe with each other. The KPIs express any parameter that is analyzed for a region, e.g. electricity production using coal fuel or heat supply via district heating as per one thousand of people in the region. The formula for the KPI along with the example figure based on the population in the Nordjylland region is:

$$KPI = \frac{Parameter}{Population\ in\ the\ region/_{1000}} \left(= \frac{Parameter}{587335/_{1000}} \right)$$

The aspects related to the reference case that are difficult to quantify, are described in a form of plain text and comments.

4.1 Energy demand, coal consumption and efficiency potential related to coal fuel

4.1.1 Bulgaria – Yugoiztochen region

Yugoiztochen Region is situated in south-eastern part of Bulgaria with Stara Zagora being the administrative center of Stara Zagora District, part of the region. The region is often referred as “The Energy Heart” of Bulgaria. The region hosts a coal mine and 3 (three) coal-fired plants, forming Maritsa East Complex. Maritsa East Complex is the biggest energy complex in South-East Europe with significant importance not only on national but also on regional level. The complex is located in a large lignite coal basin, which includes several mines, enrichment plants, a briquette plant and possesses its own railway system.

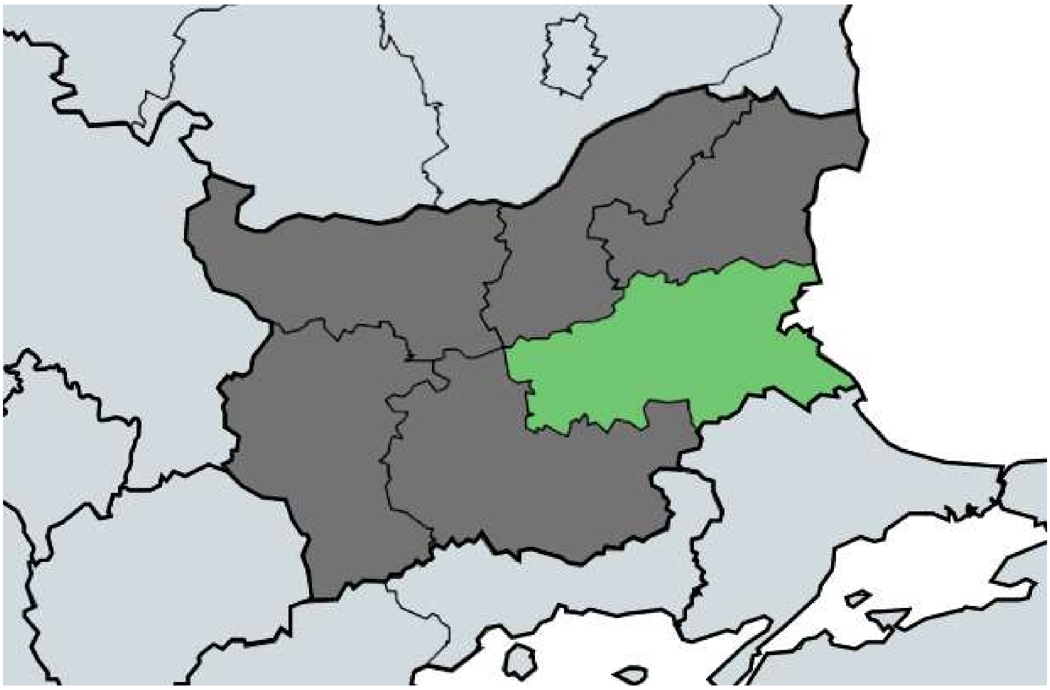


Figure 5 Location of the Yugoiztochen region on the map.[25.]

The proportion between the population in the Yugoiztochen region and the total population in the country should be calculated according to the formula:

$$Population\ ratio = \frac{Population\ in\ a\ region}{Population\ in\ a\ country} = \frac{1{,}046{,}125}{7{,}101{,}859} = 14.7\%$$

This population factor was developed in order to scale down the national values to the regional level in case the local data are unavailable.

Primary energy production in the country satisfies 62% of the gross domestic energy consumption with relatively unchanging structure in recent years and in dynamics stemming from consumption (Bulgarian National Statistic Institute data).

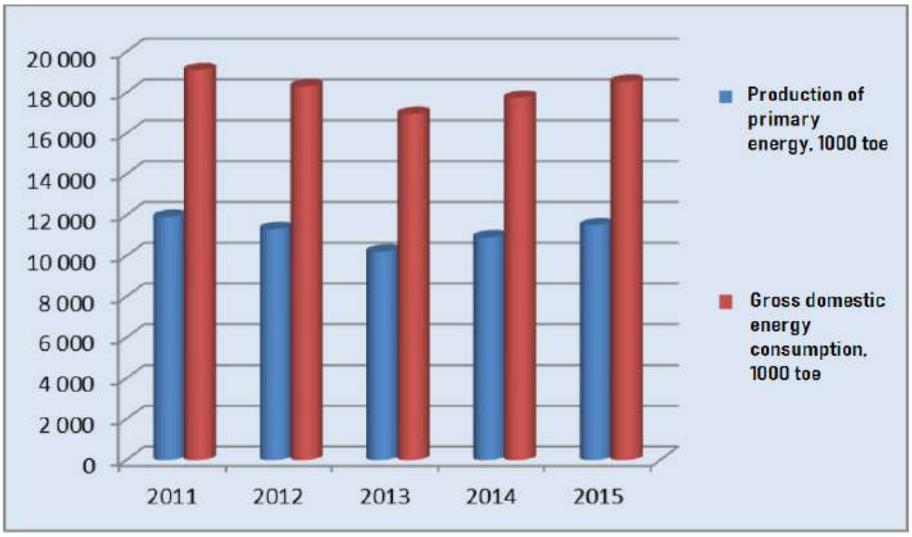


Figure 6 Primary Energy Production and Gross Domestic Energy Consumption, 1000 Toe based on general data.

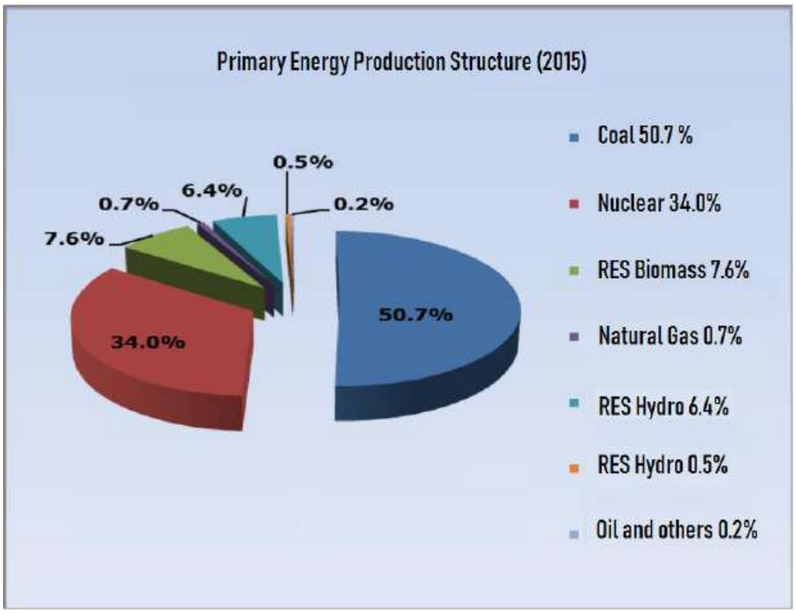


Figure 7 Primary Energy Production Structure (2015) based on general data.

About 2/3 of the fuels and energy are used by plants to produce electrical and thermal energy, approximately 1/3 of the fuels and energy - from refineries to produce petroleum products and an insignificant part - from briquette factories. The result of the conversion energy is about 60% of the input for conversion.

Final use of energy used for non - energy consumption (basically from the chemical industry) and energy consumption.

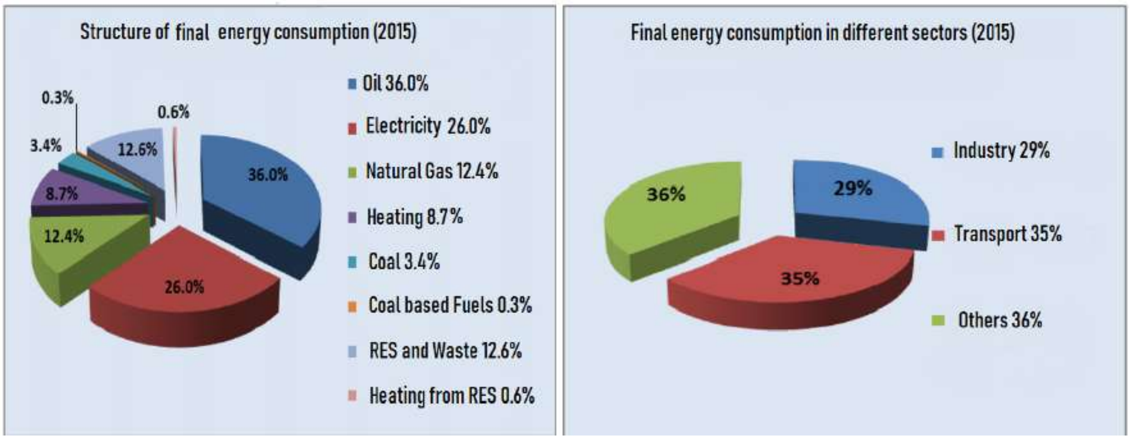


Figure 8 Structure of final energy consumption (2015).

The energy demand including heat supply, electricity production and cooling demand for the entire region in 2016 is presented on the following graph.

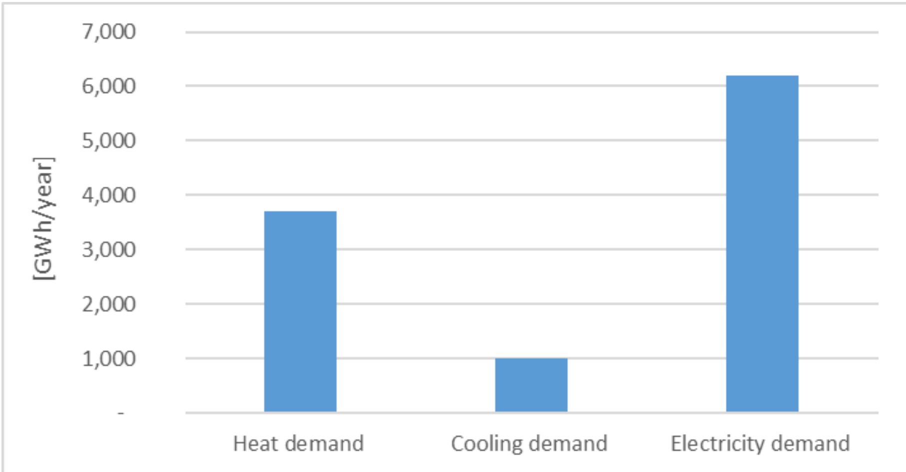


Figure 9 Annual energy demand in Yugoiztochen region indicated by general source [2.], [3.] (GWh/annum), 2016.

There is no specific data for the region, that have been reported. The data from the national level have been collected, standardized using the population factor and reported in the following section.

The annual coal consumption is collated in the table below.

Coal source (GWh/annum)

Coal production	9,900
Coal export	0
Coal import	1,400
Total coal consumption	11,300

Table 2 Annual coal consumption with the breakdown of coal source for Yugoiztochen region according to general source [3.] (GWh/annum), 2016.

The next graph shows the proportion of coal-fired electricity production (blue column) and coal-fired heat production (yellow column) in total energy demand.

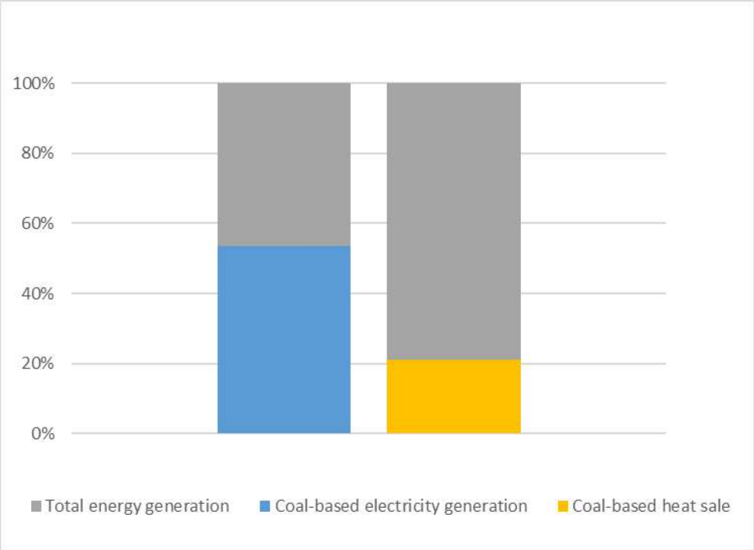


Figure 10 Proportion of energy generated using coal fuel in Yugoiztochen region according to general source [3.][2.], (%), 2016.

Energy production using coal fuel is collated in the table below.

Coal-fueled energy production (GWh/annum)

Coal-based electricity generation	3,300
Total electricity generation	6,200
Coal-based heat sale	800
Total heat sale	3,700

Table 3 Total and coal-based production of heat and electricity in Yugoiztochen region according to general source [3.][2.], (GWh/annum), 2016.

Coal consumption and coal-based energy production per 1000 of population is presented in the following table.

Key Performance Indicators (GWh/1000 of population)

Total coal consumption	10.8
Coal-based electricity generation	3.2
Coal-based heat sale	0.8

Table 4 Coal consumption and coal-based energy production per 1000 of population in Yugoiztochen region according to general source [3.], 2016.

4.1.2 Denmark – Nordjylland region (example)

Nordjylland (Nord Jutland) is one of five regions in Denmark located in the northern parts of the country. The largest cities are Aalborg, Hjørring and Frederikshavn. The last two coal-fired plants are situated in the proximity of Aalborg.

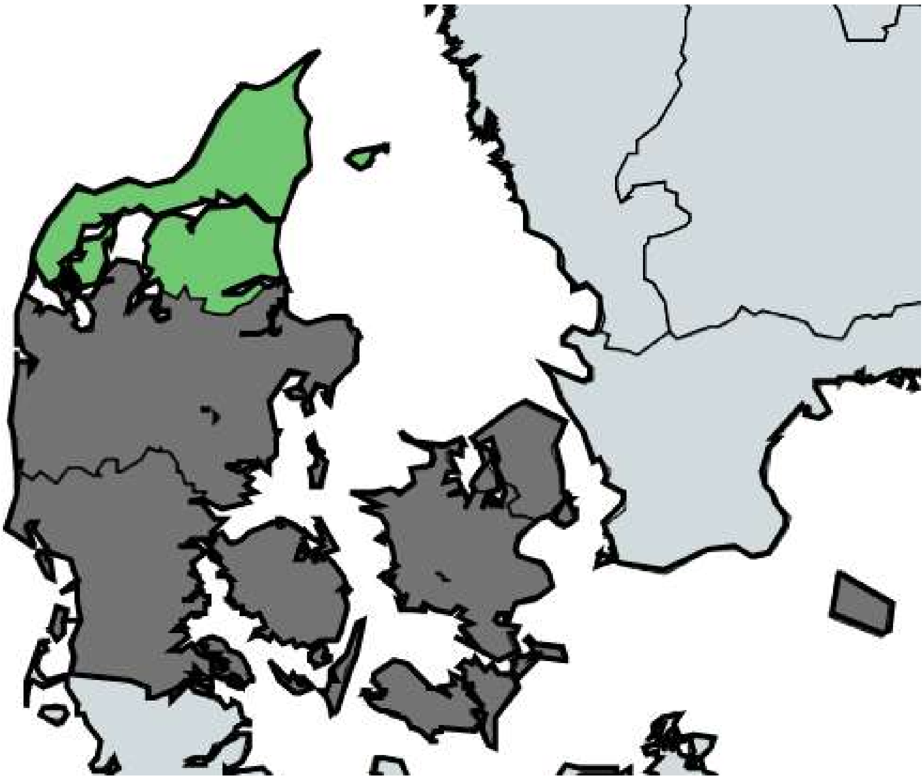


Figure 11 Location of the Nordjylland region on the map.[25.]

The energy demand including heat supply, electricity production and cooling demand for the entire region in 2016 is presented on the following graph. The energy volumes in the adjacent columns represent two different sources of data used (general and local).

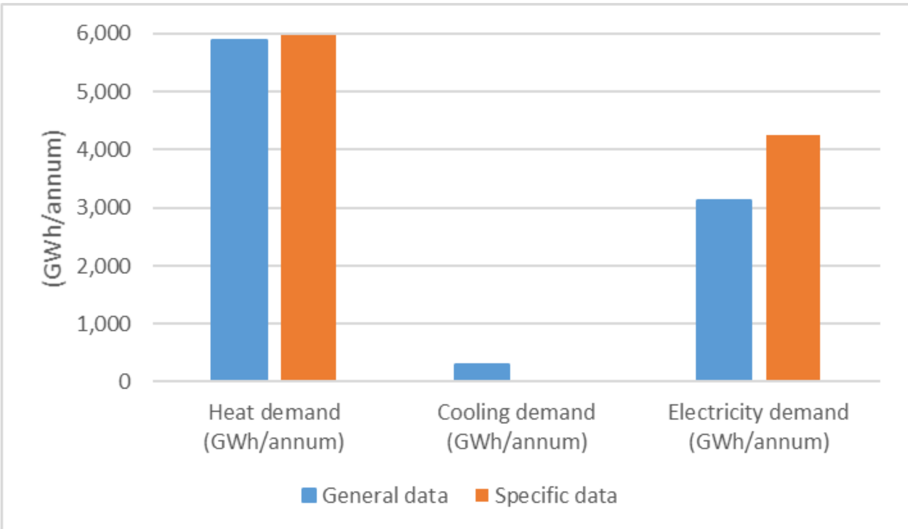


Figure 12 Annual energy demand in Nordjylland region indicated by general source [2.], [3.] and specific information [4.] (GWh/annum), 2016.

Heat sale is the heat production exclusive of DH heat losses as delivered to the final user. Electricity demand refers to the gross electricity production inclusive of transmission losses as only the total electricity output at the generators is known for the regions.

The discrepancy in data between the sourced materials is mostly due to down-sizing national data to the regional level. This approximation error shows the heat demand in Nordjylland was only underestimated by 100 GWh compared to the local statistics. There is no information about cooling needs according to the local source. Electricity production in reality is higher by circa 1,000 GWh than calculated using country figures.

The next table presents the overall consumption figures for the coal in Nordjyalland. The national volumes reduced using the population ratio appear to match the coal consumption in the electricity generation process demonstrated in the local data. This does not account for the coal used in the industry which nearly doubled the overall consumption.

Coal source (GWh/annum)	General data	Specific data
Coal production	0	0
Coal export	0	0
Coal import	1,900	4,670
Total coal consumption	2,260	4,670

Table 5 Annual coal consumption with the breakdown of coal source for Nordjylland region according to general source [3.] and specific information [4.], (GWh/annum), 2016.

Nearly 2,500 GWh of total coal consumption is utilized in the industry which leaves the remaining circa 2,200 GWh used for the energy production. Coal consumption figures indicate the cumulative usage of all types of solid fuels which include hard coal and brown coal/lignite.

Nearly 20% (overestimated to 30% based on the general data) of electricity in Nordjylland is generated using coal fuel. Similarly, circa 20% of heat (which resembles the estimates using national figures and population ratio) is produced in the coal combustion.

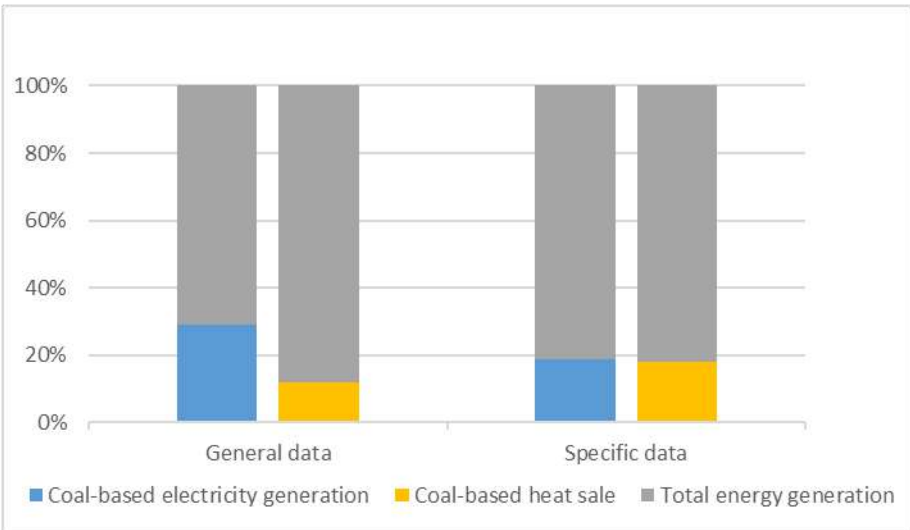


Figure 13 Proportion of energy generated using coal fuel in Nordjylland region according to general source [2.], [3.] and specific information [4.] (%), 2016.

The exact annual energy production output is collated in the table below.

Coal-fueled energy production (GWh/annum)	General data	Specific data
Coal-based electricity generation	910	800
Total electricity generation	3,120	4,260
Coal-based heat sale	710	1,080
Total heat sale	5,880	5,970

Table 6 Total and coal-based production of heat and electricity in Nordjylland region according to general source [3.] and specific information [4.], (GWh/annum), 2016.

The most important parameters have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in Nordjylland.

Key Performance Indicators (GWh/1000 of population)	General data	Specific data
Total coal consumption	3.8	8.0
Coal-based electricity generation	1.5	1.4
Coal-based heat sale	1.2	1.8

Table 7 Coal consumption and coal-based energy production per 1000 of population in Nordjylland region according to general source [3.] and specific information [4.], 2016.

4.1.3 Germany –Lausitz-Spreewald region

A NUTS2 region – according to the Nomenclature of territorial units for statistics – with a coal-driven industry is Brandenburg. Not the entire region, however, is directly affected by the carbon intensive energy sector as this particularly concerns the Lausitz-Spreewald region located in southern Brandenburg. This is Brandenburg`s part of Lusatia, which will be called "Lausitz-Spreewald" in this report. There is also a part of Lusatia in Saxonia, which is not considered in this report.

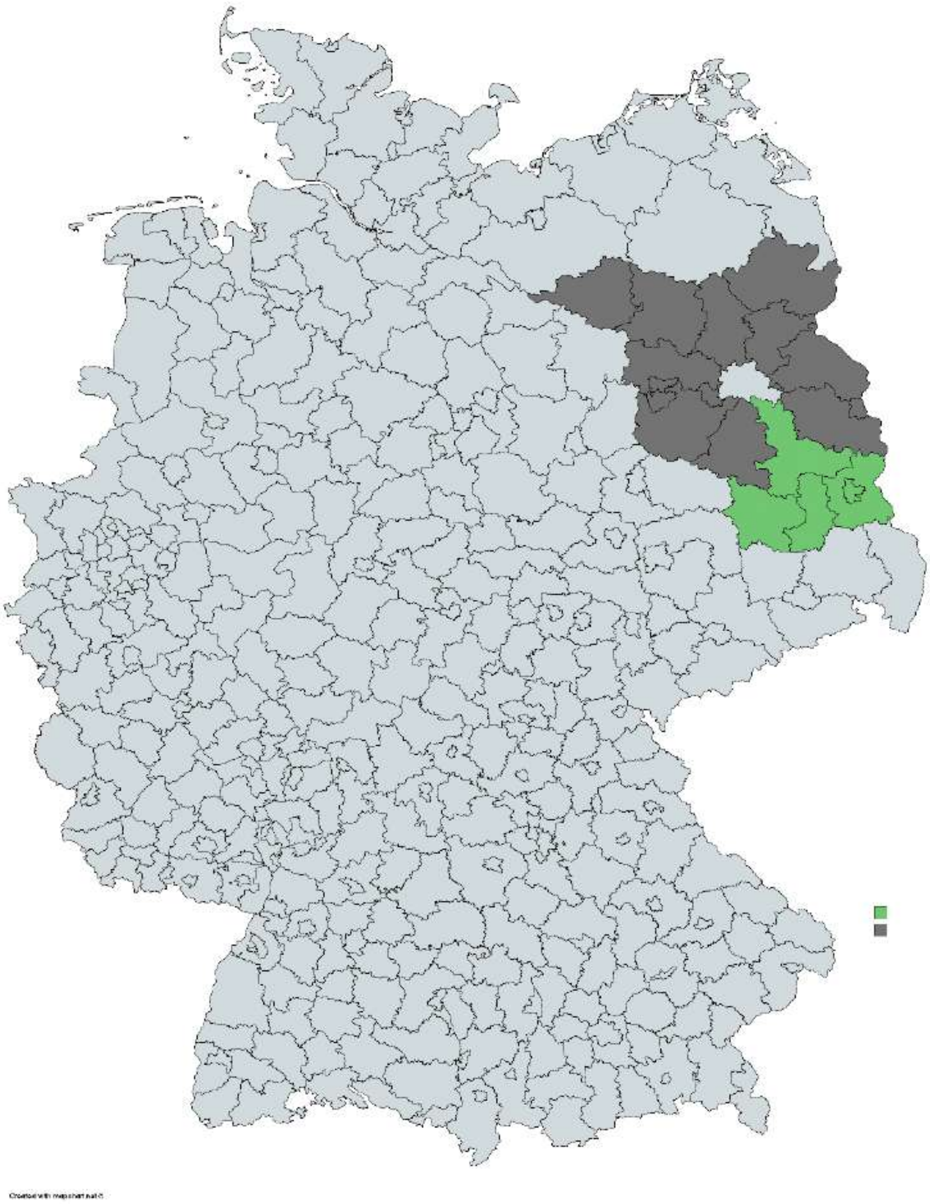


Figure 14 Location of the coal-intensive state, Lausitz-Spreewald in Brandenburg region (NUTS2), [15.].

The Lausitz-Spreewald region consists of five NUTS3 areas:

- DE407 – county (Landkreis) Elbe-Elster
- DE40B – county (Landkreis) Oberspreewald-Lausitz
- DE402 – city of Cottbus
- DE40G – county (Landkreis) Spree-Neiße
- DE406 – county (Landkreis) Dahme-Spreewald

The energy demand including heat supply, electricity production and cooling demand for the entire region in 2016 is presented on the following graph.

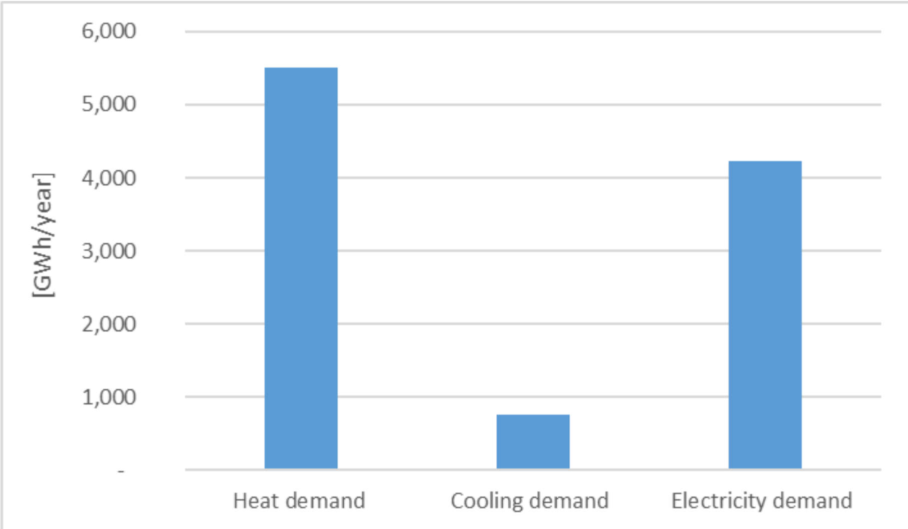


Figure 15 Annual heat and cooling demand in Lausitz-Spreewald region indicated by general source [2.] and electricity demand based on local data [14.] (GWh/annum), 2016.

Heat sale is the heat production exclusive of DH heat losses as delivered to the final user. Electricity demand refers to the gross electricity production inclusive of transmission losses as only the total electricity output at the generators is known for the regions.

Heat and cooling needs for the Lausitz-Spreewald region were sourced from the hotmaps online tool since the statistics for NUTS3 level were not available. Electricity demand was provided from local data sources.

The next table presents the overall consumption figures for the coal in Lausitz-Spreewald. In order to scale down the national values, a new extrapolation factor was developed. The population ratio proposed in the manual, does not reflect the coal dependence of Lausitz-Spreewald accurately. This is due to a high concentration of population placed around the central parts of Brandenburg, unlike the coal-based industry which is present only in five NUTS3 level locations within the Lausitz-Spreewald. For this purpose, the population factor was replaced with electricity production ratio reflecting the proportion of total electricity generated in the state Lausitz-Spreewald compared to the Brandenburg region.

$$Electricity\ production\ ratio = \frac{Electricity\ production\ in\ a\ region}{Electricity\ production\ in\ \ Brandenburg} = \frac{4{,}200\ GWh}{55{,}100\ GWh} = 7.7\%$$

Coal source (GWh/annum)	
Coal production	6,100
Coal export	0
Coal import	2,000
Total coal consumption	7,500

Table 8 Annual coal consumption with the breakdown of coal source for Lausitz-Spreewald region according to specific source[23.], (GWh/annum), 2016.

Half of the annual coal consumption is produced in the local mines while the other half is sourced from abroad. There is no direct statistics on the proportion of coal consumption in the industry.

Coal consumption figures indicate the cumulative usage of all types of solid fuels which include hard coal and brown coal/lignite.

The next graph shows the proportion of coal-fired electricity production (blue column) and coal-fired heat production (yellow column) in total energy demand. Circa 40% of electricity and 5% of heat demand in Lausitz-Spreewald is generated in the coal combustion process.

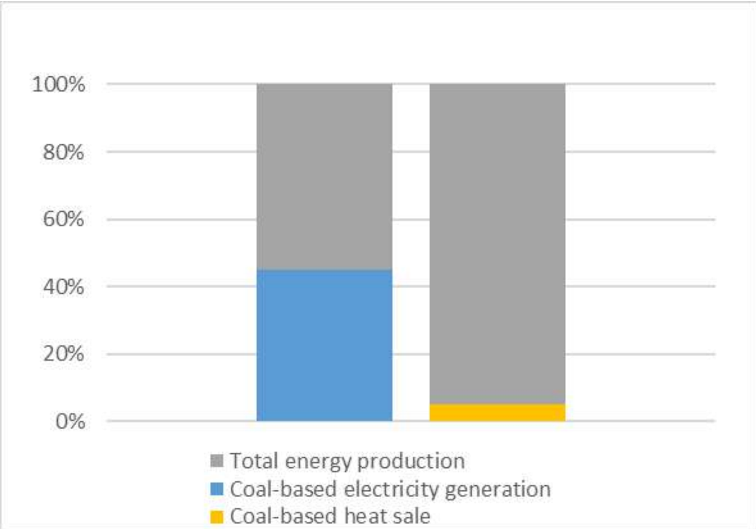


Figure 16 Proportion of heat generated using coal fuel in Lausitz-Spreewald region according to general source [3.][2.] and electricity demand based on local data[23.], (%), 2016.

The exact annual energy production output is collated in the table below.

Coal-fueled energy production (GWh/annum)	
Coal-based electricity generation	2,600[23.]
Total electricity generation	4,200
Coal-based heat sale	300
Total heat sale	5,500

Table 9 Total and coal-based production of heat and electricity in Lausitz-Spreewald region according to general source [3.][2.] and electricity demand based on local data[23.], (GWh/annum), 2016.

The most important parameters have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in Lausitz-Spreewald.

Key Performance Indicators (GWh/1000 of population)

	Total coal consumption	10.8
	Coal-based electricity generation	4.3
	Coal-based heat sale	0.5

Table 10 Coal consumption and coal-based energy production per 1000 of population in Lausitz-Spreewald region according to general source [3.] and local data[23.], 2016.

4.1.4 Greece – Western Macedonia region

Western Macedonia is one of the eleven regions in Greece, the only one without access to see coastal zone, with mostly mountainous terrain. Kozani, Ptolemais, Florina and Grevena are the major cities of the regions of which only the last is not involved in the lignite industry activities of the region.

Figure 17 Location of the coal-intensive state, Western Macedonia region (NUTS2), [15.].

The proportion between the population in the Yugoiztochen region and the total population in the country should be calculated according to the formula:

$$Population\ ratio = \frac{Population\ in\ a\ region}{Population\ in\ a\ country} = \frac{271{,}488}{10{,}768{,}193} = 2.5\%$$

This population factor was developed in order to scale down the national values to the regional level in case the local data are unavailable.

The electricity demand as registered by ELSTAT up to 2012, was in the magnitude of 964 GWh per annum (average for years 2008 up to 2012) representing 1.82% of the electricity demand of the Greek interconnected system. According to the population data of the Region for the same period represents 2.58% of total Greece and the 2.88% of the mainland where interconnected electricity system is available, resulting to a prediction of a regional electricity consumption of 1522 GWh. According to that it is presented a lower than national average electricity consumption which was taken into account on the prediction of 2016 annual consumption accordingly resulting into 933 GWh instead of 1305 GWh based on national electricity generation and portion of regional population.

Furthermore, heating and cooling data were used according to the findings of the RES H/C SPREAD project co-funded by the IEE program of the EU (2014 – 2016), where ANKO the Regional Development Agency of Western Macedonia was involved. A close prediction of heating demand is presented where specific data deals with 1781 GWh/annum while general data estimates 1938.8 GWh/annum. A significant discrepancy deals with cooling demand estimated in the magnitude of 108.5 GWh/annum by used specific data while 487.24 GWh/annum are indicated by general data, subject to the calculation of dwellings, buildings use and 2011 population of the first approach.

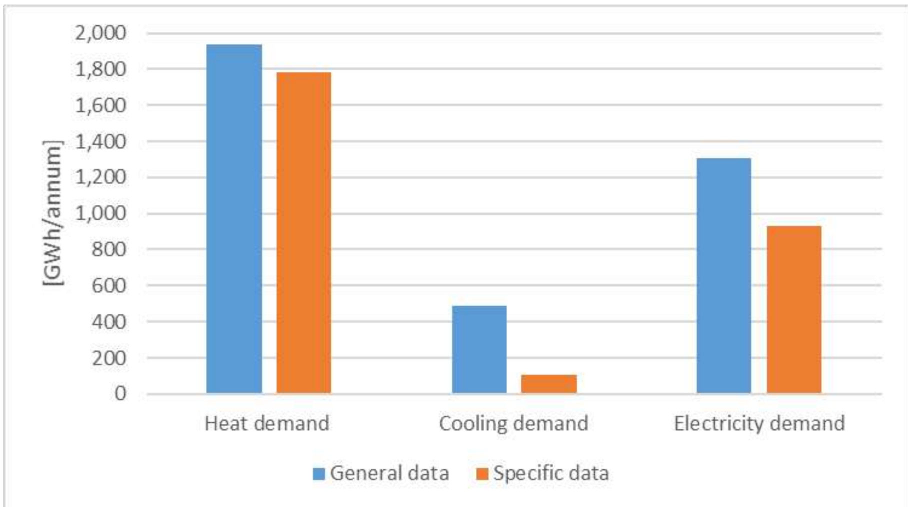


Figure Annual energy demand in Western Macedonia region according to general source [2.], [3.] and specific information [26.] (GWh/annum), 2016.

Heat sales from district heating are linked to the Kozani, Ptolemais and Amynteo cities, which are supplied heat by lignite fired power plants. Kozani DH system has a capacity of 222 MWth connected to Agios Dimitrios Power Plant. Ptolemais capacity is 105 MWth supplying heat from Kardia power Plant while will be connected to the new Ptolemais V plant after its commissions in 2021. Amynteo of a 25 MWth capacity is connected to the Amynteo Power Plant is searching for alternative heat supply sources building a same capacity biomass boiler for sustain DH operation after plant's closure. A new DH system is expected to operate in Florina city of a 104 MWth capacity linked with Meliti power plant operation [27.].

National heat sold data refers to 2.134 PJ or 589.7 GWh which is consistent to the local data of 485.7 GWh [16], derived from DH companies for 2016, taking into account the existence of an additional DH system supplied heat from lignite power plant in Megalopolis – Peloponnese Region. With respect to the fact that organized heat supply is totally based on lignite fired plant operation with limited use of their back up diesel fuelled boilers it can be concluded that heat market is dominated by lignite industry in the Region of Western Macedonia. Rest of the region uses diesel and alternative fuels in domestic boilers for covering individually their heating needs.

Lignite is the dominant domestic fossil fuel used for decades as the main energy source for electricity production. Exploited lignite deposits are located mainly in the region of Western Macedonia, while a second and only lignite region is located in Megalopolis – Peloponnese region. Lignite's utilization serves mainly the electricity production sector in the magnitude of 95% or more, while imported coal is used as supplementary fuel.

Total lignite consumption of the region was based on data reported in the LCP database of EEA for power plants operation in 2016 [29.]. The significant discrepancy between general and specific data deals with the availability of exploited lignite deposits in only two regions of the country, producing and utilizing the lignite mined.

Coal source (GWh/annum)	General data	Specific data
Coal production	1,300	0
Coal export	0	0
Coal import	50	0
Total coal consumption	1,300	40,300

Table 11 Annual coal consumption with the breakdown of coal source for Western Macedonia region according to general source [3.] and specific information [29.], (GWh/annum), 2016.

The next graph shows the proportion of coal-fired electricity production (blue column) and coal-fired heat production (yellow column) in total energy demand.

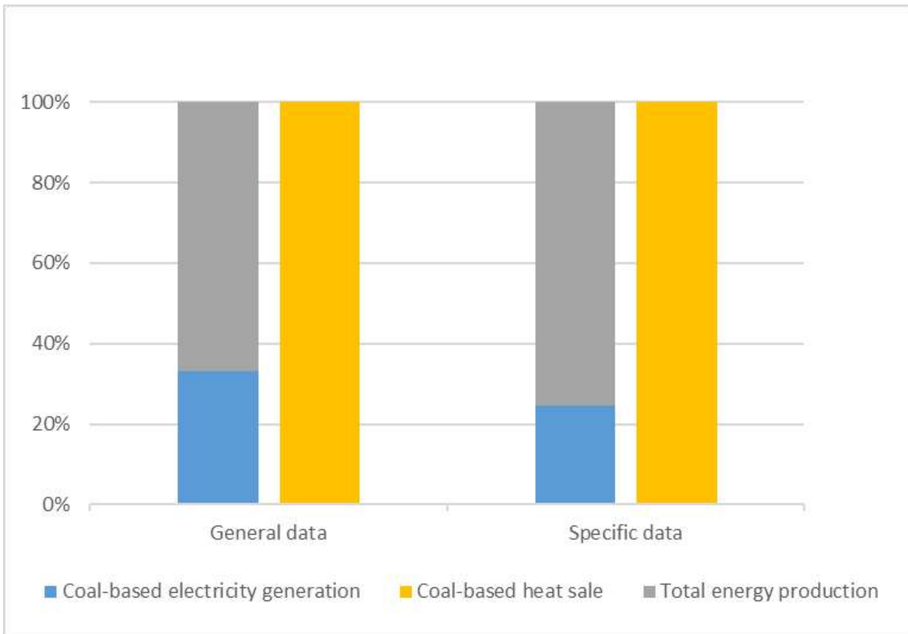


Figure 18 Proportion of energy generated using coal fuel in Western Macedonia region according to general source [2.], [3.] and specific information [30.][4.] (%), 2016.

The exact annual energy production output is collated in the table below, as derived from published data of power plants hourly production by IPTO SA processed by CERTH/CPERI[30.].

Coal-fueled energy production (GWh/annum)	**General data**	**Specific data**
Coal-based electricity generation	450	12,600
Total electricity generation	1,300	950
Coal-based heat sale	15	500
Total heat sale	1,950	1,800

Table 12 Total and coal-based production of heat and electricity in Western Macedonia region according to general source [3.] and specific information[30.], (GWh/annum), 2016.

Coal consumption and coal-based energy production per 1000 of population is presented below.

Key Performance Indicators (GWh/1000 of population)	**General data**	**Specific data**
Total coal consumption	4.7	147.4
Coal-based electricity generation	1.6	46.2
Coal-based heat sale	0.1	1.8

Table 13 Coal consumption and coal-based energy production per 1000 of population in Western Macedonia region according to general source [3.] and specific information [30.], 2016.

4.1.5 Hungary – Észak-Alföld region

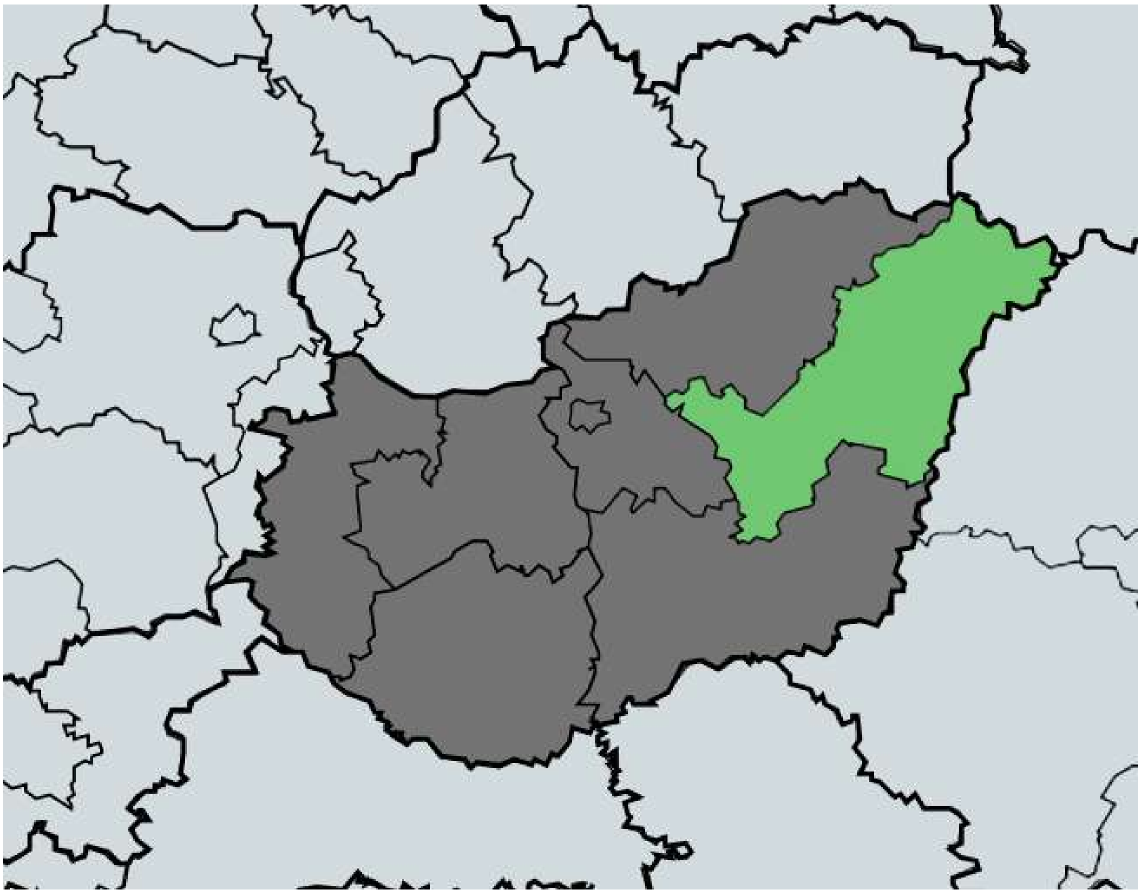


Figure 19 Location of the Észak-Alföld region on the map.[25.]

The proportion between the population in the Yugoiztochen region and the total population in the country should be calculated according to the formula:

$$Population\ ratio = \frac{Population\ in\ a\ region}{Population\ in\ a\ country} = \frac{1{,}468{,}088}{9{,}797{,}561} = 14.9\%$$

This population factor was developed in order to scale down the national values to the regional level in case the local data are unavailable.

The energy demand including heat supply, electricity production and cooling demand for the entire region in 2016 is presented on the following graph.

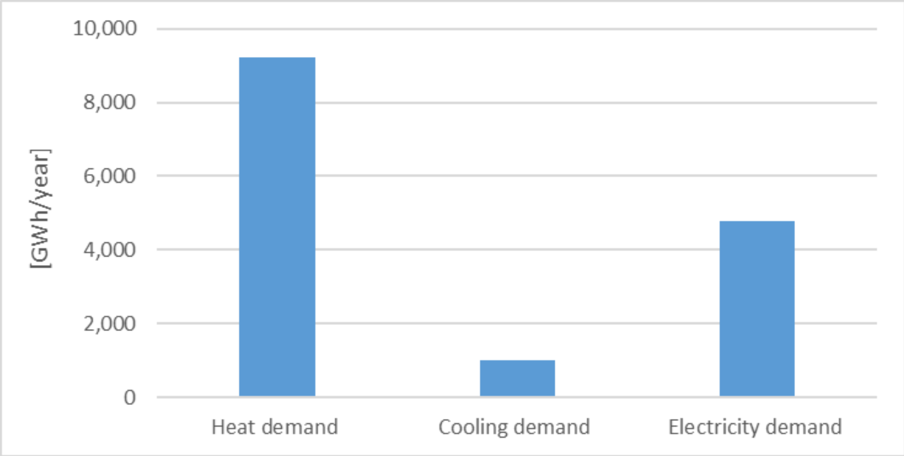


Figure 20 Annual heat and cooling demand in Észak-Alföld region indicated by general source (GWh/annum), 2016.

There is no specific data for the region, that have been reported. The data from the national level have been collected, standardized using the population factor and reported in the following section.

The annual coal consumption is collated in the table below.

Coal source (GWh/annum)

Coal production	2,600
Coal export	700
Coal import	1,900
Total coal consumption	4,000

Table 14 Annual coal consumption with the breakdown of coal source for Észak-Alföld region according to general source [3.] (GWh/annum), 2016.

The next graph shows the proportion of coal-fired electricity production (blue column) and coal-fired heat production (yellow column) in total energy demand.

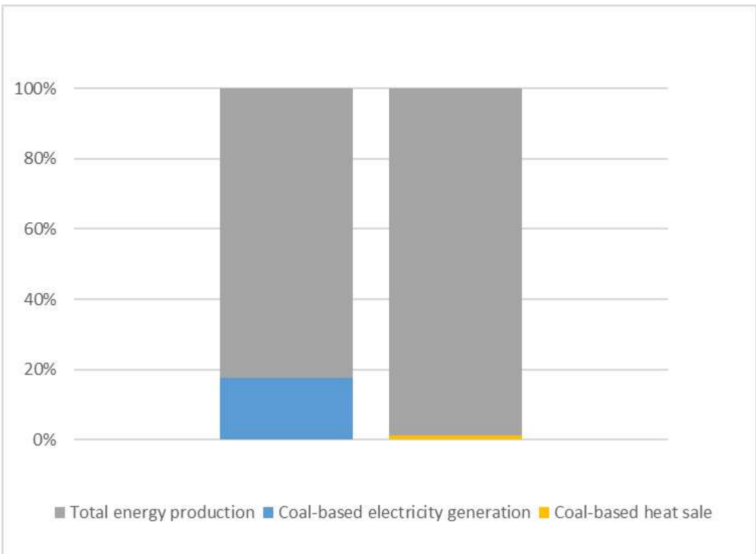


Figure 21 Proportion of energy generated using coal fuel in Észak-Alföld region according to general source [3.][2.], (%), 2016.

Energy production using coal fuel is collated in the table below.

Coal-fueled energy production (GWh/annum)

Coal-based electricity generation	800
Total electricity generation	4,800
Coal-based heat sale	100
Total heat sale	9,200

Table 15 Total and coal-based production of heat and electricity in Észak-Alföld region according to general source [3.][2.], (GWh/annum), 2016.

Coal consumption and coal-based energy production per 1000 of population is presented in the following table.

Key Performance Indicators (GWh/1000 of population)

Total coal consumption	2.7
Coal-based electricity generation	0.5
Coal-based heat sale	0.0

Table 16 Coal consumption and coal-based energy production per 1000 of population in Észak-Alföld region according to general source [3.], 2016.

4.1.6 Poland – Lodzkie region

Lodzkie is a region poor in mineral resources. There are 585 documented deposits, of which only a dozen are of greater importance for the economy. From the economic point of view, the most important are lignite deposits near Bełchatów. It is also found in documented deposits in Złoczew and Rogoźno. The Brown Coal Mine "Bełchatów" covers about half of the domestic demand for this raw material.

In the northern part of the region there are mineral-geothermal waters with favorable conditions for production in the wells in Uniejów, Poddębice and Skierniewice.

The valleys of larger rivers in the voivodship (Warta, Pilica, Bzura) lie on its outskirts. To the interior of the upland reach only narrow valleys of small watercourses, which radially propagate from the center towards the main large valleys. The largest reservoirs are the Sulejowski Reservoir and the Jeziorsko Reservoir.

Lodzkie is one of the best developing voivodships in the country in the area of renewable energy sources. The region has a large potential of biomass, geothermal waters and wind. There are more than 170 wind power plants in Lodz. Natural geothermal resources of the region are used in heating and recreation. The intensified development of the energy sector in the region, observed in recent years, has contributed to the creation of links and cooperation between institutions and enterprises.

Figure 22 Location of the Lodzkie region on the map.[25.]

The proportion between the population in the Lodzkie region and the total population in the country should be calculated according to the formula:

$$Population\ ratio = \frac{Population\ in\ a\ region}{Population\ in\ a\ country} = \frac{2{,}471{,}620}{37{,}972{,}964} = 6.5\%$$

This population factor was developed in order to scale down the national values to the regional level in case the local data are unavailable.

The energy demand including heat supply, electricity production and cooling demand for the entire region in 2016 is presented on the following graph.

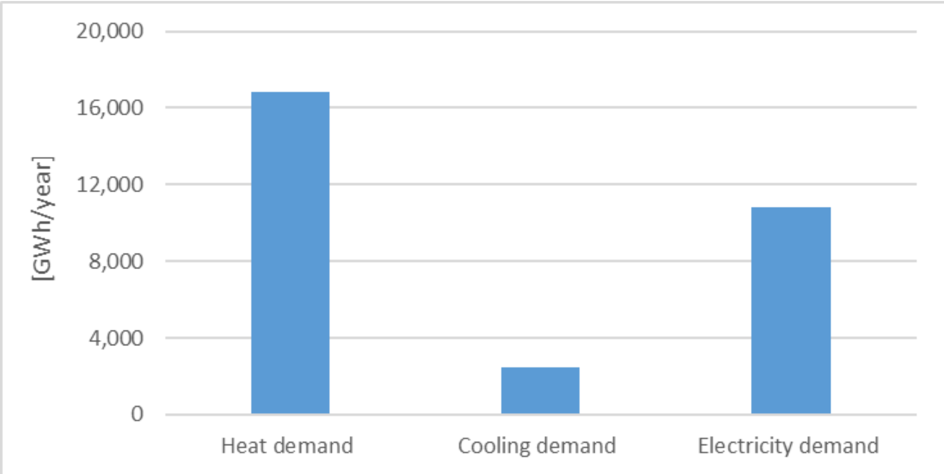


Figure 23 Annual energy demand in Lodzkie region indicated by general source [2.], [3.] (GWh/annum), 2016.

There is no specific data for the region, that have been reported. The data from the national level have been collected, standardized using the population factor and reported in the following section.

The annual coal consumption is collated in the table below.

Coal source (GWh/annum)

Coal production	37,100
Coal export	8,200
Coal import	3,800
Total coal consumption	49,100

Table 17 Annual coal consumption with the breakdown of coal source for Lodzkie region according to general source [3.] (GWh/annum), 2016.

The next graph shows the proportion of coal-fired electricity production (blue column) and coal-fired heat production (yellow column) in total energy demand.

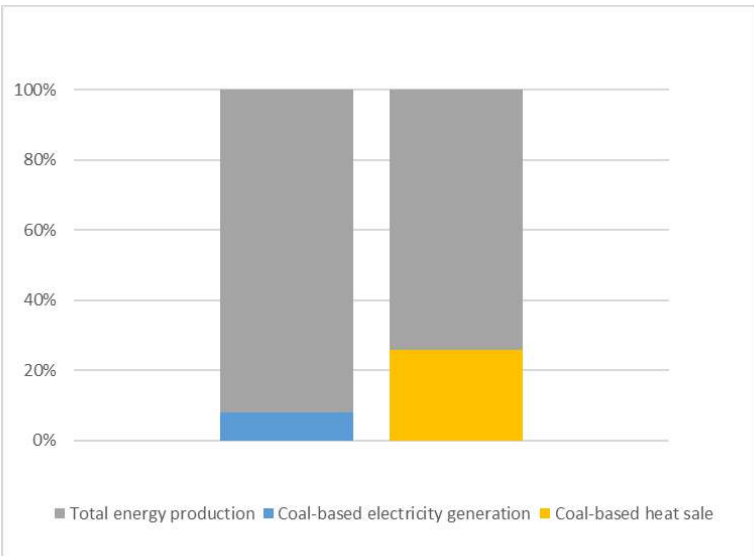


Figure 24 Proportion of energy generated using coal fuel in Lodzkie region according to general source [3.][2.], (%), 2016.

Energy production using coal fuel is collated in the table below.

Coal-fueled energy production (GWh/annum)

Coal-based electricity generation	900
Total electricity generation	10,800
Coal-based heat sale	4,400
Total heat sale	16,800

Table 18 Total and coal-based production of heat and electricity in Lodzkie region according to general source [3.][2.], 2016.

Coal consumption and coal-based energy production per 1000 of population is presented in the following table.

Key Performance Indicators (GWh/1000 of population)

Total coal consumption	19.9
Coal-based electricity generation	0.4
Coal-based heat sale	1.8

Table 19 Coal consumption and coal-based energy production per 1000 of population in Lodzkie region according to general source [3.], 2016.

4.1.7 Romania – South-West Oltenia region

South-West Oltenia Region is located in the southwestern part of Romania and comprises five counties: Dolj, Olt, Valcea, Mehedinti and Gorj. The subsoil of the South-West Oltenia Region is rich in natural resources such as coal, lignite exploited by the National Company of the Oltenia Lignite in the counties of Gorj and Valcea. Soil and subsoil resources are the basis of raw materials in the local and regional economy, their presence being a premise for the development of human settlements, the multipurpose employment of the workforce and the increase in living standards.

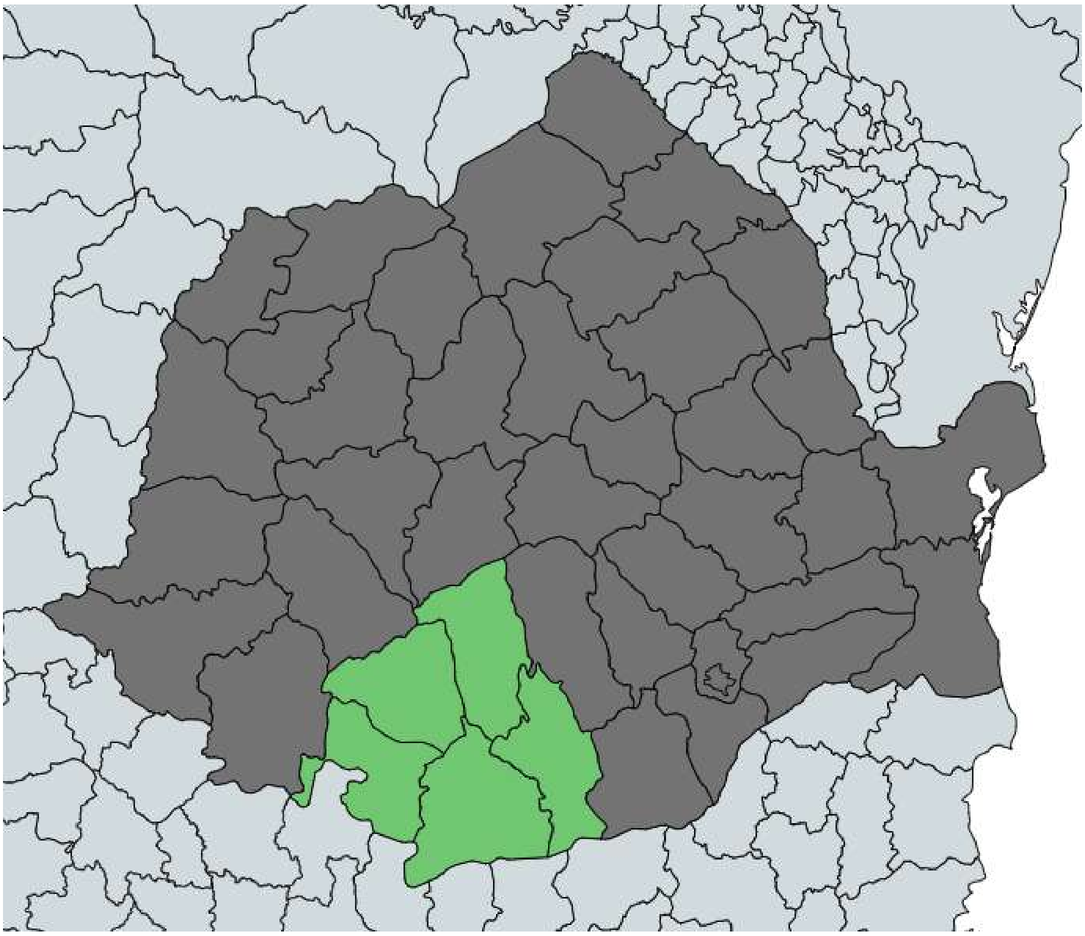


Figure 25 Location of the South-West Oltenia region on the map.[25.]

Population ratio for the South-West Oltenia region compared with the total population in Romania is:

$$Population\ ratio = \frac{Population\ in\ a\ region}{Population\ in\ a\ country} = \frac{1{,}901{,}095}{19{,}640{,}000} = 9.6\%$$

The main primary energy resources in the year 2017 were 34,291.4 * thousand toe, out of which 21,303.5 thousand toe in domestic production and 12,987.9 thousand toe in import, having the following structure.

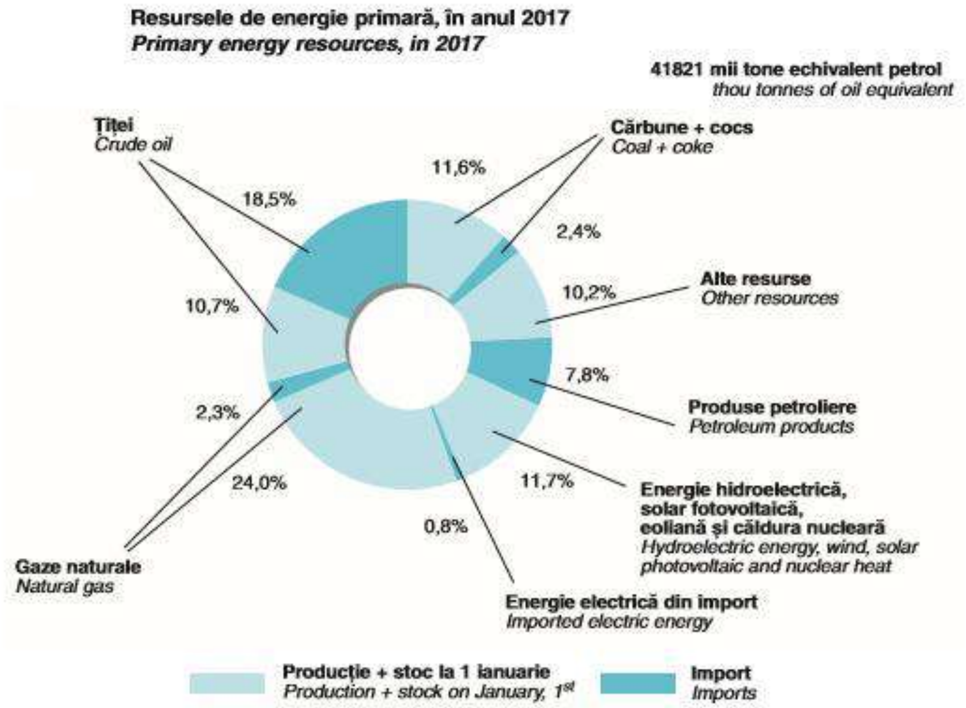


Figure 26 Primary energy resources local data[38.], (%), 2017.

Electricity production by combustion of coal extracted from the region (the key power plants in cities: Rovinari, Turceni, Isalnita, Craiova, Govora) and the use of water falls (Danube hydroelectric power stations - Iron Gates I and II, hydroelectric power plants on the Middle Olt) makes the region the most important area where electricity is produced in Romania. At present, the thermoelectric power plants are in a continuous process of retrofitting to increase the efficiency and to reduce the emissions generated by the combustion of coal.

The energy demand including heat supply, electricity production and cooling demand for the entire region in 2016 is presented on the following graph.

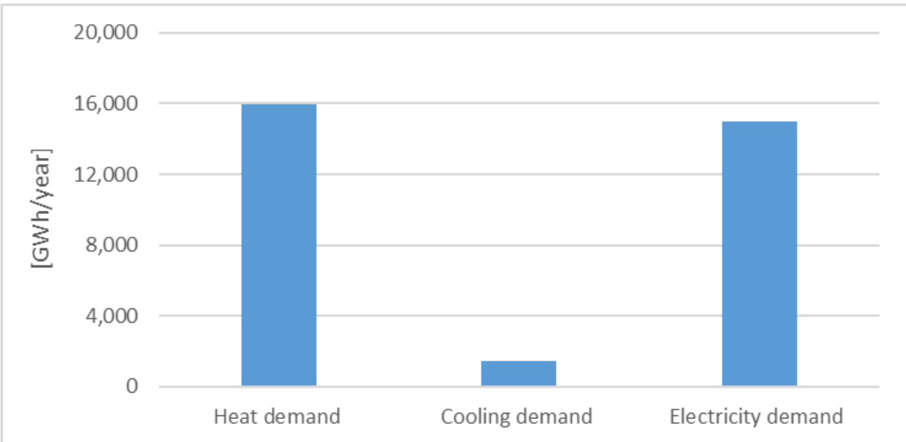


Figure 27 Annual energy demand in South-West Oltenia region indicated by general source [2.], [3.] (GWh/annum), 2016.

In 2017, Complexul Energetic Oltenia produced 15 TWh of energy. In percent, this represents 24% of the country's total energy production, at a production of 22.5 million tons of coal.

The coal consumption and coal related energy production figures have been obtained using the local data sources. These are presented in the following section.

The annual coal consumption is collated in the table below.

Coal source (GWh/annum)

Coal production	5,000
Coal export	0
Coal import	600
Total coal consumption	5,900

Table 20 Annual coal consumption with the breakdown of coal source for South-West Oltenia region according to specific source [39.][3.], (GWh/annum), 2017.

The next graph shows the proportion of coal-fired electricity production (blue column) and coal-fired heat production (yellow column) in total energy demand.

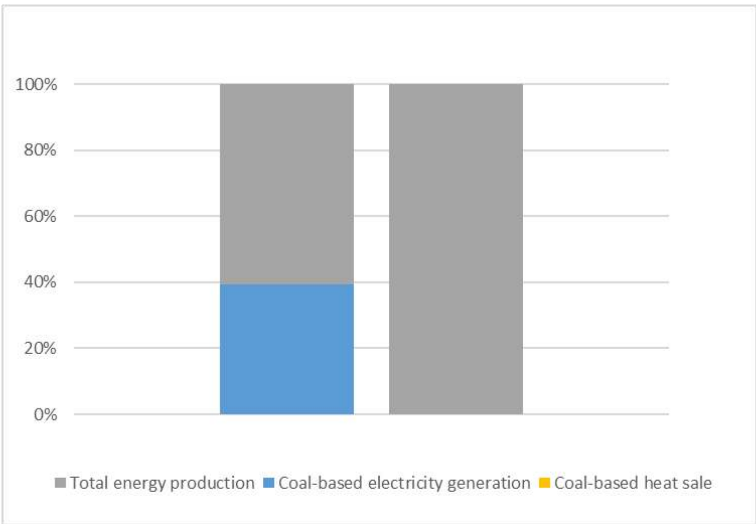


Figure 28 Proportion of energy generated using coal fuel in South-West Oltenia region according to specific source [39.][3.], (%), 2017.

Energy production using coal fuel is collated in the table below.

Coal-fueled energy production (GWh/annum)

Coal-based electricity generation	5,900
Total electricity generation	15,000
Coal-based heat sale	0
Total heat sale	16,000

Table 21 Total and coal-based production of heat and electricity in South-West Oltenia region according to specific source [39.], (GWh/annum), 2017.

Coal consumption and coal-based energy production per 1000 of population is presented in the following table.

Key Performance Indicators (GWh/1000 of population)

	Total coal consumption	3.1
	Coal-based electricity generation	0.97
	Coal-based heat sale	0.0

Table 22 Coal consumption and coal-based energy production per 1000 of population in South-West Oltenia region according to specific source [39.][3.], 2017.

Energy characteristics of the counties of the S-W Oltenia Region is described below.

The strong points in the industrial production of the Region are hydropower (Mehedinţi, Vâlcea, Olt, Gorj) and thermoenergy (Gorj, Dolj); where the Region is the national leader (hydroelectric power 60.3%, thermoelectricity 39.6%).

- Dolj County - The main natural resources of the county are the oil and gas reserves (Stoina, Pieleşti, Coţofeni). Energetic Complex SA Craiova - power producer (930 MW installed power at SE Isalnita and SE Craiova).

- Gorj County Gorj – The county is rich in diverse natural resources, some of them exploited and used by the industries, others expecting opportunities for use. The main resources are:
    - Lignite exploited through underground or surface mines in Rovinari, Jilţ and Motru. In Gorj County, lignite deposits are 50-180 m deep. Reserves are estimated at over 1 billion tons that can be exploited for a further 40 years under exploitation at maximum yields of existing mines.
    - Oil is extracted in Zicleni, Bustuchin and Colibaşi. At the present level of production it is expected that the reserves will last for another 40-50 years.
    - Natural gas is in association with oil. Major resources are found at Bustuchin, Stoina and Turburea. Gorj county has about 35% of Romania's natural gas reserves, but there are no processing units. As a result of its reserves, in Gorj County the extractive industry occupies a leading position, its main component being the extraction of non-coking coal - lignite in two big basins, Motru and Rovinari. Lignite extraction has and continues to have a major impact on the entire economy of the county. The main problem is the decrease of Romania's electricity consumption and the orientation towards other forms of its generation (water, nuclear energy, renewable resources). In response to this, a number of measures have already been taken to reduce costs by limiting the activity to underground mines.
    - The National Company of the Oltenia Lignite Tg-Jiu supplies lignite to the large thermal power stations from Işalnita, Craiova II, Rovinari, Turceni, to other industrial units and population. Confirmed industrial reserves are 2.2 billion tons of lignite, located in the Gorj, Vâlcea and Mehedinţi counties. The extracted lignite has a calorific power of 1600-1900 kcal / kg, its use being for the production of electric and thermal energy by burning in the industrial and household facilities of the population. Gorj county occupies the first place in the country in the production of lignite through the two carboniferous basins, Rovinari and Motru.

- The National Petroleum - Tg-Jiu Branch, accounts for about 35% of the gas production and 8% of the country's oil.
- Complexul Energetic Rovinari S.A, S.C. Complexul Energetic Turceni S.A are the most important units producing electricity in the country. Changing the national energy strategy to reduce the amount of electricity generated by thermal power stations at higher costs than other forms of production (hydro, nuclear, renewable) will cause a fall not only for the three big economic players directly involved but also for the of a large number of companies that depend on their existence.

- Olt County - Slatina Hydropower Branch, one of the 12 branches of the Hydroelectric Company, puts in the potential of Olt, has 8 hydroelectric plants, totaling an installed capacity of 379 MW and an average energy output of 890 GWh / year. The first three hydropower plants (Strejeşti, Arceşti and Slatina) in the sector of the Slatina Hydropower Branch are located on the middle course of the Olt River, and the next five hydroelectric plants (Ipoteşti, Drăgăneşti, Frunzaru, Rusăneşti and Izbiceni) are located on the Lower Olt River.

- Mehedinti County- Hidroelectrica SA The Iron Gates Substation Branch - Drobeta Turnu Severin, produces the largest part of the electricity in hydropower plants, through the largest hydroelectric plants in Romania Portile de Fier I, with an installed capacity of 1080 MW and Iron Gates II, with the installed power of 250 MW. Both hydroelectric plants are operated in partnership with the Romanian and Serbian power plants at Portile de Fier I and they generate 2160 MW, and those from the Iron Gates II 500 MW

- Valcea County- The county has reserves of oil, natural gas, coal, which together with the huge hydropower potential created the possibility of developing the energy industry. In addition to the Govora Thermal Power Plant, which has an industrial capacity of 307 MW, the Lotru - Ciunget Hydroelectric Plant with 510 MW industrial power, two hydropower plants on the Lotru River, Bradisor (115 MW), Malaia (18 MW) and other 11 hydropower plants on the Olt River with a capacity of 469 MW, with a production greater than 2700 GWh/year.

4.1.8 Slovenia – Savinjska region

Slovenia is divided into two NUTS 2 regions, Vzhodna and Zahodna Slovenija and then divided further into twelve NUTS 3 regions. Savinjska is one of the eight NUTS 3 regions of Vzhodna Slovenija. It has 31 municipalities and 12% of Slovenia's population. The largest municipalities are Celje, Velenje and Žalec. The location of Savinjska region is showed in the image below.

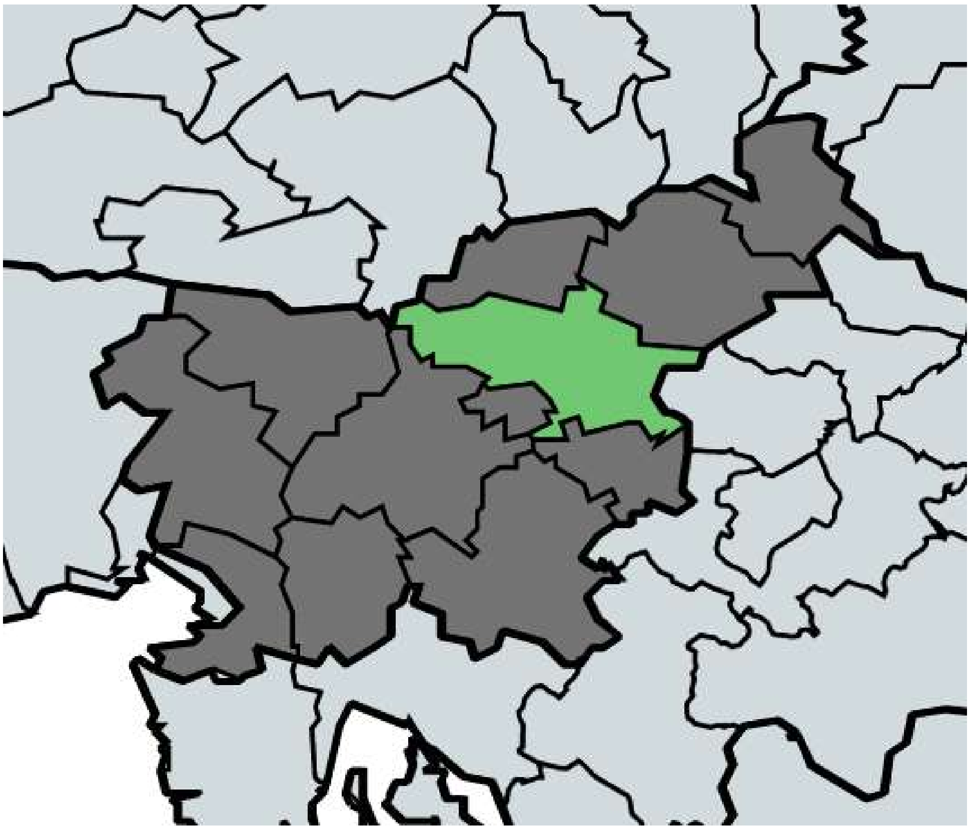


Figure 29 Location of the Savinjska region on the map.[25.]

The proportion between the population in the Yugoiztochen region and the total population in the country should be calculated according to the formula:

$$Population\ ratio = \frac{Population\ in\ a\ region}{Population\ in\ a\ country} = \frac{254{,}144}{2{,}065{,}895} = 12.3\%$$

This population factor was developed in order to scale down the national values to the regional level in case the local data are unavailable.

The only operating coal mine in Slovenia, Premogovnik Velenje (Velenje lignite mine), is situated in Velenje and at the biggest operating coal-fired power plant in the country, Termoelektrarna Šoštanj, in Šoštanj, both part of the Savinjska region. Thermal power plant Šoštanj accounts for nearly one third of country's electricity generation as well as provides thermal energy used for district heating in the Šaleška dolina valley. Slovenia is relatively small country and both within the context of the Savinjska region and the country as a whole, the lignite importance for a currently well-balanced energy mix for the security of supply reasons as well as the Šoštanj thermal power plant as one of the largest source of electricity production are the biggest factors to consider in terms of wider impacts caused by a future phase out of coal. For these reasons the report and the SWOT analysis will focus on NUTS 3 Savinjska region and in some chapters on the country as a whole as well.

Velenje coal mine is with an over 140-year tradition in lignite mining firmly rooted in the Slovenian energy economics. At today's mining output, there are enough deposits of the Velenje lignite for another four decades of the coal mine operation, however, mining sites will close before lignite reserves are exhausted due to changes in the energy industry and the envisaged changes in the operation of the thermal power plant. In 2017, Velenje lignite mine produced 3.35 million tonnes of lignite and had 1.255 employees. All of Velenje mine lignite output is used at the Šoštanj thermal power plant (93.3% of lignite is sold for electricity generation and 2.5% for heating generation).

The newest addition to the Šoštanj thermal power plant (TEŠ) was the construction of a modern, highly efficient (43%) BAT 600 MW unit with the intent to replace existing old, outdated and inefficient units and deliver CO_2 emission reductions of 35%. Unit 6 which started operating in the spring 2015 is designed to be operational until 2054.

TEŠ is the biggest thermal power plant in Slovenia with the installed power of 1029 MW:

- Unit 5, installed power: 345 MW, start year of operation: 1978 (shut down in 2015, revitalized in 2018).
- Unit 6, installed power: 600 MW, start year of operation: 2015.
- Gas unit 1, installed power: 42 MW, start year of operation: 2008.
- Gas unit 2, installed power: 42 MW, start year of operation: 2008.

The energy demand including heat supply, electricity production and cooling demand for the entire country and the Savinjska region in 2016 is presented on the following graph.

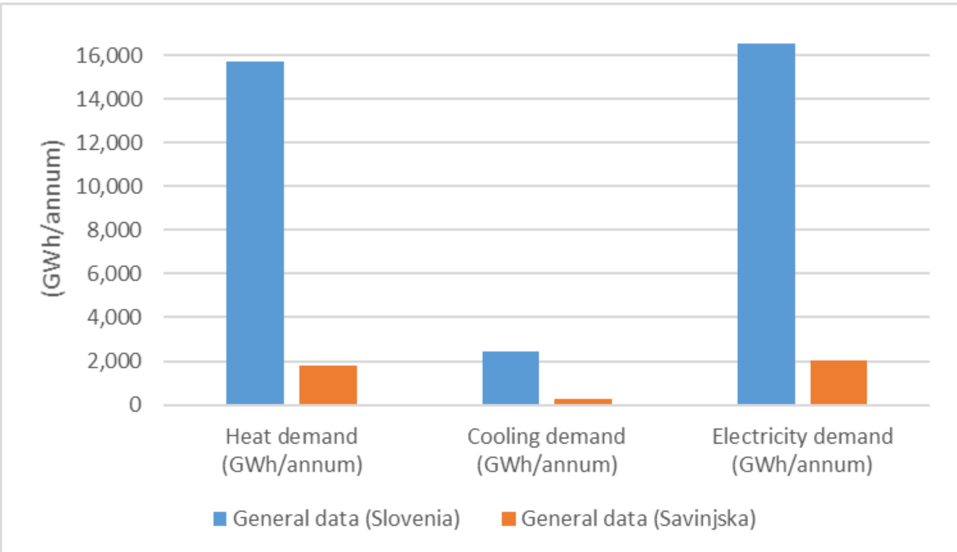


Figure 30 Annual energy demand in Slovenia and Savinjska region indicated by general source [2.], [3.] (GWh/annum), 2016.

There is no information about heat and cooling needs according to the local source, therefore the general source was used for a determination of heat and cooling demand of the region.

Electricity production for the Savinjska region was acquired by was downsizing national data to the regional level.

The next table presents the overall consumption figures for the coal in Slovenia and Savinjska region. General data was in this case very consistent with the local data, therefore the figures used in the table below derive from general source. Considering the fact that the whole amount of coal is being extracted in the Savinjska region, the coal production in the region is equal to the production in the country. Around 0.2 Mtoe of coal that was imported was primarily used at heat and power plant Termoelektrarna Toplarna Ljubljana (TE-TOL) in Ljubljana for the purposes of heat generation for the district heating system in Ljubljana in highly efficient cogeneration together with electricity.

Coal source (GWh/annum)	**Slovenia**	**Savinjska**
Coal production	10,467	10,467
Coal export	0	0
Coal import	2,326	0
Coal stock	0	0
Total coal consumption	12,793	10,467

Table 23 Annual coal consumption with the breakdown of coal source for Slovenia and Savinjska region according to general source [3.] and specific information (GWh/annum), 2016.

Coal consumption figures indicate the cumulative usage of all types of solid fuels which include hard coal and brown coal/lignite.

Nearly 30% of electricity in Slovenia is generated using lignite from Savinjska region. There was no available data for the Savinjska region, however, taking into account contribution of the coal to the country's total electricity generation and negligible contribution of other sources to the electricity generation in the region, it can be concluded that the electricity generation in the region is in a great share based on coal production. According to the general information on heat demand in the region and local data on coal-based heat sale, circa 20% of heat is produced in the coal combustion.

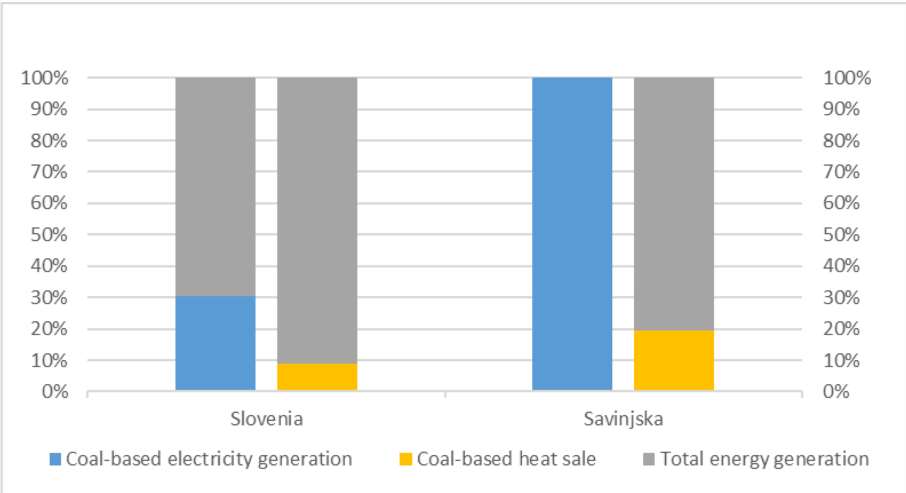


Figure 31 Proportion of energy generated using coal fuel in Slovenia and Savinjska region according to general source [2.], [3.] and specific information [43.] (%), 2016.

The exact annual energy production output is collated in the table below.

Coal-fueled energy production (GWh/annum)	Slovenia	Savinjska
Coal-based electricity generation	5,000	4,600
Total electricity generation	16,500	4,600
Coal-based heat sale	1,417	350
Total heat sale	15,733	1,808

Table 24 Total and coal-based production of heat and electricity in Slovenia and Savinjska region according to general source [3.] and specific information [42.], (GWh/annum), 2016.

The most important parameters have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in Savinjska region.

Key Performance Indicators (GWh/1000 of population)	General data	Specific data
Total coal consumption	41	
Coal-based electricity generation		18.1
Coal-based heat sale		1.4

Table 25 Coal consumption and coal-based energy production per 1000 of population in Savinjska region according to general source [3.] and specific information [42.], 2016.

4.1.9 Spain – Extremadura region

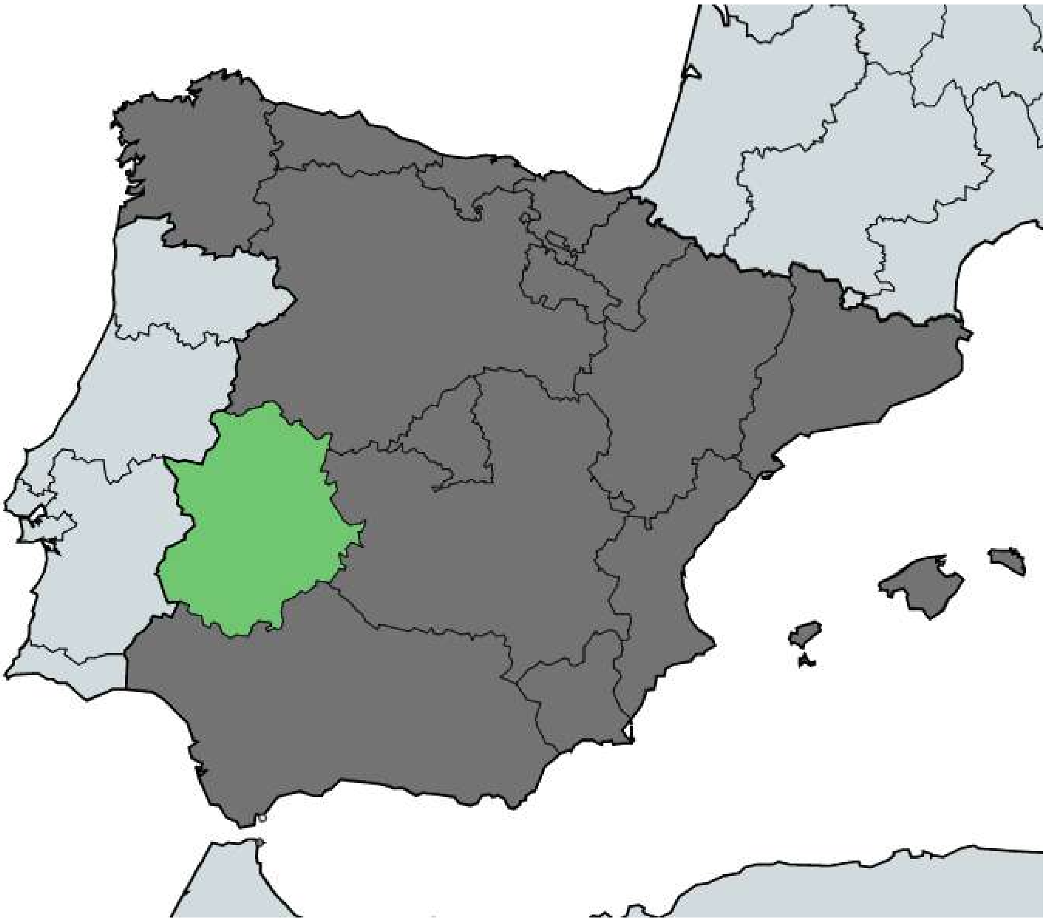


Figure 32 Location of the Extremadura region on the map.[25.]

The proportion between the population in the Extremadura region and the total population in the country should be calculated according to the formula:

$$Population\ ratio = \frac{Population\ in\ a\ region}{Population\ in\ a\ country} = \frac{1{,}077{,}525}{46{,}528{,}024} = 2.32\%$$

This population factor was developed in order to scale down the national values to the regional level in case the local data are unavailable. The energy demand including heat supply, electricity production and cooling demand for the entire region in 2016 is presented on the following graph.

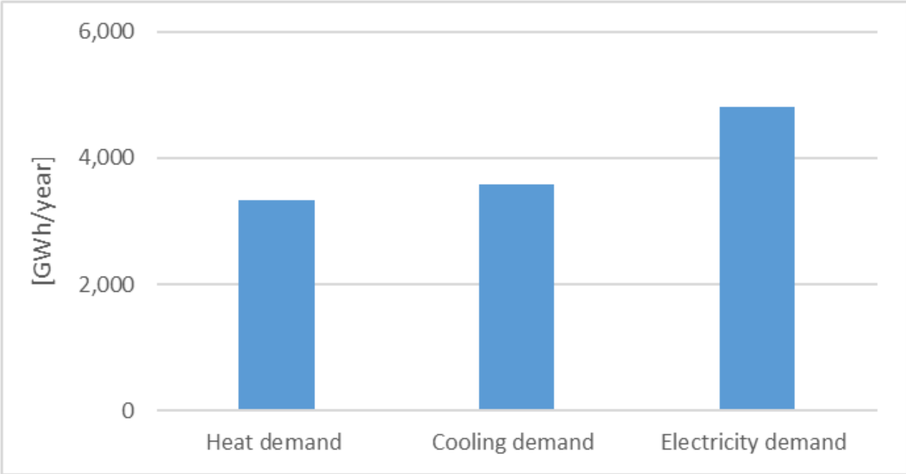


Figure 33 Annual energy demand in Extremadura region indicated by general source [2.], [3.] (GWh/annum), 2016.

There is no specific data for the region, that have been reported. The data from the national level have been collected, standardized using the population factor and reported in the following section.

Although, the following figures demonstrate a coal activity in the region, this is only a result of the extrapolation of national figures to the regional level using the population factor. Lack of the specific data sources, however, can mislead the actual picture for Extremadura, which is entirely free of any coal-intensive industry.

The annual coal consumption is collated in the table below.

Coal source (GWh/annum)	
Coal production	320
Coal export	130
Coal import	2,870
Total coal consumption	3,520

Table 26 Annual coal consumption with the breakdown of coal source Extremadura region according to general source [3.] (GWh/annum), 2016.

The next graph shows the proportion of coal-fired electricity production (blue column) and coal-fired heat production (yellow column) in total energy demand.

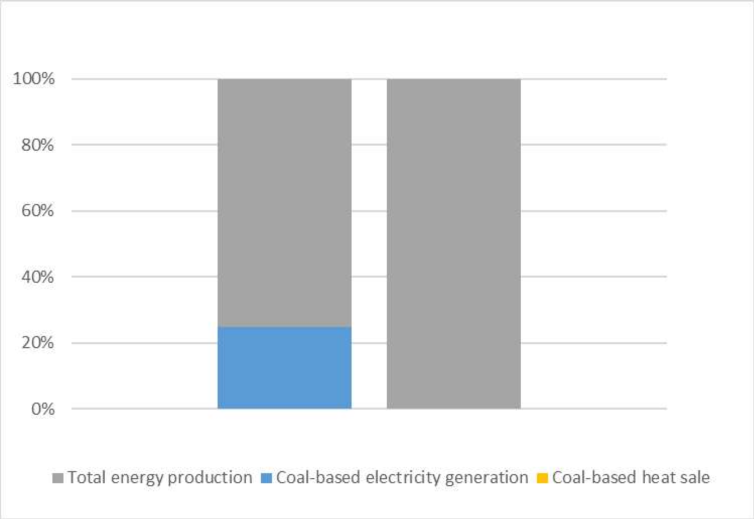


Figure 34 Proportion of energy generated using coal fuel in Extremadura region according to general source [3.][2.], (%), 2016.

Energy production using coal fuel is collated in the table below.

Coal-fueled energy production (GWh/annum)

Coal-based electricity generation	1,200
Total electricity generation	4,800
Coal-based heat sale	0
Total heat sale	3,300

Table 27 Total and coal-based production of heat and electricity in Extremadura region according to general source [3.][2.], (GWh/annum), 2016.

Coal consumption and coal-based energy production per 1000 of population is presented in the following table.

Key Performance Indicators (GWh/1000 of population)

Total coal consumption	3.3
Coal-based electricity generation	1.1
Coal-based heat sale	0.0

Table 28 Coal consumption and coal-based energy production per 1000 of population in Extremadura region according to general source [3.], 2016.

4.2 Energy sources for alternative energy production

4.2.1 Bulgaria – Yugoiztochen region

Current RES consumption

- Heat supply

The only RES source for heat production in the region origins from the biomass.

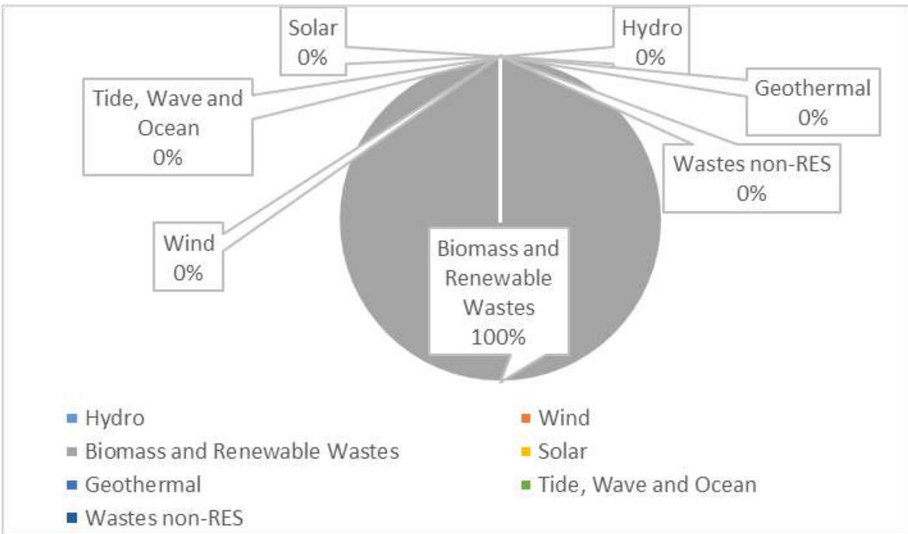


Figure 35 Heat production using renewable energy sources in Yugoiztochen region according to general source [3.], (%), 2016,

The heat production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in the region. These are presented in the table below.

Heat supply using RES

	GWh	GWh/1000 of population
Hydro	0	0.0
Wind	0	0.0
Biomass and Renewable Wastes	20	0.02
Solar	0	0.0
Geothermal	0	0.0
Tide, Wave and Ocean	0	0.0
Wastes non-RES	0	0.0
Total RES heat	20	0.0
Total heat demand	3,700	3.5

Table 29 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Yugoiztochen region (GWh) according to general source [3.] (GWh/annum), 2016.

- Electricity supply

The RES fuel mix in the electricity generation process indicates that the hydro power outnumbers the other energy sources. Over 60% of total electricity production comes from hydro power and is supplemented by even energy contribution solar PV, wind and biomass.

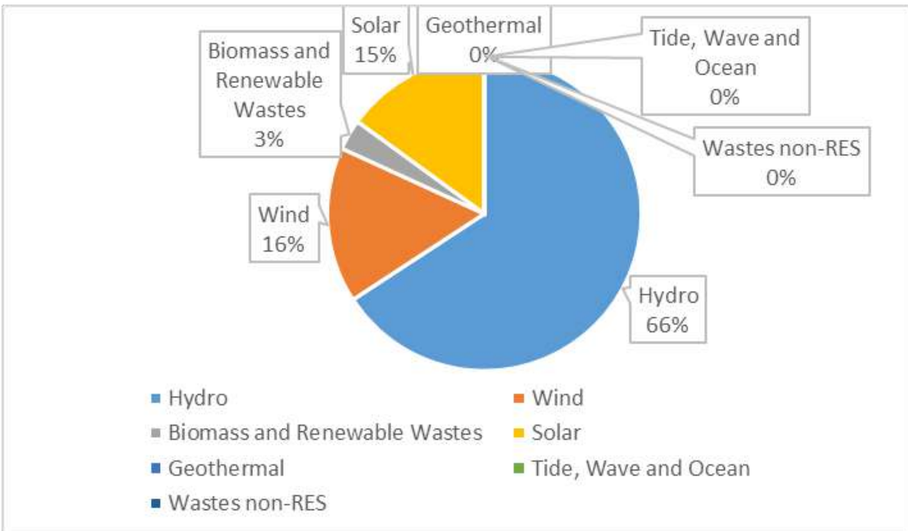


Figure 36 Electricity production using renewable energy sources the Yugoiztochen region (GWh) according to general source [3.] (GWh/annum), 2016.

The electricity production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in the region. These are presented in the table below.

Electricity production using RES

	GWh	GWh/1000 of population
Hydro	250	0.2
Wind	61	0.1
Biomass and Renewable Wastes	12	0.0
Solar	57	0.1
Geothermal	0	0.0
Tide, Wave and Ocean	0	0.0
Wastes non-RES	0	0.0
Total RES electricity	380	0.4
Total electricity demand	6,200	5.9

Table 30 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the Yugoiztochen region (GWh) according to general source [3.] (GWh/annum), 2016.

<u>Overview of total RES potential</u>

- Biomass, waste, solar energy

The next graph shows the possible heat contribution to the total heat demand using all available RES sources. This includes a biomass, waste and solar energy sources.

Please see 2 Glossary for the definitions of the presented energy sources.

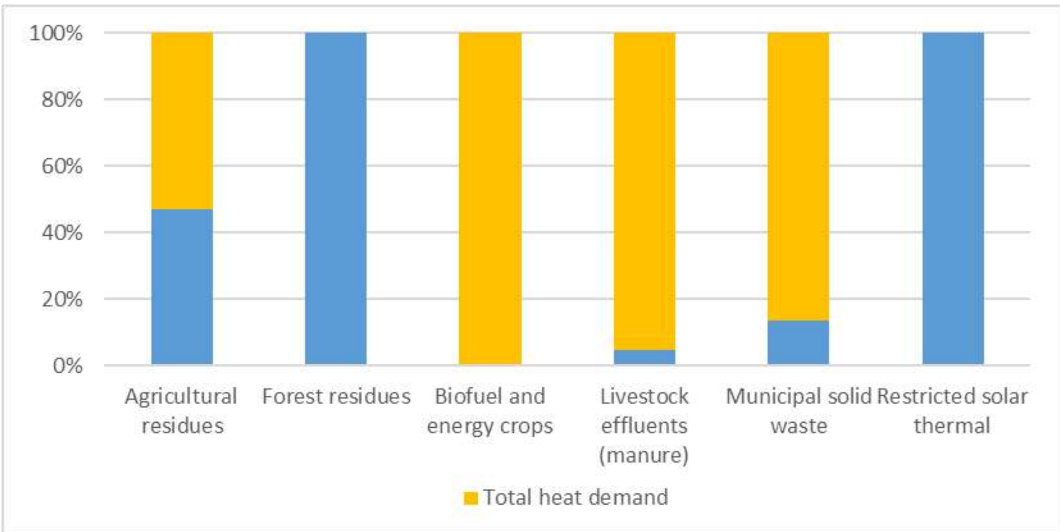


Figure 37 Heat production potential from renewable energy sources in proportion to the total heat demand in Yugoiztochen region according to general source [2.] (%), 2016.

4.2.2 Denmark – Nordjylland region

This section summarizes the current contribution of RES in energy generation and investigates the total potential of utilizing renewable energy sources which could offset coal-fired energy production.

<u>Current RES consumption</u>

- Heat supply

According to the fuel consumption statistics in 2016, majority of heat production in Nordjylland origins from biomass and renewable waste. The second most popular is geothermal energy.

The local figures of 60% biomass-based heat and 35% RES heat contribution from geothermal energy slightly diverged from the values demonstrated in the general source.

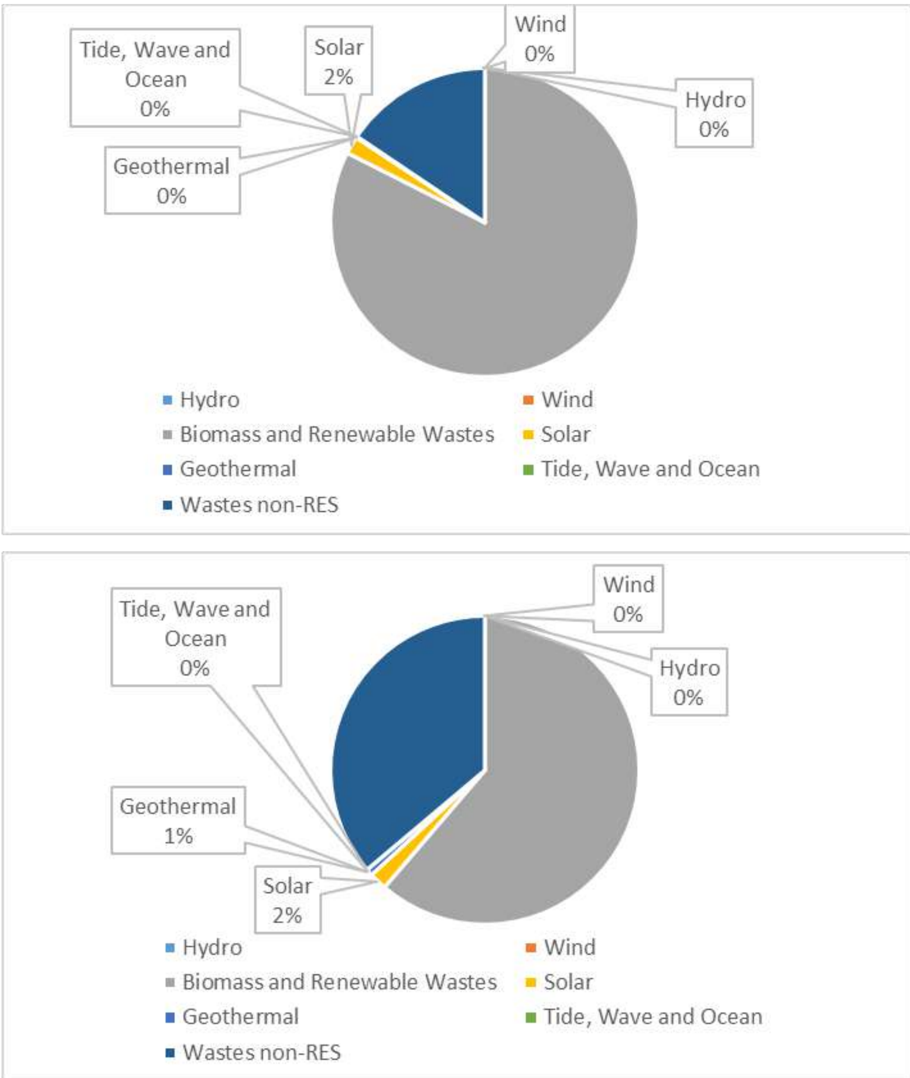


Figure 38 Heat production using renewable energy sources in Nordjylland region according to general source [3.] (top chart) and specific information [4.] (bottom chart), (%), 2016.

The annual thermal energy volumes by the renewable energy source compared with total heat demand are gather in the following table. Heat production from biomass and renewable sources is nearly 1/3 higher than it was derived using national figures. Similarly, solar heat supply is reality is twice as much while heat production from waste is more than 4 times higher.

Overall, almost half of total heat demand is supplied from the biomass and renewable waste fired plants. The second highest heat contributor (30% of total heat needs in the region) is energy from waste.

The heat production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in Nordjylland. These are presented in the table below.

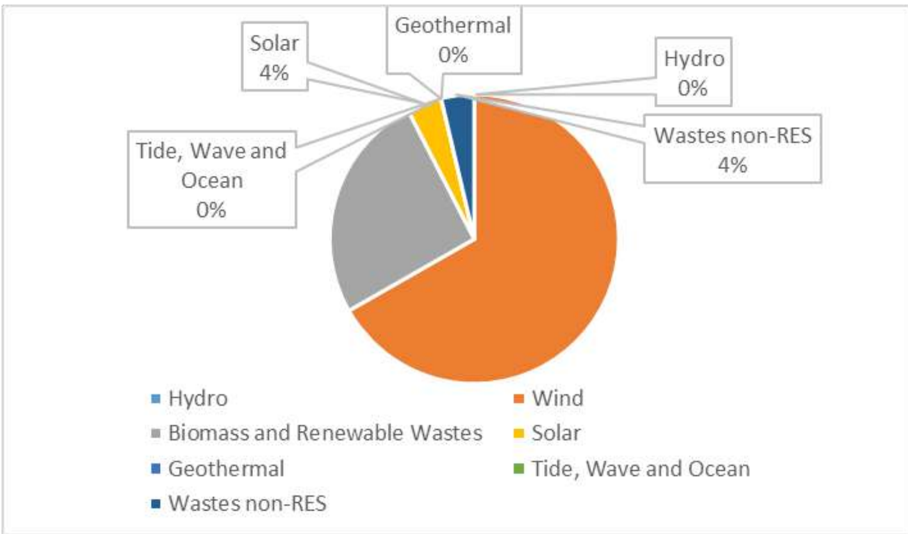
Heat supply using RES

	General data		Specific data	
	GWh	GWh/1000 of population	GWh	GWh/1000 of population
Hydro	0	0.0	0	0.0
Wind	0	0.0	0	0.0
Biomass and Renewable Wastes	1,890	3.2	2,840	4.8
Solar	40	0.1	90	0.2
Geothermal	5	0.0	30	0.1
Tide, Wave and Ocean	0	0.0	0	0.0
Wastes non-RES	360	0.6	1,680	2.9
Total RES heat	2,290	3.9	4,640	7.9
Total heat demand	5,880	10.0	5,970	10.2

Table 31 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Nordjylland region (GWh) according to general source [3.] and specific information [4.] (GWh/annum), 2016.

- Electricity supply

The RES fuel mix in the electricity generation process indicates that the wind power outnumbers the other energy sources. Nearly 90% of total electricity production comes from wind power and is supplemented by energy from waste, solar PV and biomass. These proportions slightly diverge when compared with the national figures.



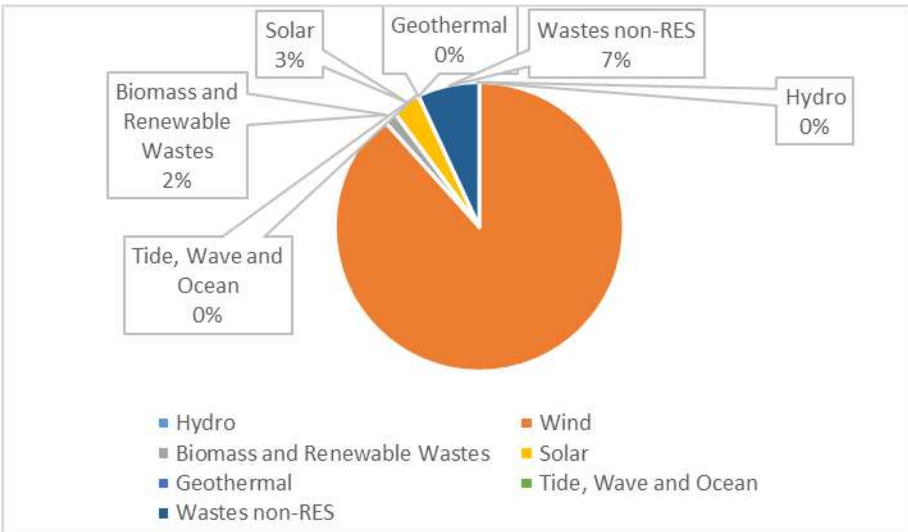


Figure 39 Electricity production using renewable energy sources in Nordjylland region according to general source [3.] (top chart) and specific information [4.] (bottom chart) 2016, (%).

In total energy balance, almost half of electricity consumption in the region is covered by the wind farms. The electricity production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in Nordjylland. These are presented in the table below.

Electricity production using RES

	General data		Specific data	
	GWh	GWh/1000 of population	GWh	GWh/1000 of population
Hydro	0	0.0	0	0.0
Wind	1,310	2.2	2,070	3.5
Biomass and Renewable Wastes	500	0.9	30	0.1
Solar	80	0.1	80	0.1

Geothermal	0	0.0	0	0.0
Tide, Wave and Ocean	0	0.0	0	0.0
Wastes non-RES	70	0.1	160	0.3
Total RES electricity	1,960	3.3	2,340	4.0
Total electricity demand	3,120	5.3	4,260	7.3

Table 32 Electricity production using RES and its proportion per 1000 of population compared to total electricity demand in the Nordjylland region according to general source [3.] and specific information [4.] (GWh/annum), 2016.

<u>Overview of total RES potential</u>

Based on the available resources in the Nordjylland region, there is still a plenty of potential for RES energy generation.

- Biomass, waste, solar energy

The next graph shows the possible heat contribution to the total heat demand using all available RES sources. This includes a biomass, waste and solar energy sources.

The figures in the adjacent columns are sourced from different data sources, the national statistics and the local information. Please see 2 Glossary for the definitions of the presented energy sources.

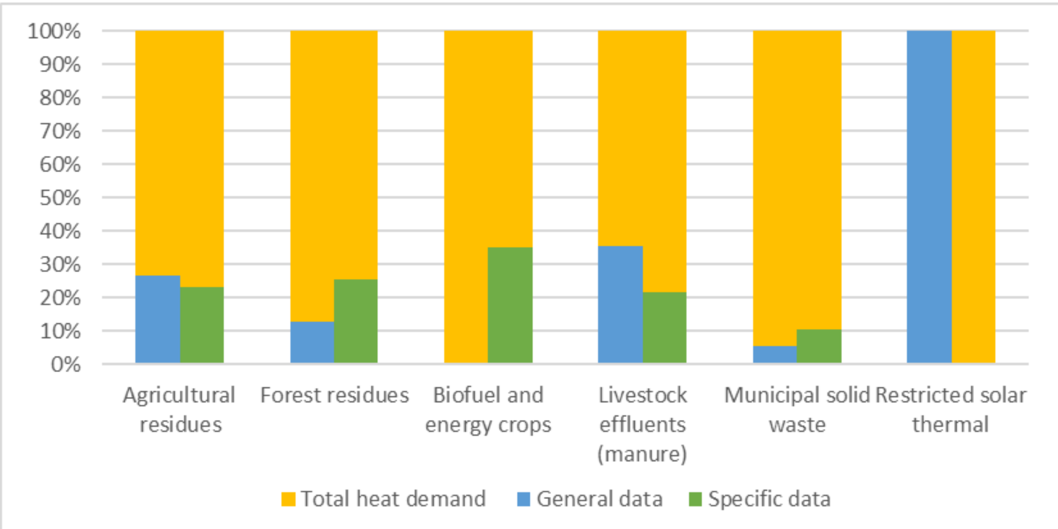


Figure 40 Heat production potential from renewable energy sources in proportion to the total heat demand in Nordjylland region according to general source [2.] and specific information [4.] (%), 2016.

- Geothermal energy

The potential of shallow geothermal energy is identified at average 1.04 W/mK. This thermal conductivity of the ground, based on the scale <0.7; 1.2 W/mK> and compared to all European locations, indicates a good ability of the soil to transfer heat. [2.] This, however, only refer to the undersurface layers. The thermal conditions of the deep ground in the Nordjylland region, are rather ordinary. There are neither areas with the heat-flow density (HFD) above 90 mW/m^2 nor high temperature distribution (>50°C) below 1000 m. The southern parts of the region have, however, potential underground reservoirs (area marked in green in the following map).

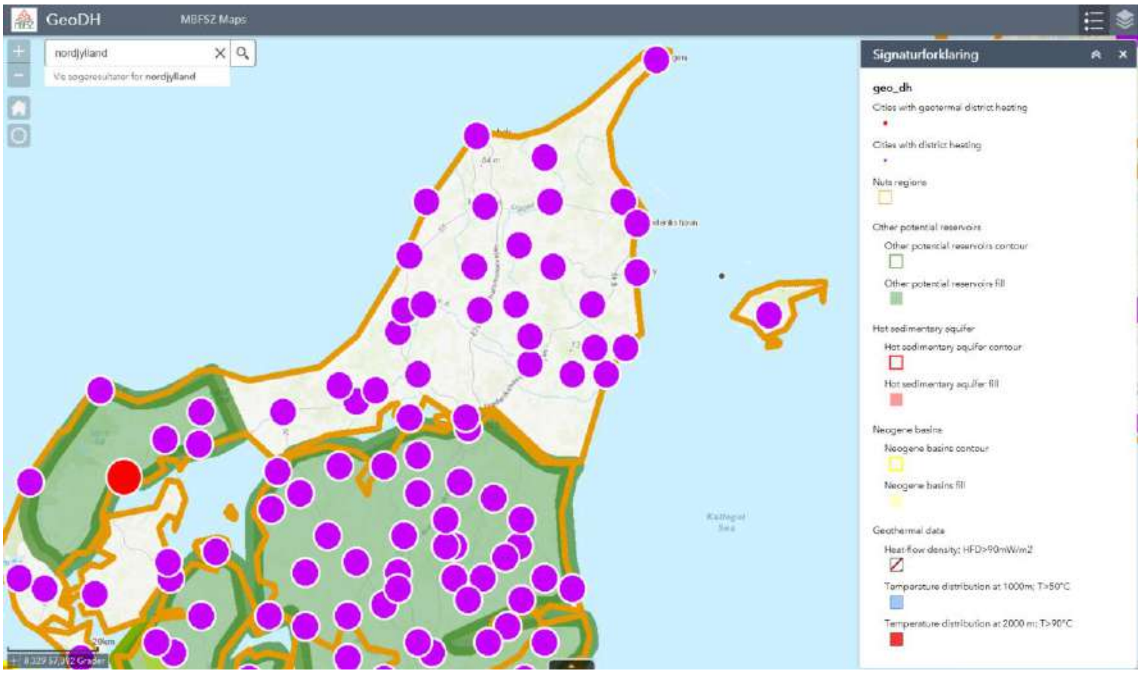


Figure 41 Geothermal energy potential in Nordjylland region. [11.]

- Excess heat

The other alternative for coal-based energy is and excess heat. This can be extracted from the industrial sites that are already in operation as e.g. waste combustion plants, water treatment plants and power plants. The estimated potential of heat production using different excess heat source is presented on the graph below.

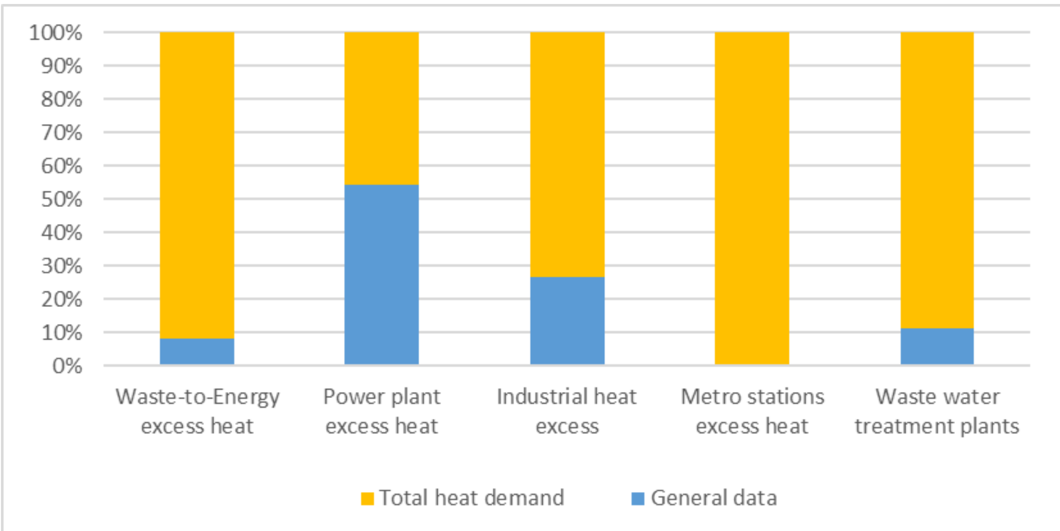


Figure 42 Excess heat potential in Nordjylland region. [12.]

- Wind power

Wind parameters in the region are listed in the table below.

Wind potential at 50 meters		
Average wind speed	6	m/s
Maximum wind speed	14	m/s
Minimum wind speed	4	m/s

Table 33 Wind power potential in Nordjylland region. [2.], (m/s).

The wind power has the largest potential in the western parts of the land and along the coastline. The mean power density for 10% of windiest area in Nordjylland is 540 W/m^2. The typical wind energy density as can be concluded from the map below, is around 350 W/m^2 on the land and circa 700 W/m^2 for the offshore installations.[5.]

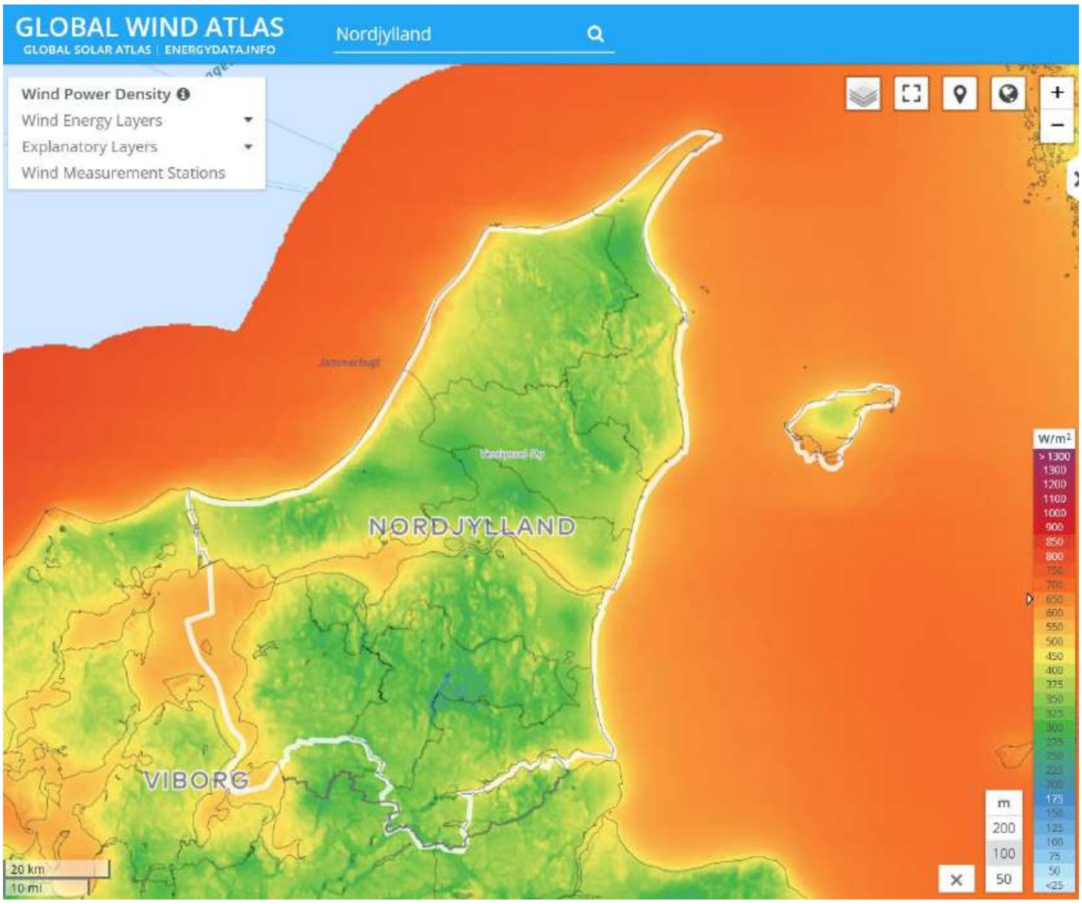


Figure Wind potential in Nordjylland region [5.], (W/m²).

4.2.3 Germany –Lausitz-Spreewald region

This section summarizes the current contribution of RES in energy generation and investigates the total potential of utilizing renewable energy sources which could offset coal-fired energy production.

Current RES consumption

- Heat supply

According to the fuel consumption statistics in 2016, majority of heat production in Lausitz-Spreewald origins from biomass and renewable waste reaching almost 80% contribution. In the second place almost equally popular (between 5% and 8%) are solar thermal, geothermal energy and non-renewable waste.

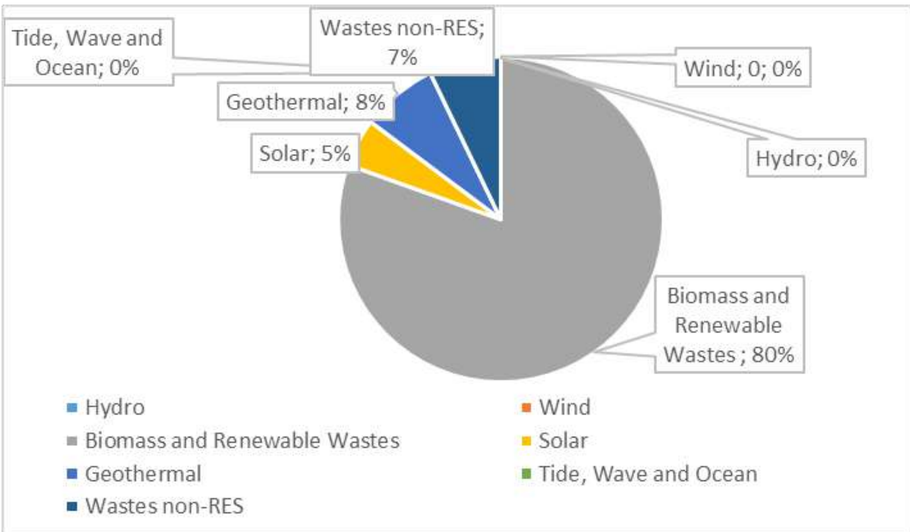


Figure 43 Heat production using renewable energy sources in Lausitz-Spreewald region according to specific information 252[16.], (%), 2015/2016.

The annual thermal energy volumes by the renewable energy source compared with total heat demand are gathered in the following table.

Overall, almost 1/5 of total heat demand is supplied renewable energy resources.

The heat production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in Lausitz-Spreewald. These are presented in the table below.

Heat supply using RES

	GWh	GWh/1000 of population
Hydro	0	0.0
Wind	0	0.0
Biomass and Renewable Wastes	860	1.5
Solar	50	0.1
Geothermal	80	0.1
Tide, Wave and Ocean	0	0.0
Wastes non-RES	80	0.1
Total RES heat	1,070	1.8
Total heat demand	5,500	9.4

Table 34 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Lausitz-Spreewald region (GWh) according to specific information [16.], (GWh/annum), 2015/2016.

- Electricity supply

The RES fuel mix in the electricity generation process indicates that the wind power outnumbers the other energy sources. Over 60% of total electricity production comes from wind power and is supplemented by even energy contribution solar PV and biomass.

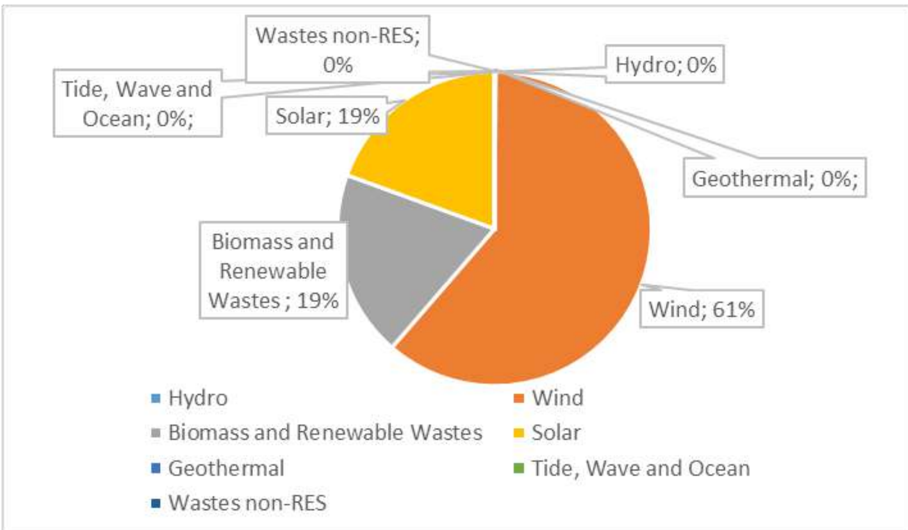


Figure 44 Electricity production using renewable energy sources the Lausitz-Spreewald region (GWh) according to specific information [16.], (GWh/annum), 2015/2016.

In total energy balance, almost nearly 1/3 of electricity consumption in the region is covered by the renewables.

The electricity production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in Lausitz-Spreewald. These are presented in the table below.

Electricity production using RES

	GWh	GWh/1000 of population
Hydro	1	0.0
Wind	680	1.2
Biomass and Renewable Wastes	210	0.4
Solar	220	0.4
Geothermal	0	0.0
Tide, Wave and Ocean	0	0.0
Wastes non-RES	0	0.0
Total RES electricity	1,110	1.9
Total electricity demand	4,200	7.2

Table 35 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the Lausitz-Spreewald region (GWh) according specific information [16.], (GWh/annum), 2015/2016.

Overview of total RES potential

Based on the available resources in the Lausitz-Spreewald region, there is still a significant potential for RES energy generation.

- Biomass, waste, solar energy

The next graph shows the possible heat contribution to the total heat demand using all available RES sources. This includes a biomass, waste and solar energy sources.

The figures in the adjacent columns are sourced from different data sources, the national statistics and the local information. Please see 2 Glossary for the definitions of the presented energy sources.

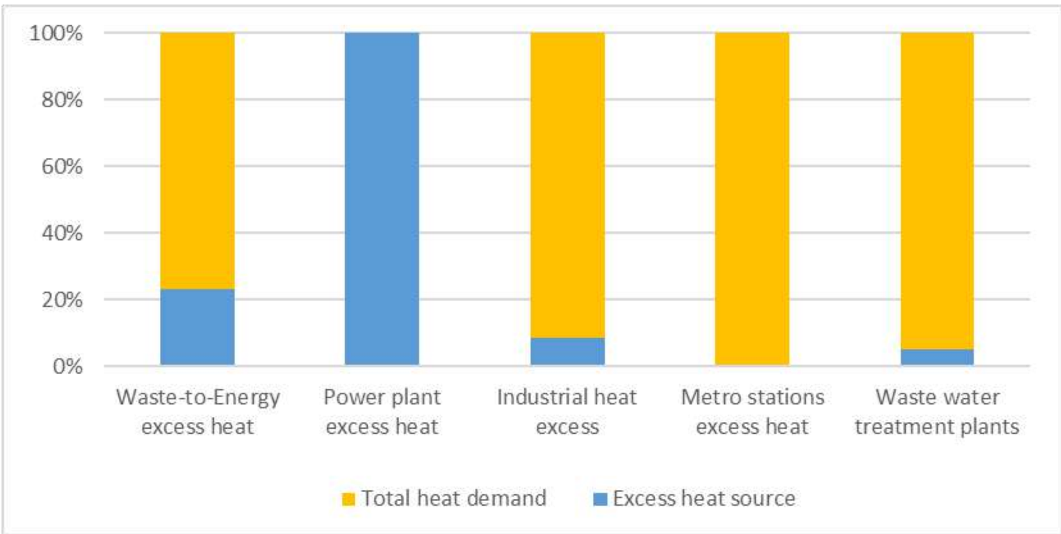


Figure 45 Heat production potential from renewable energy sources in proportion to the total heat demand in Lausitz-Spreewald region according to general source [2.] (%), 2016.

- Geothermal energy

The potential of shallow geothermal energy is identified at average 40 W/mK. This thermal conductivity of the ground, compared to all European locations, indicates a good ability of the soil to transfer heat. [2.] This, however, only refer to the undersurface layers.

The thermal conditions of the deep ground in most of the Lausitz-Spreewald region, are rather ordinary. There are neither areas with the heat-flow density (HFD) above 90 mW/m^2 nor high temperature distribution (>50°C) below 1000 m. Only the northern parts of the region (DE406 – Dahme-Spreewald) demonstrate to have some underground heat sources above 50°C at depth below 1000 m and even 90°C at depth below 2000 m. (area marked in red and blue in the following map).

The region has also a high potential of underground reservoirs (area marked in green in the following map).

Figure 46 Geothermal energy potential in Lausitz-Spreewald region [11.].

- Excess heat

The other alternative for coal-based energy is an excess heat. This can be extracted from the industrial sites that are already in operation as e.g. waste combustion plants, water treatment plants and power plants. The estimated potential of heat production using different excess heat source is presented on the graph below.

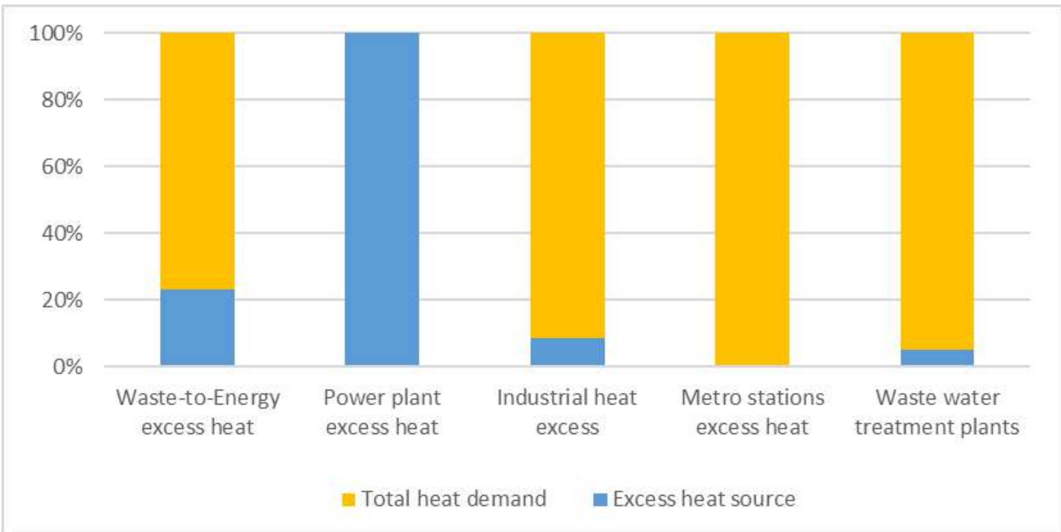


Figure 47 Excess heat potential in Lausitz-Spreewald region [12.].

The highest excess heat source that in theory could cover the total heat demand of the state is generated in the coal-fired power plants. The phasing out of coal strategy assumes shutting down the existing coal facilities which indicate this excess heat would no longer be in place.

However, the potential replacement of the coal-fueled plants with alternative technologies could reinstate the opportunity of utilizing waste heat for district heating supply.

- Wind power

Wind parameters in the region are listed in the table below.

Wind potential at 50 meters		
Average wind speed	3	m/s
Maximum wind speed	5	m/s
Minimum wind speed	2	m/s

Table 36 Wind power potential in Lausitz-Spreewald region [2.], (m/s).

The wind power has the largest potential in the southern and central parts of the state. The mean power density for 10% of windiest area in the entire Brandenburg region is 330 W/m^2. The typical wind energy density in the Lausitz-Spreewald as can be concluded from the map below, is around 200 W/m^2 which is peaking up to 300 W/m^2 in the windiest sections of theregion.[5.]

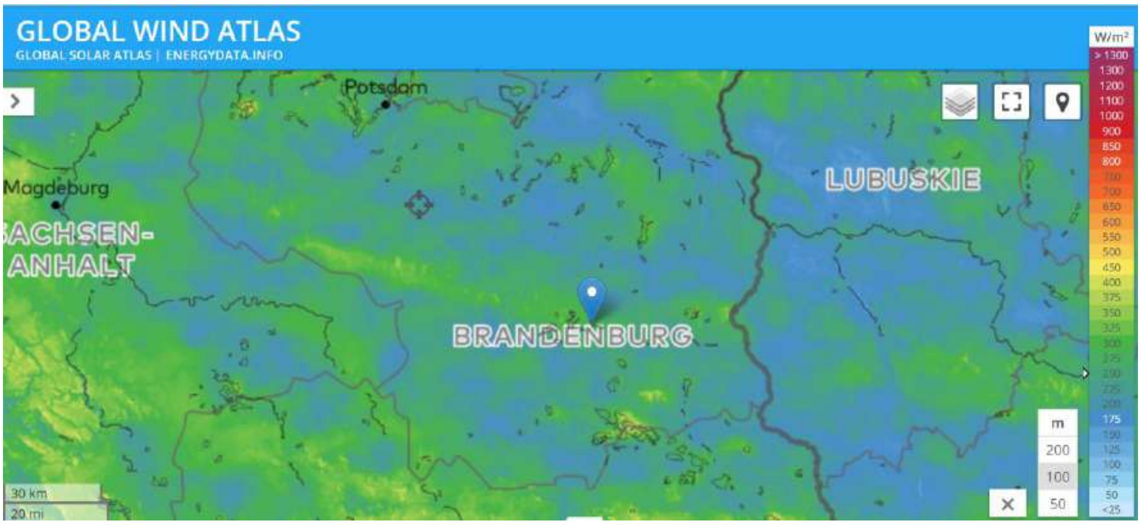


Figure Wind potential in Lausitz-Spreewald region [5.], (W/m^2).

4.2.4 Greece – Western Macedonia region

This section summarizes the current contribution of RES in energy generation and investigates the total potential of utilizing renewable energy sources which can act as alternative solutions to the lignite energy production.

Current RES consumption

- Heat supply

According to the fuel consumption statistics in 2016, renewable sources are not involved in the heat sold category of Western Macedonia, which presents the same profile as the total country.

According to EUROSTAT, the share of renewable energy in gross final energy consumption by the heating and cooling sector in Greece was 15.08% during 2016 (Code: sdg_07_40)[31.]. Due to unavailability of specific data published in regional basis, the national average was used in order to estimate a value of 292 GWh produced by biomass and solar in Western Macedonia.

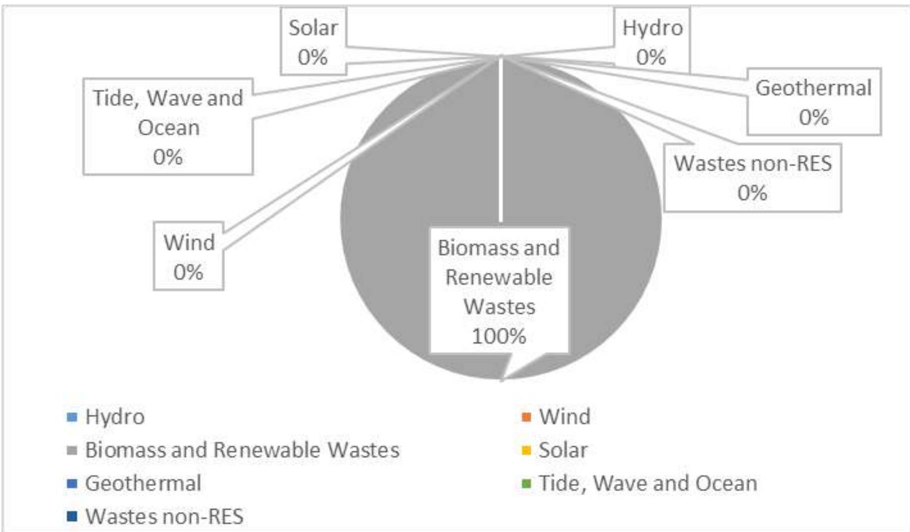


Figure 48 Heat production using renewable energy sources in Western Macedonia region according to general source [31.][3.], (%), 2016.

The heat production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in the region. These are presented in the table below.

Heat supply using RES

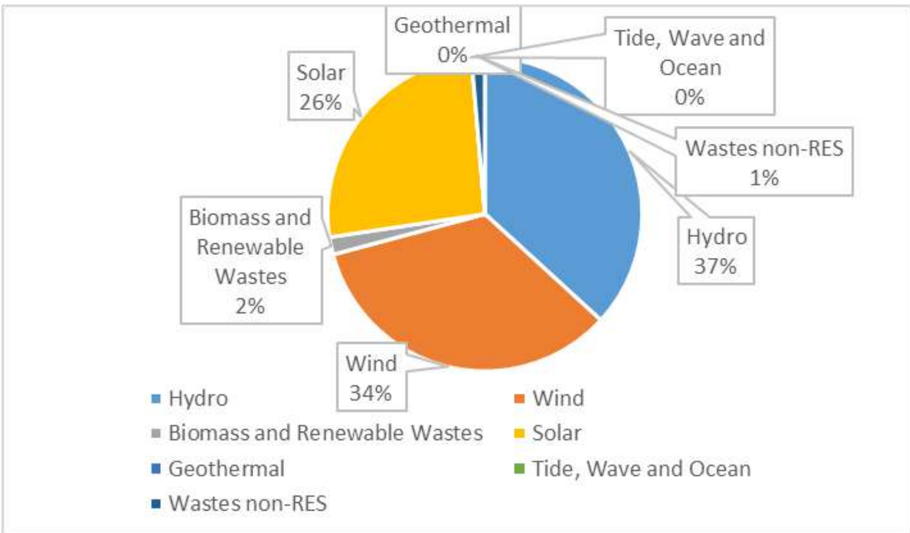
	GWh	GWh/1000 of population
Hydro	0	0.0
Wind	0	0.0
Biomass and Renewable Wastes	290	1.1
Solar	0	0.0
Geothermal	0	0.0

Tide, Wave and Ocean	0	0.0
Wastes non-RES	0	0.0
Total RES heat	290	1.1
Total heat demand	1,950	7.2

Table 37 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Western Macedonia region (GWh) according to general source [31.][3.], (GWh/annum), 2016.

- Electricity supply

The RES fuel mix in the electricity generation process is relevant to the Greek interconnected system supplying electricity the mainland of the country. These values are slightly diverge compared with the national figures, where also non interconnected system is taken into account. A significant deviation deals with hydro where in specific data only RES hydro, meaning small scale hydro plants have been taken into account.



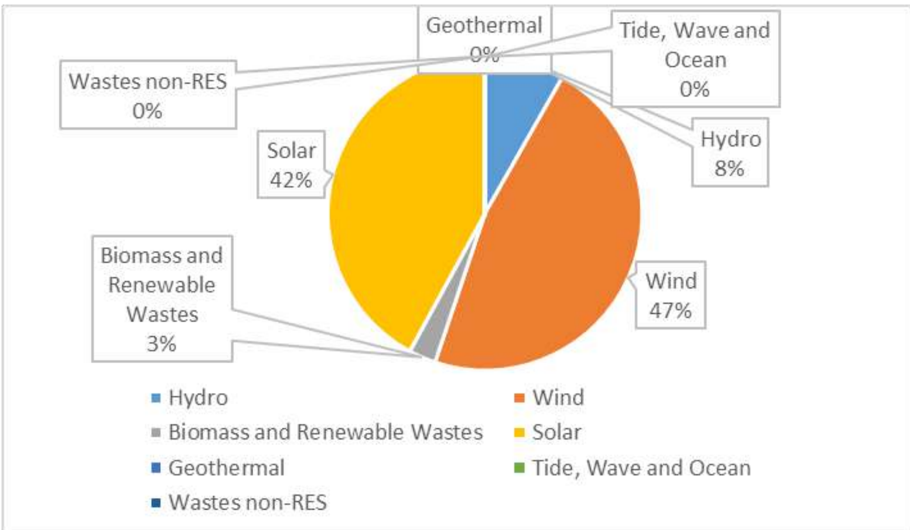


Figure 49 Electricity production using renewable energy sources in Western Macedonia region according to general source [3.] (top chart) and specific information [26.],[33.] (bottom chart) (%), 2016.

Western Macedonia, having equal energy supply profile with the national grid covers almost 20% of the electricity consumption by RES as depicted in the following table.

Electricity production using RES

	General data		Specific data	
	GWh	GWh/1000 of population	GWh	GWh/1000 of population
Hydro	140	0.5	19	0.1
Wind	130	0.5	109	0.4
Biomass and Renewable Wastes	10	0.0	7	0.0
Solar	100	0.4	97	0.4
Geothermal	0	0.0	0	0.0
Tide, Wave and Ocean	0	0.0	0	0.0
Wastes non-RES	10	0.0	0	0.0
Total RES electricity	380	1.4	265	1.0
Total electricity demand	1,305	4.8	933	3.4

Table 38 Electricity production using RES and its proportion per 1000 of population compared to total electricity demand in the Western Macedonia region according to general source [3.] and specific information [26.],[33.] (GWh/annum), 2016.

Overview of total RES potential

Based on the available resources in the Western Macedonia region, there is still a plenty of potential for RES energy generation.

- Biomass, waste, solar energy

The next graph shows the possible heat contribution to the total heat demand using all available RES sources. This includes a biomass, waste and solar energy sources. The figures in the adjacent columns are sourced from different data sources, the national statistics and the local information.

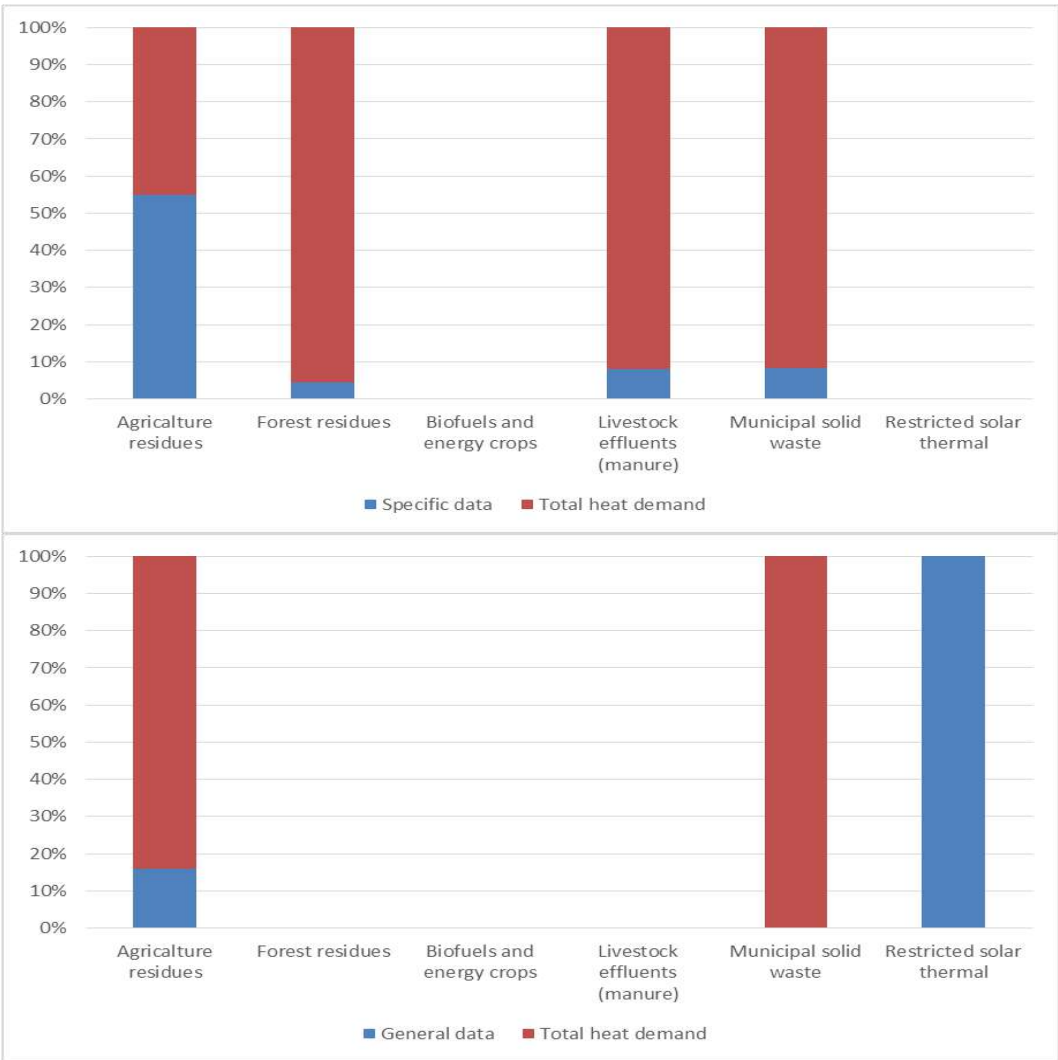


Figure 50 Heat production potential from renewable energy sources in proportion to the total heat demand in Western Macedonia region according to general source [2.] and specific information [4.] (%), 2016.

- Geothermal energy

Although geothermal potential are not identified in the general data for the region, it is estimated that a solution involving geothermal heat pumps can bring a magnitude of 202 GWh or 10.4 of heat demand in Western Macedonia thermal needs [14].

- Excess heat

A very limited potential of excess heat utilization in the region of Western Macedonia is presented based only on waste water treatment plants according to the available data.

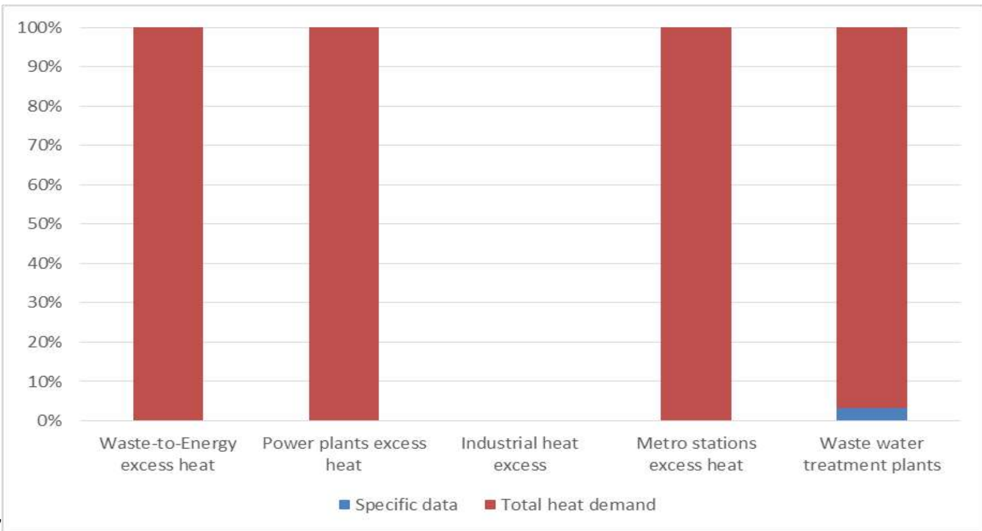


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Figure 51 Excess heat potential in Western Macedonia region, [12.].

- Wind power

Wind parameters in the region are listed in the table below.

Wind potential at 50 meters		
Average wind speed	2.45	m/s
Maximum wind speed	11.52	m/s
Minimum wind speed	0.31	m/s

Table 39 Wind power potential in Western Macedonia region, [2.], (m/s).

The wind power potential is rather limited in comparison with other regions in Greece, having also a narrow frame of application in appropriate locations.[5.]

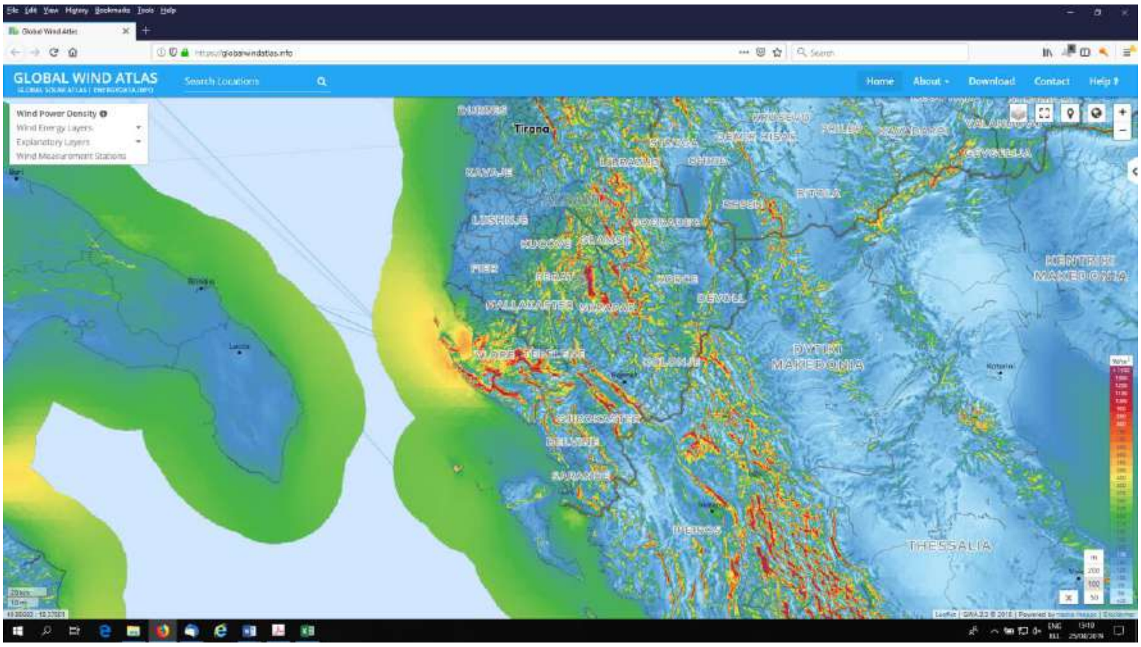

Figure 52 Wind potential in Western Macedonia region, [5.], (W/m²).

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4.2.5 Hungary – Észak-Alföld region

Current RES consumption

- Heat supply

The key RES source for heat production in the region origins from the biomass.

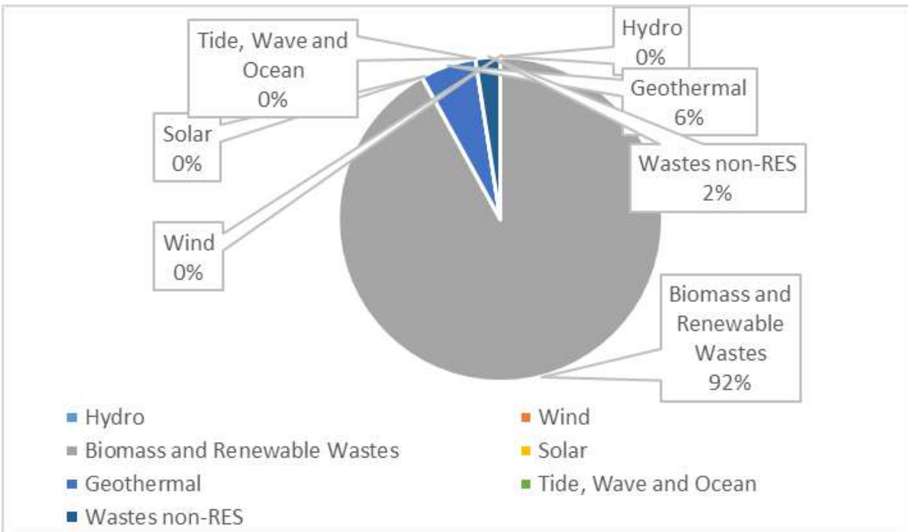


Figure 53 Heat production using renewable energy sources in Észak-Alföld region according to general source [3.], (%), 2016,

The heat production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in the region. These are presented in the table below.

Heat supply using RES

	GWh	GWh/1000 of population
Hydro	0	0.0
Wind	0	0.0
Biomass and Renewable Wastes	240	0.2
Solar	0	0.0
Geothermal	10	0.0
Tide, Wave and Ocean	0	0.0
Wastes non-RES	10	0.0
Total RES heat	260	0.2
Total heat demand	9,200	6.3

Table 40 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Észak-Alföld region (GWh) according to general source [3.] (GWh/annum), 2016.

- Electricity supply

The RES fuel mix in the electricity generation process indicates that the hydro power outnumbers the other energy sources. Over 60% of total electricity production comes from hydro power and is supplemented by even energy contribution solar PV, wind and biomass.

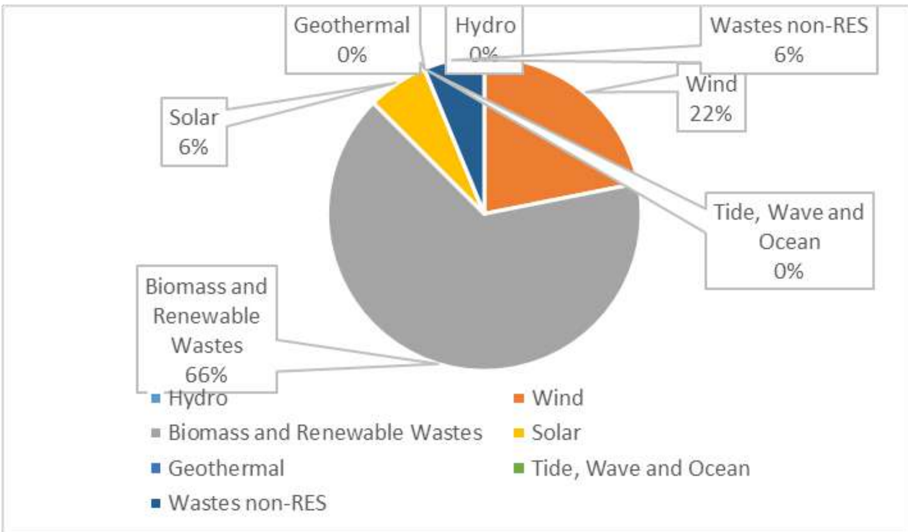


Figure 54 Electricity production using renewable energy sources the Észak-Alföld region (GWh) according to general source [3.] (GWh/annum), 2016.

The electricity production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in the region. These are presented in the table below.

Electricity production using RES

	GWh	GWh/1000 of population
Hydro	250	2.4
Wind	61	0.6
Biomass and Renewable Wastes	12	0.1
Solar	57	0.5
Geothermal	0	0.0
Tide, Wave and Ocean	0	0.0
Wastes non-RES	0	0.0
Total RES electricity	380	3.6
Total electricity demand	6,200	6.6

Table 41 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the Észak-Alföld region (GWh) according to general source [3.] (GWh/annum), 2016.

Overview of total RES potential

- Biomass, waste, solar energy

The next graph shows the possible heat contribution to the total heat demand using all available RES sources. This includes a biomass, waste and solar energy sources.

Please see 2 Glossary for the definitions of the presented energy sources.

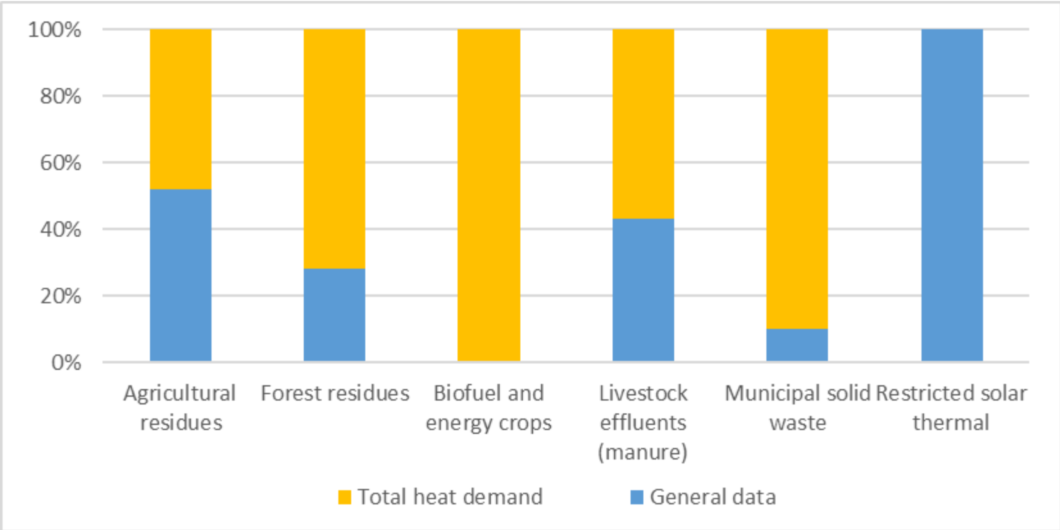


Figure 55 Heat production potential from renewable energy sources in proportion to the total heat demand in Észak-Alföld region according to general source [2.] (%), 2016.

- Excess heat

The other alternative for coal-based energy is and excess heat. This can be extracted from the industrial sites that are already in operation as e.g. waste combustion plants, water treatment plants and power plants. The estimated potential of heat production using different excess heat source is presented on the graph below.

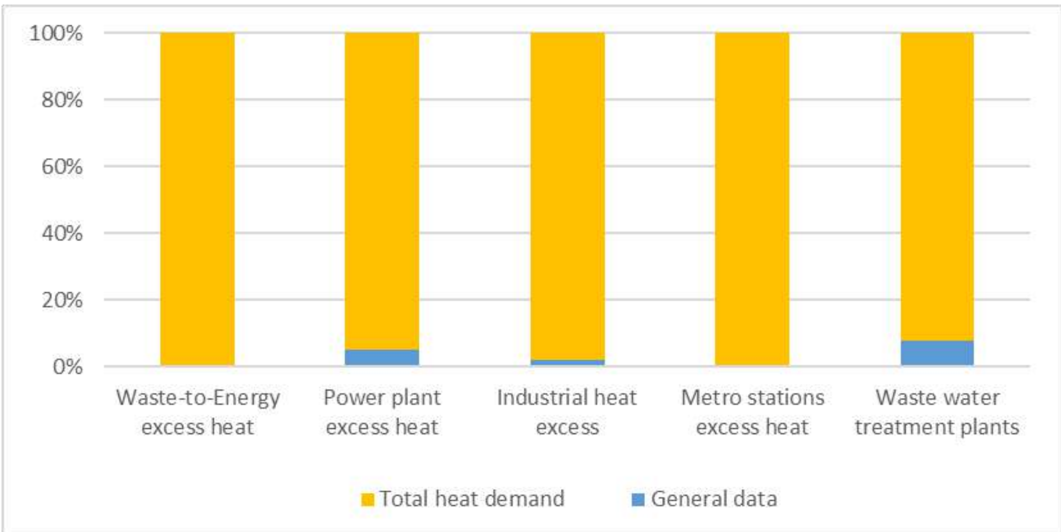


Figure 56 Excess heat potential in Észak-Alföld region. [12.]

- Wind power

Wind parameters in the region are listed in the table below.

Wind potential at 50 meters		
Average wind speed	2.68	m/s
Maximum wind speed	13.74	m/s
Minimum wind speed	1.21	m/s

Table 42 Wind power potential in Észak-Alföld region. [2.], (m/s).

The typical wind energy density as can be concluded from the map below, is around 175 W/m^2 on the land and there is no access to the sea for the offshore installations.[5.]

4.2.6 Poland – Lodzkie region

The resources of alternative energy in Lodzkie region are mainly facilitated by climatic conditions and geothermal water deposits. Due to the location of the region, in the very center of the country, the climate is mild and sunny, especially the central and eastern parts of the voivodeship - the districts the city of Lodz and the eastern Lodz. The development of photovoltaics is especially present and active in poviats: Brzeziński, Rawski and Tomaszów as well as Opoczyński.

In 2016, 86 municipalities had solar and photovoltaic installations located in public utility buildings, which were used exclusively for heating and electricity generation for own needs. Large-scale photovoltaic installations are also developing more and more intensively.

The production of energy using wind power plants is also quite favorable, especially in the northern parts of the region in the following districts: Kutnowski, Łęczycki, Łowicki and the northern parts of the districts: Poddębicki, Zgierski, Brzeziński and Skierniewicki. In 2016, there were approx. 475 wind power plants operating in the voivodeship with the total capacity of approx. 600 MW.

The region has large reserves of geothermal waters, with the potential of development of heating purposes. The most productive are the waters of Lower Cretaceous and Lower Jurassic, located in the districts of Poddębice, as well as in the north parts of the region.

Current RES consumption

- Heat supply

The key RES source for heat production in the region origins from the biomass.

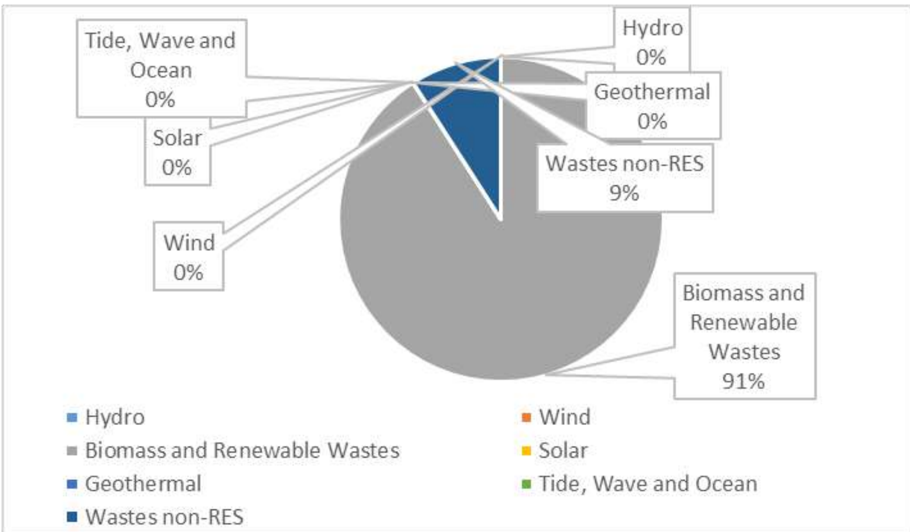


Figure 57 Heat production using renewable energy sources in Lodzkie region according to general source [3.], (%), 2016,

The heat production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in the region. These are presented in the table below.

Heat supply using RES

	GWh	GWh/1000 of population
Hydro	0	0.0
Wind	0	0.0
Biomass and Renewable Wastes	250	0.1
Solar	0	0.0
Geothermal	0	0.0
Tide, Wave and Ocean	0	0.0
Wastes non-RES	30	0.0
Total RES heat	280	0.1
Total heat demand	16,800	6.8

Table 43 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Lodzkie region (GWh) according to general source [3.] (GWh/annum), 2016.

- Electricity supply

The RES fuel mix in the electricity generation process indicates that the biomass power outnumbers the other energy sources. Over 60% of total electricity production comes from biomass power and is supplemented by hydro and wind energy.

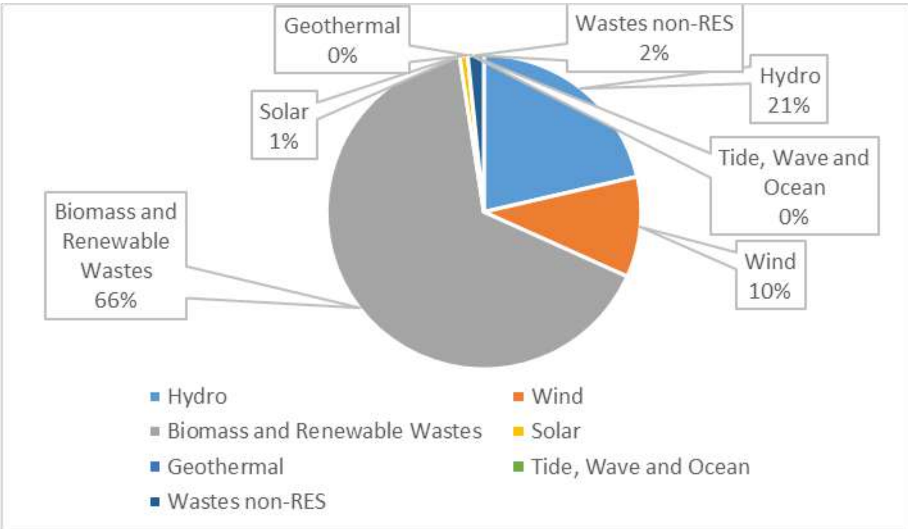


Figure 58 Electricity production using renewable energy sources the Lodzkie region (GWh) according to general source [3.] (GWh/annum), 2016.

The electricity production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in the region. These are presented in the table below.

Electricity production using RES

	GWh	GWh/1000 of population
Hydro	169	0.1
Wind	80	0.0
Biomass and Renewable Wastes	520	0.2
Solar	10	0.0
Geothermal	0	0.0
Tide, Wave and Ocean	0	0.0
Wastes non-RES	10	0.0
Total RES electricity	790	0.3
Total electricity demand	10,800	4.4

Table 44 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the Lodzkie region (GWh) according to general source [3.] (GWh/annum), 2016.

Overview of total RES potential

- Biomass, waste, solar energy

The next graph shows the possible heat contribution to the total heat demand using all available RES sources. This includes a biomass, waste and solar energy sources.

Please see 2 Glossary for the definitions of the presented energy sources.

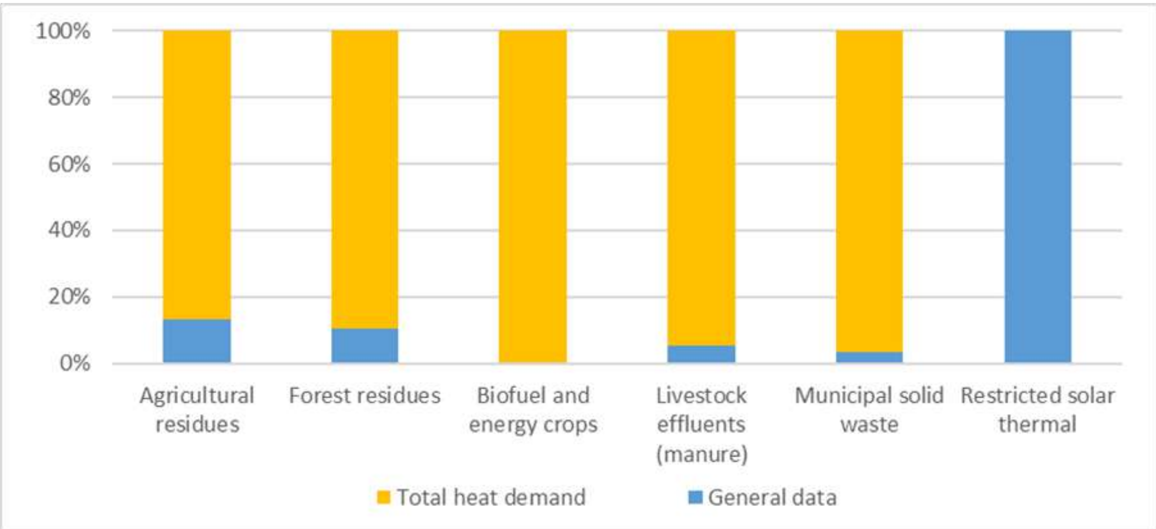


Figure 59 Heat production potential from renewable energy sources in proportion to the total heat demand in Lodzkie region according to general source [2.] (%), 2016.

- Geothermal energy

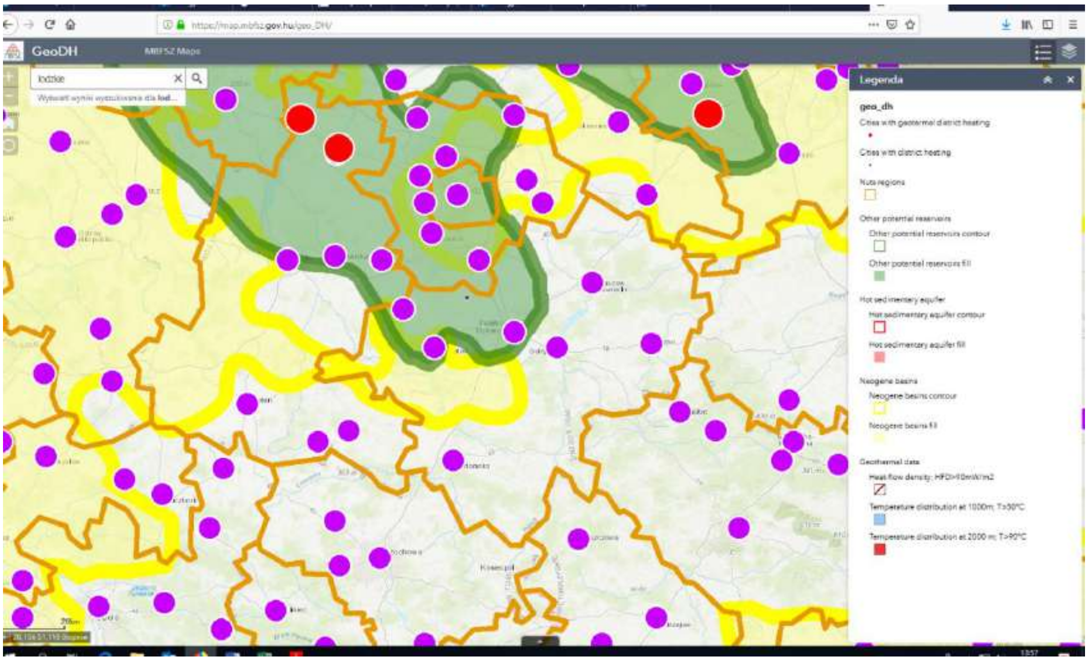


Figure 60. Geothermal energy potential in Lodzkie region

- Wind power

Wind parameters in the region are listed in the table below.

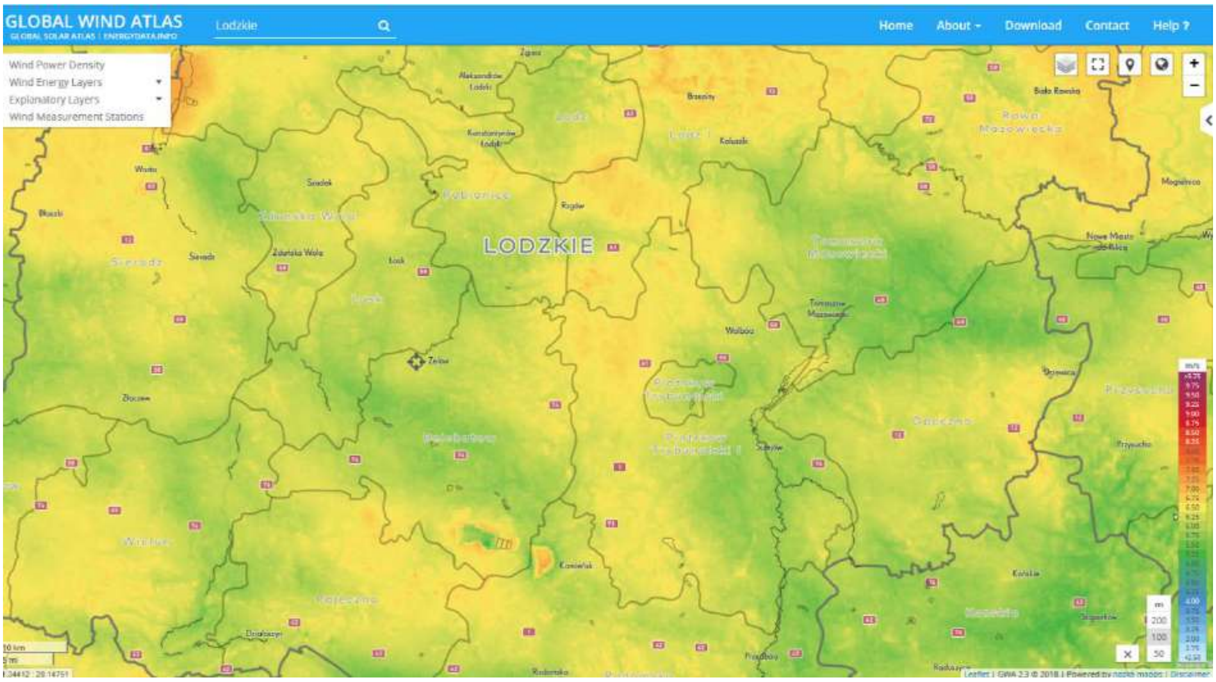


Figure 61. Wind potential in Lodzkie Region (W/m2)

The typical wind energy density as can be concluded from the map below, is around 300 W/m^2 on the land and there is no access to the sea for the offshore installations.[5.]

Wind potential at 50 meters		
Average wind speed	6,66	m/s
Maximum wind speed	6,79	m/s
Minimum wind speed	6,28	m/s

Table 45. Wind potential at 50 meters for Lodzkie Region 2016.

4.2.7 Romania – South-West Oltenia region

Current RES consumption

- Heat supply

According to EUROSTAT, the share of renewable energy in gross final energy consumption by the heating and cooling sector in Romania was 26,86% during 2016, but unfortunately, there are no specific data published in regional basis.

- Electricity supply

Romania can develop production systems on all types of renewable sources, depending on the specificity of each geographical area in the country. Following the studies carried out at our country level, the potential for green energy production is 18.3% biomass, 13.5% wind and solar energy, 23% micro hydro power plants and 2% vol. And geothermal. Romania's potential for green energy production and the percentage distribution of estimated renewable energies for 2017 are highlighted in the figure below.

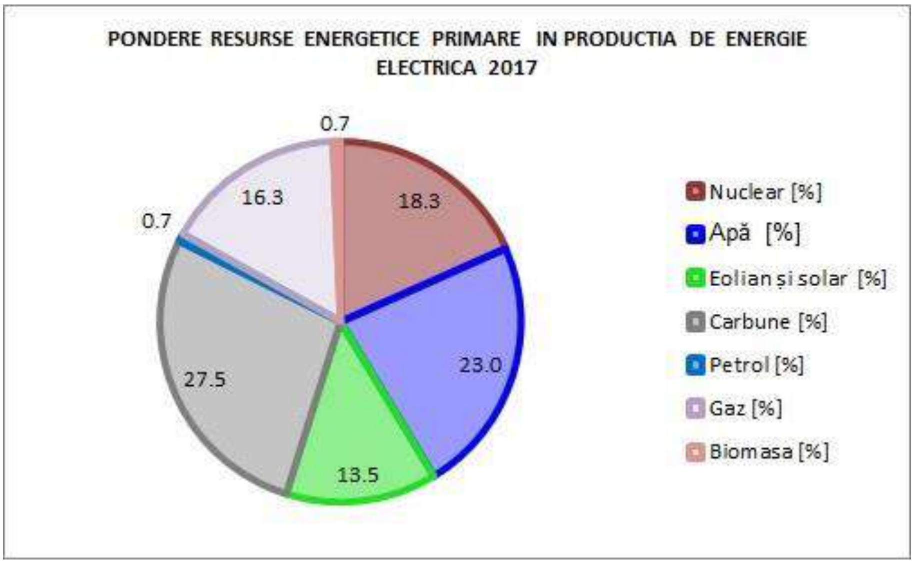


Figure 62 Romania's potential for green energy production and the percentage distribution of estimated renewable energies, (%), 2017,

Puterea instalată și producția de energie electrică
Installed capacity and production of electric energy

	2012	2013	2014	2015	2016	2017	
Puterea instalată a grupurilor electrogene (la sfârșitul anului) *Installed capacity of electric generating sets (end of year)*							
Total (mii kW)	**21767**	**22947**	**23884**	**23829**	**23580**	**23574**	***Total (thou kW)***
Termoelectrică	13356	12803	12734	12735	12537	12570	*Thermoelectric*
Hidroelectrică	6548	6610	6613	6638	6642	6600	*Hydroelectric*
Eoliană 1)	1863	3534	4537	4456	4401	4404	*Wind 1)*
Pe locuitor 2) (W)	1085	1148	1200	1202	1197	1203 3)	*Per inhabitant 2) (W)*
Producția de energie electrică *Electric energy production*							
Total (milioane kWh)	**59047**	**58888**	**65675**	**66296**	**65104**	**64296**	***Total (million kWh)***
Termoelectrică	44062	38641	38579	40245	38158	40181	*Thermoelectric*
Hidroelectrică	12337	15307	19279	17007	18536	14853	*Hydroelectric*
Eoliană 1)	2648	4940	7817	9044	8410	9262	*Wind 1)*
Pe locuitor 2) (kWh)	2943	2947	3299	3345	3304	3282 3)	*Per inhabitant 2) (kWh)*

1) Inclusiv energia solară fotovoltaică. / *Including photovoltaic solar energy.*
2) Pentru perioada **2012-2017** s-a utilizat populația rezidentă la **1 iulie** a fiecărui an, estimată în condiții de comparabilitate cu rezultatele definitive ale Recensământului Populației și al Locuințelor - 2011.
*For the **2012-2017** period, usually resident population on **July 1st** of each year was used, estimated under comparability conditions with the final results of the Population and Housing Census - 2011.*
3) Date provizorii. / *Provisional data.*

Figure 63 Romania's potential for green energy production and the percentage distribution of estimated renewable energies, (%), 2017,

The RES fuel mix in the electricity generation process indicates that the hydro power outnumbers the other energy sources. 70% of total electricity production comes from hydro power and is supplemented by even energy contribution wind and solar PV.

The national figures for the entire country have been standardized using the population ratio to reflect the RES electricity production in the South-West Oltenia region.

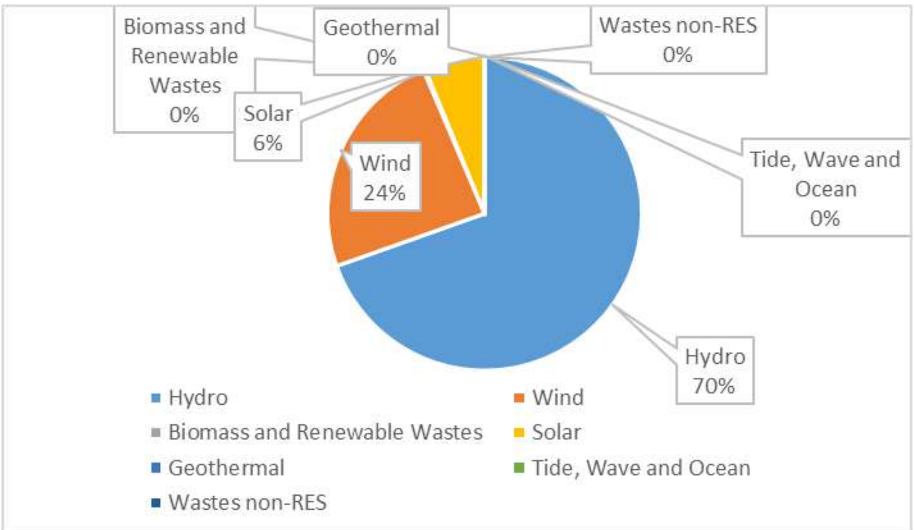


Figure 64 Electricity production using renewable energy sources in the South-West Oltenia region (GWh) according to general source [3.] (GWh/annum), 2016.

The electricity production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in the region. These are presented in the table below.

Electricity production using RES

	GWh	GWh/1000 of population
Hydro	1,700	0.9
Wind	600	0.3
Biomass and Renewable Wastes	0	0.0
Solar	200	0.1
Geothermal	0	0.0
Tide, Wave and Ocean	0	0.0
Wastes non-RES	0	0.0
Total RES electricity	2,500	1.3
Total electricity demand	15,000	7.9

Table 46 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the South-West Oltenia region (GWh) according to general source [3.] (GWh/annum), 2016.

Overview of total RES potential

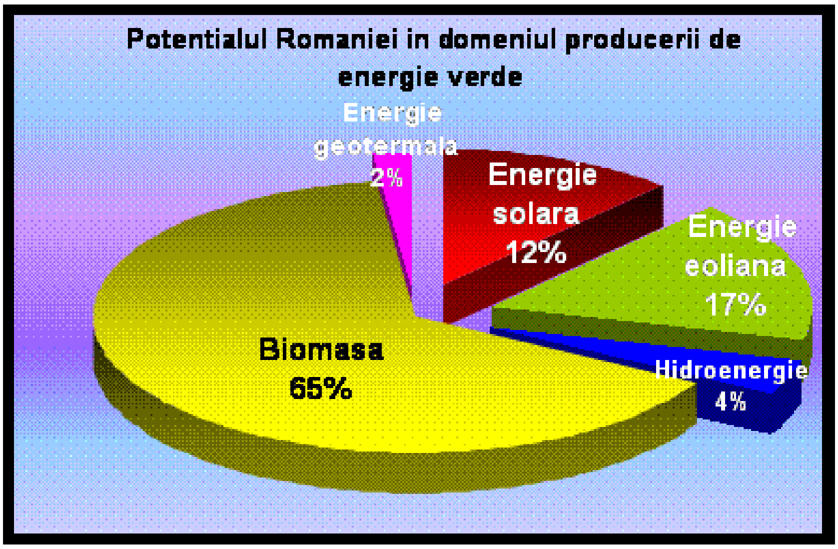


Figure 65 Proportions of potential RES in Romania according to local source, [55.], (MJ/m²).

- Solar potential

The monthly range of thermal values in Romania reaches peak values in June (1.49 kWh/m²/day) and minimum values in February (0.34 kWh/m²/day). In the solar-thermal energy potential assessments, water and / or swimming-pool heating applications (domestic hot water, heating, etc.) have been taken into consideration, and solar-photovoltaic potential assessments have taken into account both photovoltaic network connection and autonomous (non-network) connections for isolated consumers.[55.]

In Oltenia, the map with the distribution of the average annual flows of incident solar energy on the horizontal surface of the region, where 5 zones are distinguished by the average annual flows of incident solar energy (more than half of the country's surface benefits from a flow of annual average energy of 1275 kWh/m^2). The data is expressed in kWh/m^2/year, horizontally, this value being the one used in energy applications for both photovoltaic and thermal solar.

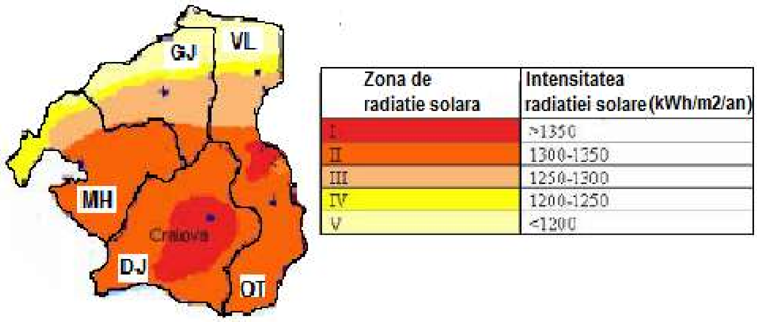


Figure 66 Solar energy potential map in the South-West Oltenia region according to local source, [55.], (kWh/m²/annum).

Concerning the electricity produced by the hydropower plants in the South-West Oltenia Region, the situation is fluctuating, but the differences in production values are still predictable in the context of climatic conditions in the region. The European Union has suggested to Romania that special attention be paid to increasing wind energy production, according to a study, estimated at 14,000 MW of the country's wind potential, is the largest in South-Eastern Europe and the second in Europe.

- Wind potential

In the strategy for capitalizing renewable energy sources, the declared national wind potential is 14,000 MW (installed power), which can provide an amount of about 23,000 GWh / year of energy. In 2016, taking into account the specific conditions of that year, wind power plants in Romania produced 6.52 TWh. The main reason why the technical potential of about 10.23 TWh / year is currently being used in only 60.7% is the adequacy of the national energy system that can not take over the unpredictable production sources.

In 2016, photovoltaic parks in Romania produced 1.67 TWh. The construction of photovoltaic parks has benefited from a support scheme in 2009-2016, according to Law 220/2008. Photovoltaic capacities are to be developed both in the form of medium capacity solar parks, made on degraded or poorly productive land, and in the form of low dispersed capacities made by energy consumers who can make the transition to prosumer. Until 2030, photovoltaic systems will reach a total installed capacity of approx. 3.100 MW_p (a production of about 5 TWh/year).

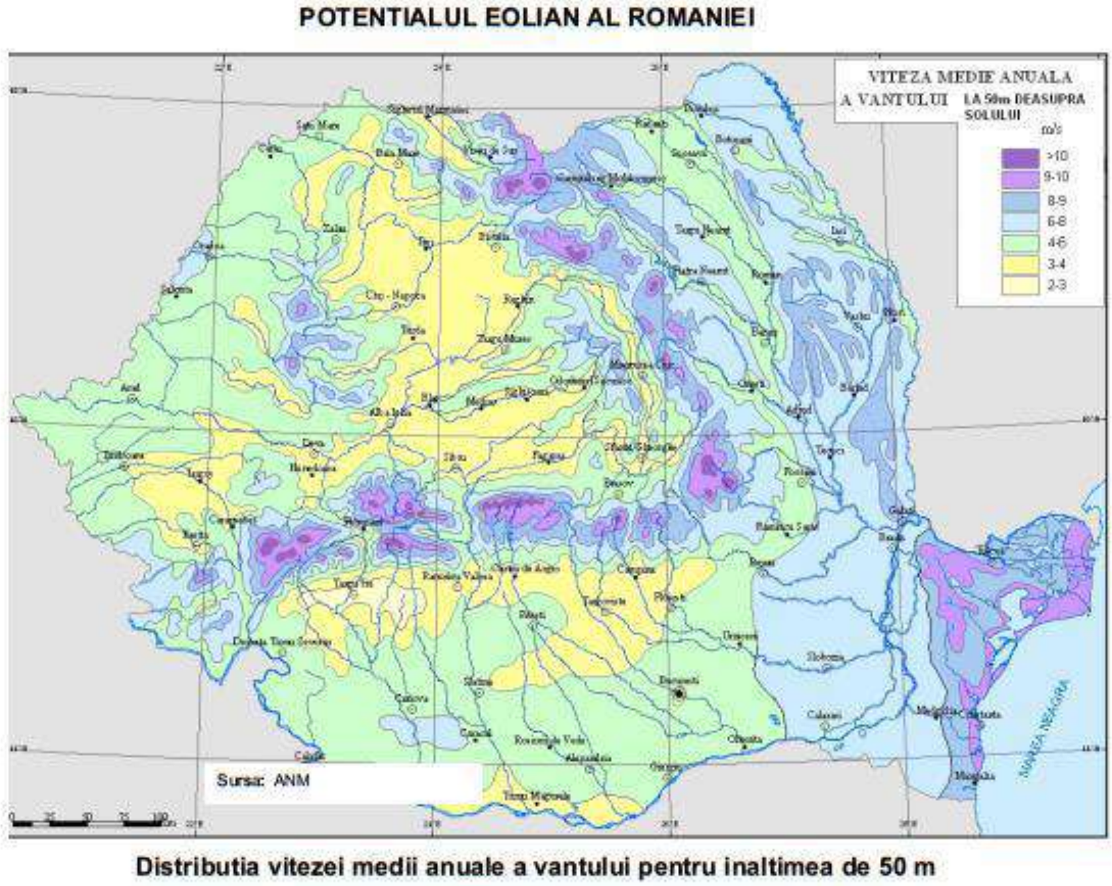


Figure 67 Wind energy speed at 50m in Romania according to local source, [55.], (m/s).

- Solar energy

Solar energy can be used for energy purposes either in the form of heat, which can be used for the preparation of domestic hot water and heating of buildings or for the production of electricity in photovoltaic systems. The distribution of solar energy on the national territory is relatively uniform with values between 1,100 and 1,450 kWh/m^2/year.

Minimum values are recorded in depression areas and maximum values in Dobrogea, eastern Baragan and southern Oltenia. At the end of 2016, solar parks with a total power of 1,360 MW were installed in Romania, which, according to project energies, produced 1.91 TWh / year. In 2016, photovoltaic parks in Romania produced 1.67 TWh.

The main reason why the solar potential is not exploited to a higher degree is that the national energy system can not take over the large variations in power injection generated by photovoltaic sources in the absence of properly sized balancing and storage systems.

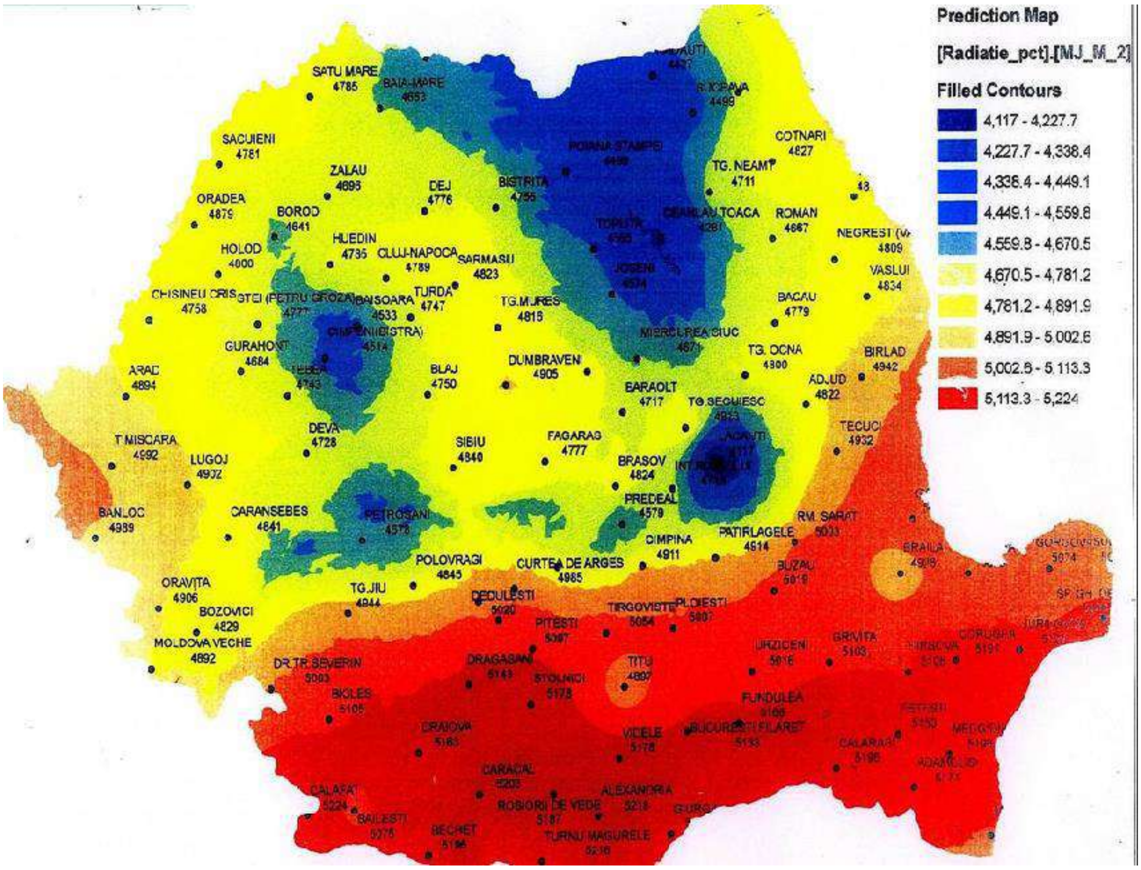


Figure 68 Solar radiation map in Romania according to local source, [55.], (MJ/m²).

- Biomass, bioliquids, biogas, waste and waste gas and sludge fermentation

The biomass energy potential is estimated at a total of 318,000 TJ / year, equivalent to 7,6 million toe.

Data on solid biomass production presents a high degree of uncertainty (about 20%), with a central estimate of 42 TWh in 2015.

The main form of energy biomass produced in Romania is firewood, burned in low-efficiency stoves. The consumption of firewood used in households is estimated at 36 TWh / year. In 2015, the production of biofuels was about 1.5 TWh and the biogas of 0.45 TWh.

In 2015, only 0.7 TWh of national electricity produced from biomass, bioliquids, biogas, waste and waste and slurry fermentation gases in capacities of 126 MW installed capacity.

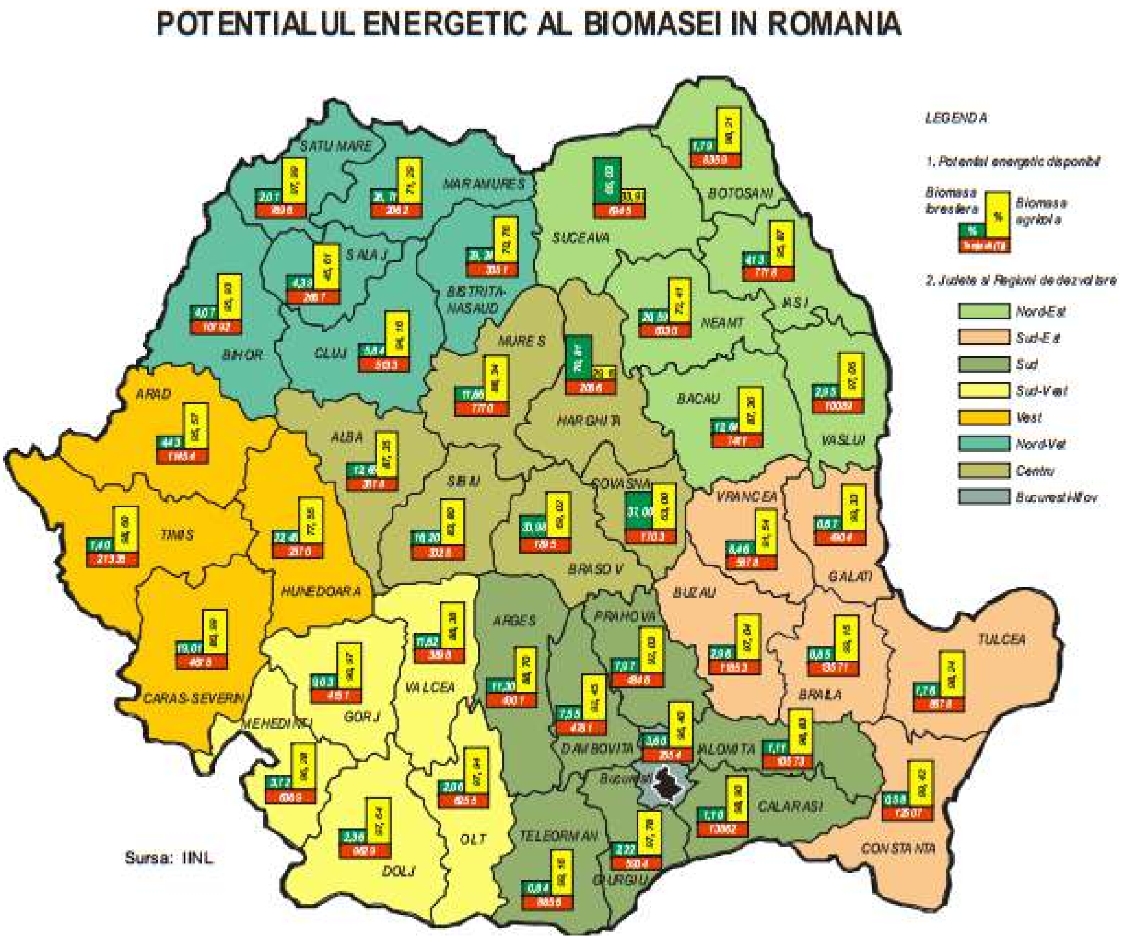


Figure 69 Biomass potential map in Romania according to local source, [55.], (MJ/m²).

- Geothermal energy

Several areas in which the geothermal potential is estimated to allow economic applications in a large area in Western Transylvania and on smaller areas in northern Bucharest, north of Ramnicu Vâlcea and around Ţăndărei locality have been identified in Romania. Previous research in 1990 revealed that the potential of the known geothermal resources in Romania is about 7 PJ / year (about 1.67 million Gcal / year). The records for the period 2014-2016 indicate that all of this potential is capitalized annually as heat or hot water between 155,000 and 200,000 Gcal.

Key Performance Indicators (kWh/1000 of population)	**General data**
Wind electric energy production (including photovoltaic solar energy)	4,9
Fuelwood energy production (including biomass)	1,9

Table 47 Proportion of RES electricity production per 1000 of population according to specific information, [55.], (GWh/annum).

4.2.8 Slovenia – Savinjska region

This chapter summarizes the current contribution of renewables in energy generation and investigates the total potential of utilizing renewable energy sources which could offset coal-fired energy production.

Current RES consumption

- Heat supply

According to the Energy balance of Slovenia for 2017, majority of heat production from renewables in Slovenia origins from biomass and renewable wastes. The second most popular is geothermal energy, with a 7% share and wastes form non-RES with a 6% share. As there were no available specific data for Savinjska region, the national figures were downsized with population ratio, which results in the same shares of heat production using different renewable energy sources at regional level.

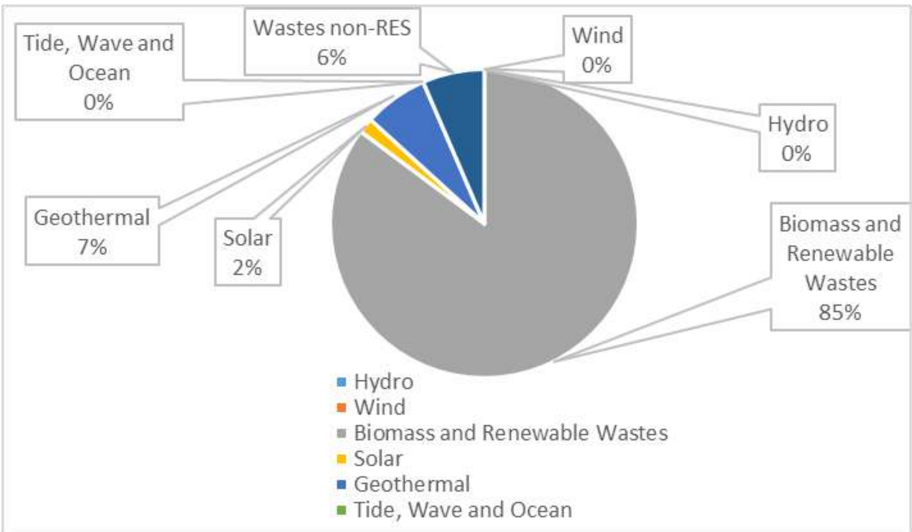


Figure 70 Heat production using renewable energy sources in Slovenia according to specific information, [41.], (%), 2018.

Overall, wood is one of the most important renewable sources in the country as wood and other solid biomass represent around 50% of the share of renewable energy sources in energy supply in Slovenia. In 2016, total energy supply from biomass was 7,076 GWh.

The heat production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in Savinjska region. These are presented in the table below.

Heat supply using RES

	GWh	GWh/1000 of population
Hydro	0	0.00
Wind	0	0.00
Biomass and Renewable Wastes	826	3.24
Solar	16	0.06
Geothermal	66	0.26
Tide, Wave and Ocean	0	0.00
Wastes non-RES	64	0.25
Total RES heat	972	3.82
Total heat demand	1,808	7.10

Table 48 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Savinjska region (GWh) according to general source [41.], (GWh/annum), 2018.

According to the Statistical Office of the Republic of Slovenia, the share of energy from renewable sources in gross final energy consumption in Slovenia for 2017 was 21.55%. Gross final energy consumption from renewable sources is calculated as the sum of gross final electricity consumption from renewable sources, gross final energy consumption from renewable sources for heating and cooling, and final energy consumption from renewable sources in transport.

- Electricity supply

In Slovenia, the amount of electricity delivered from facilities using RES in 2017 was 4,479 GWh, which represents around 30% of the total electricity generated in the country. The share of electricity generated in hydro power plants and facilities using RES annually varies, depending on hydrological and other conditions, and the investments in new generating facilities using RES.

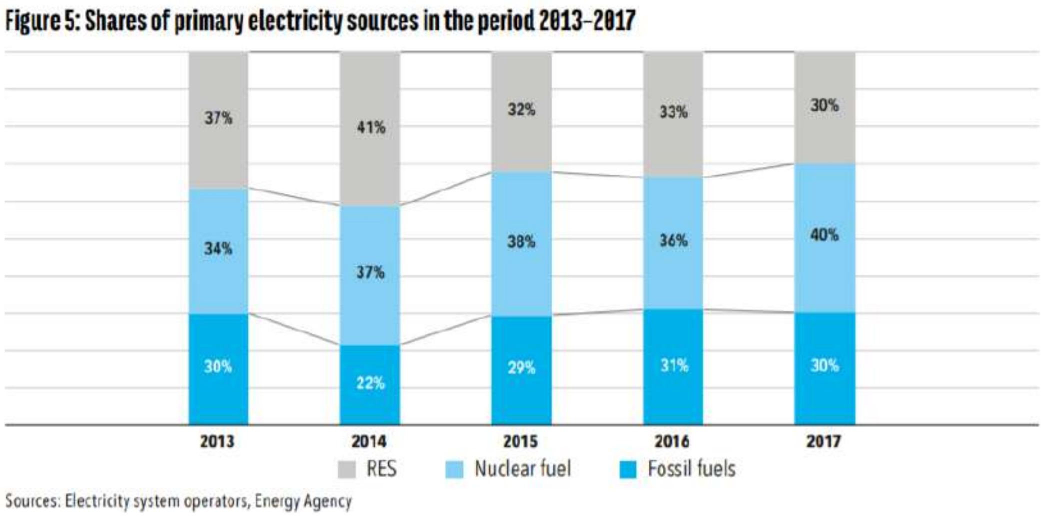


Figure 71 Shares of primary electricity sources, [44.], in the period 2013–2017.

In the structure of production of electricity from renewable sources in Slovenia, the hydro power prevailed with around 90% share, followed with the solar energy, biomass and renewable wastes energy. Wind energy accounted for only 6 MWh of total electricity production in the country.

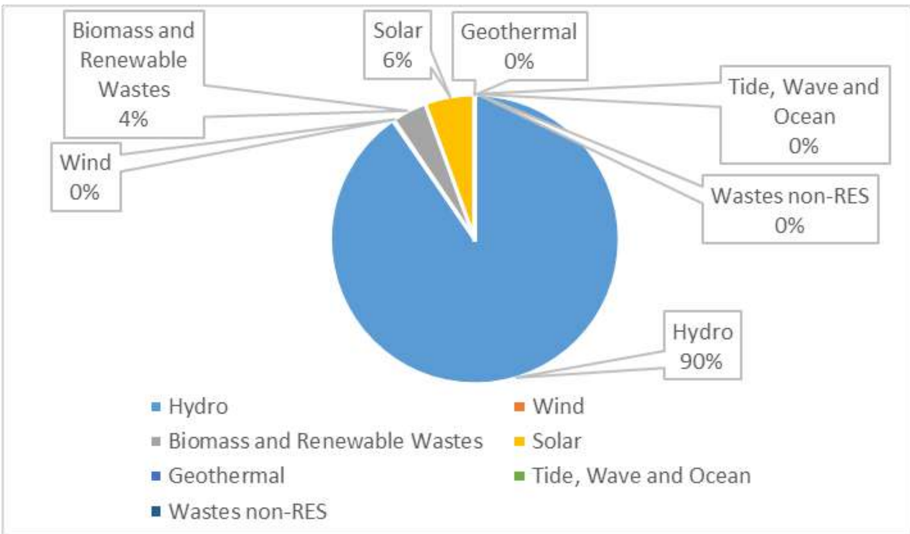


Figure 72 Electricity production using renewable energy sources in Slovenia according to specific information, [44.], (%), 2018.

In 2017, in Slovenia the following nine companies were operating large facilities with a capacity of over 10 MW:

- Termoelektrarna Šoštanj (TEŠ),
- Nuklearna elektrarna Krško (NEK),
- Dravske elektrarne Maribor (DEM),
- Savske elektrarne Ljubljana (SEL),
- Soške elektrarne Nova Gorica (SENG),
- Hidroelektrarne na spodnji Savi (HESS),
- Termoelektrarna Brestanica (TEB),
- Javno podjetje Energetika Ljubljana (JPEL),
- HSE – Energetska družba Trbovlje (HSE ED Trbovlje).

Companies DEM, SEL, HESS, and SENG generate electricity in hydroelectric power plants, however, none of hydro power plants operated by these companies is located in Savinjska region. This inidicates that electricity production from RES in Savinjska region is generated in smaller facilities such as smaller solar power plants, facilities using biomass, CHP units and similar. There were no specific numbers on electricity production using RES for Savinjska region but compared to the large powerplants operated by above listed companies and the importance of the hydropower, the electricity generated in smaller facilities does not represent a significant share in total electricity from RES production.

The electricity production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in Slovenia. These are presented in the table below.

Electricity production using RES

	GWh	GWh/1000 of population
Hydro	4,048	1.96
Wind	6	0.00
Biomass and Renewable Wastes	175	0.08
Solar	250	0.12
Geothermal	0	0.00
Tide, Wave and Ocean	0	0.00
Wastes non-RES	0	0.00
Total RES electricity	4,479	2.17
Total electricity demand	16,500	7.98

Table 49 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the Slovenia according to specific source, [44.], GWh/annum), 2018.

Overview of total RES potential

Based on the available resources in Slovenia, there is still a plenty of potential for RES energy generation in the country as well as in the region.

The total RES potential of Slovenia and Savinjska region was explored with a number of interactive websites in a combination with specific sources of information available either for national or regional level.

List of interactive websites used for determination of RES potential:

- HotMaps – Heating and Cooling Open Source Tool for Mapping and Planning of Energy Systems
- GeoDH Maps – open source tool for mapping geothermal resources
- Global Wind Atlas
- Heat Road Map Europe (HRE4)
- Atlas trajnostne energije

- Biomass, waste, solar energy

The next graph shows the possible heat contribution to the total heat demand using all available RES sources. This includes a biomass, waste and solar energy sources.

According to HotMaps - Heating and Cooling Open Source Tool for Mapping and Planning of Energy Systems, forest residues and solar thermal energy have higher heat production potential compared to other biomass and waste sources.

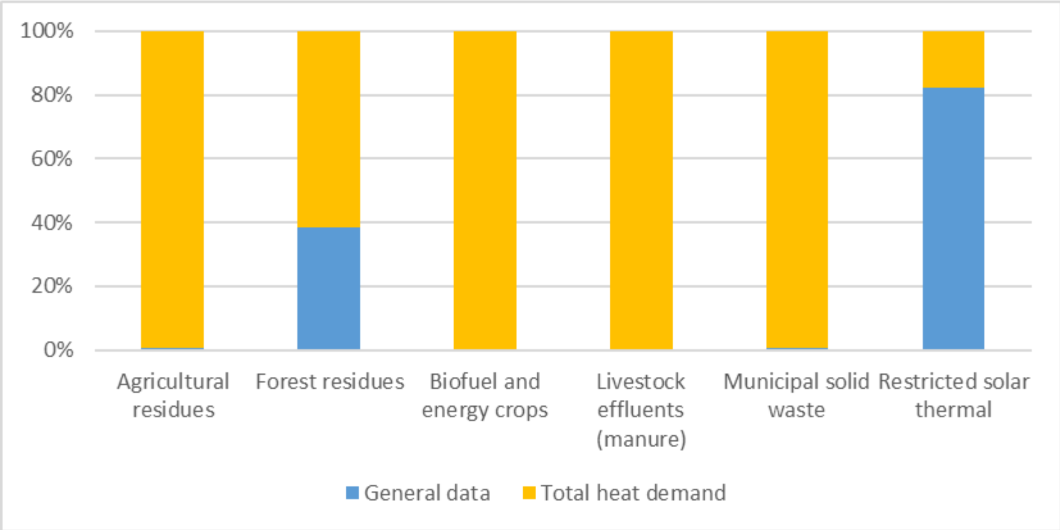


Figure 73 Heat production potential from renewable energy sources in proportion to the total heat demand in Savinjska region according to general source [2.] (%), 2016.

Solar energy is in Slovenia used either for electricity generation with photovoltaic system or heat production with solar collectors. Heat production from solar energy in Slovenia in 2016 was around 130 GWh, electricity generation approximately 250 GWh. In the structure of total supplied energy in Slovenia, the share of solar energy was ca. 2% (2016).

The image below shows global annual irradiation on horizontal surface in Slovenia in kWh/m^2.

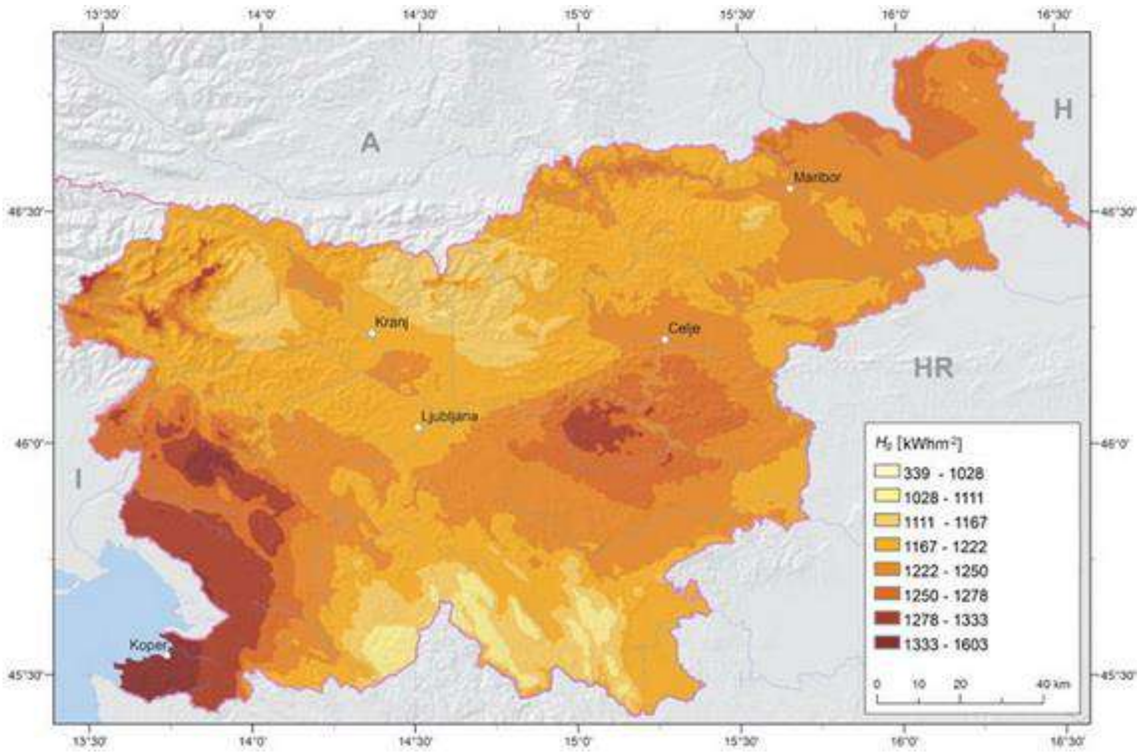


Figure 74 Global annual irradiation on horizontal surface in Slovenia, [45.].

The average annual horizontal irradiation in Savinjska regionis above country's average:

- Slovenia: ca. 1,000 kWh/m^2
- Savinjska: ca. 1,167-1,222 kWh/m^2.

Slovenia belongs to the most forested countries in Europe with a high wood biomass potential. 1,180,281 ha of forests cover more than a half of its territory (forestation amounts to 58.2 %). Most Slovenian forests are located within the area of beech, fir-beech and beech-oak sites (70 %), which have a relatively high production capacity. According to the Slovenia Forest Service, the growing stock of Slovenian forests amounts to 352,878,333 cubic metres or 299 cubic metres per hectare, moreover all Slovenian municipalities have a part of the territory covered with forests, thus each municipality has a theoretical potential of woody biomass for energy use.

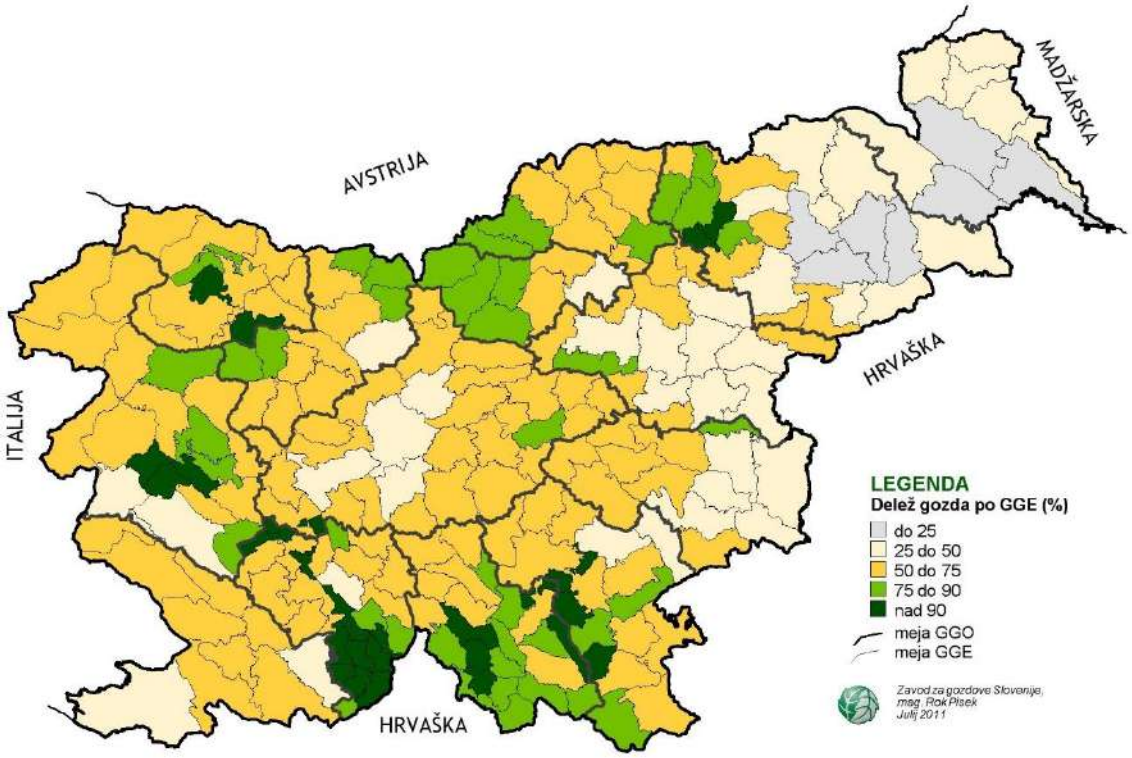


Figure 75 Forest cover in Slovenia, [46.], [%].

The Regional analysis of RES potential and material flow from 2010 showed in the in the Savinjsko – Šaleška region (SaŠa region), the subregion of Savinjska statistical region, the wood biomass is the dominant potential.

Municipality:		Solčava	Luče	Ljubno ob Savinji	Gornji Grad	Rečica ob Savinji	Nazarje	Mozirje	Šmartno ob Paki	Šoštanj	Velenje	TOTAL
Estimated free wood potential	m^3/year	12,526	24,009	18,994	21,464	5,084	10,604	8,789	1,714	17,547	8,064	**128,796**
Used forest potential	m^3/year	11,593	18,065	15,500	16,788	4,357	9,657	8,254	1,799	11,878	8,634	106,524
Maximum felling possible:	m^3/year	24,119	42,074	34,494	38,252	9,441	20,261	17,043	3,513	29,425	16,698	235,320

Figure 76 Estimated free wood potential for the SaŠa region [47.], 2010.

Municipality:		Solčava	Luče	Ljubno ob Savinji	Gornji Grad	Rečica ob Savinji	Nazarje	Mozirje	Šmartno ob Paki	Šoštanj	Velenje	TOTAL
Unfelled free forest potential	m^3/year	15.061	27.518	22.599	23.147	5.595	11.224	10.504	1.937	19.280	9.670	
Prevented exploitation of forests	m^3/year	2.535	3.509	3.605	1.683	511	620	1.715	223	1.733	1.606	
Estimated free wood potential	m^3/year	12.526	24.009	18.994	21.464	5.084	10.604	8.789	1.714	17.547	8.064	
Estimated free WB potential for energy purposes (30% of forest mass)	m^3/year	3,758	7,203	5,698	6,439	1,525	3,181	2,637	514	5,264	2,419	**38,639**

Figure 77 Estimated free WB potential for the SaŠa region, [47.], 2010.

In the SaŠa region, the estimated free annual potential amounts to 38,639 m^3 of wood biomass, which represents 85,06 MWh of thermal energy per year (primary final energy).

76 % of forests in Slovenia are in private property, 24 % of forests are public (owned by the state or local communities). Larger state-owned forest estates enable good professional management, however the private forest estates are small, fragmented and owned by a large number of owners (around 413,000). The latter presents a serious obstacle for professional work in private forests, optimal wood manufacturing process and utilisation of forest potential.

- Geothermal energy

Analysis of thermal conditions of the deep ground in the Savinjska region with general source does not identify any geothermal potential in the region.

Figure 78 Geothermal energy potential in Savinjska region, [11.].

Image above shows that there are neither areas with the heat-flow density (HFD) above 90 mW/m^2 nor high temperature distribution (>50°C) below 1000 m or high temperature distribution (>90°C) below 2000 m. Nonetheless, there are areas in Slovenia and Savinjska region that have been researched in the past and where the geothermal potential has been recognized.

Most researched areas with a geothermal energy potential in the country:

- Pannonian Slovenia,
- Krško-Brežiško polje plain,
- Rogaško-Celjsko area,
- Ljubljanska basin,

-	Slovenian Istria and
-	the area of Zahodna Slovenija.

The image below shoes temperature distribution at 1,000 m across the country, where the area with highest temperatures and heat-flow density in Savinjska region (Rogaško-Celjsko area) is market with red.

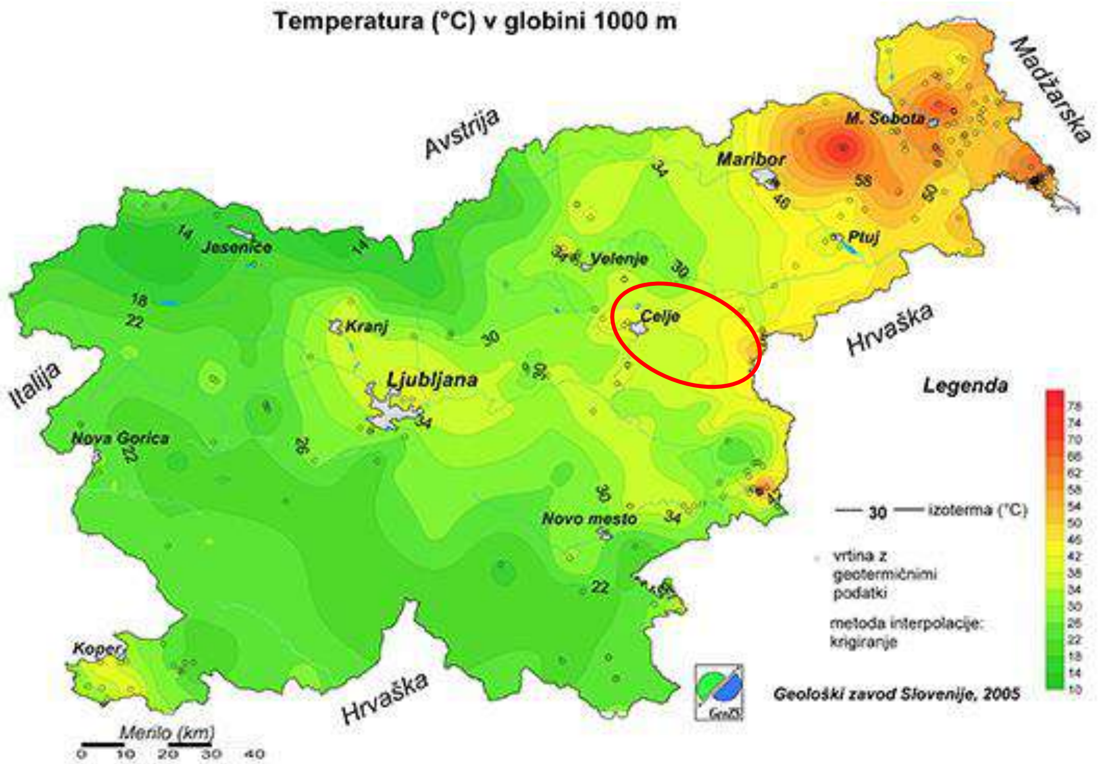


Figure 79 Temperature distribution at 1000 m, [46.].

-	Excess heat

According to the available data from general source, in the Savinjska region there is a very limited potential of excess heat utilization. A waste watter treatment plant that have been considered in the graph below are: Celje, Laško, Mozirje, Rogaška Saltina, Šentjur, Šoštanj, Žalec.

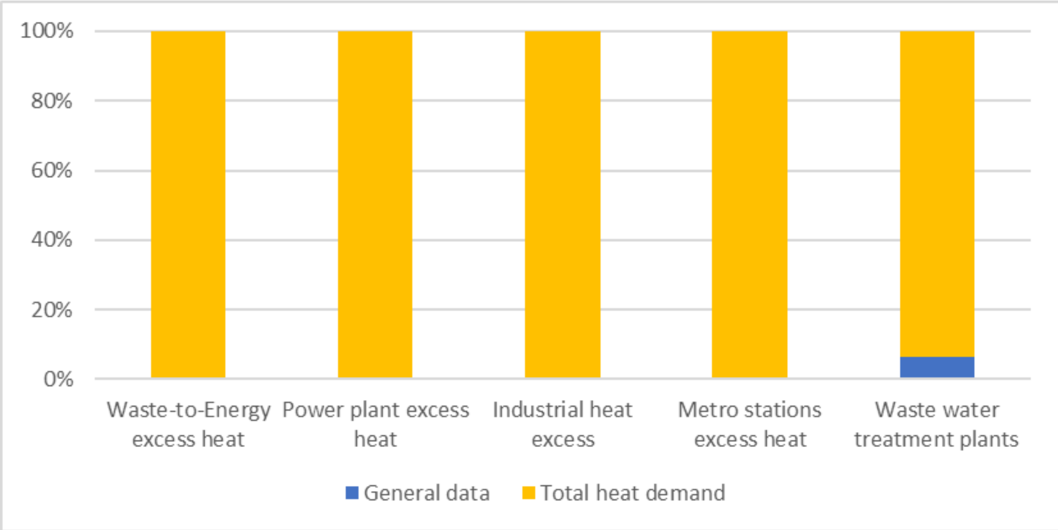


Figure 80 Excess heat potential in Savinjska region, [12.].

Excess heat potential (MWh/year) in the areas of Savinjska region is additionally presented in the image below. Red, orange and yellow mark the amount of potential energy per year (red: > 5,000 MWh/ year, orange 1,000 – 5,000 MWh/year, yellow < 1,000 MWh/year). The excess heat in the region is extracted either from waste water treatment plants, industrial sites, power plants or waste treatment plant.

Figure 81 Excess heat potential in Savinjska region, [49.].

In Slovenia, only in the municipal waste incinerator in Municipality of Celje (Savinjska region) heat is produced from biodegradable waste, and in the area of former ironwork Ravne na Koroškem (Koroška region) waste heat from industrial processes is used for heat distribution. In 2017, heat, produced from biodegradable waste covered 2.15%, and waste heat from industrial processes 1.5% of all generated heat for the supply of distribution systems.

- Wind power

Wind parameters in the Savinjska region are listed in the table below.

Wind potential at 50 meters

Average wind speed	3.5	m/s
Maximum wind speed	8.1	m/s
Minimum wind speed	1.1	m/s

Table 50 Wind power potential in Savinjska region, [2.].

Average wind speed at 50 meters for whole country is additionally presented in the following image.

The wind power has the largest potential in the south-western parts of the country near the coastline, where the typical wind energy density is from 200 to 400 W/m^2. The wind power potential of the Savinjska is rather limited in comparison with other regions in Slovenia as the typical wind energy density in Savinjska region is around 100-125 W/m^2 as can be concluded from the map below [5.]

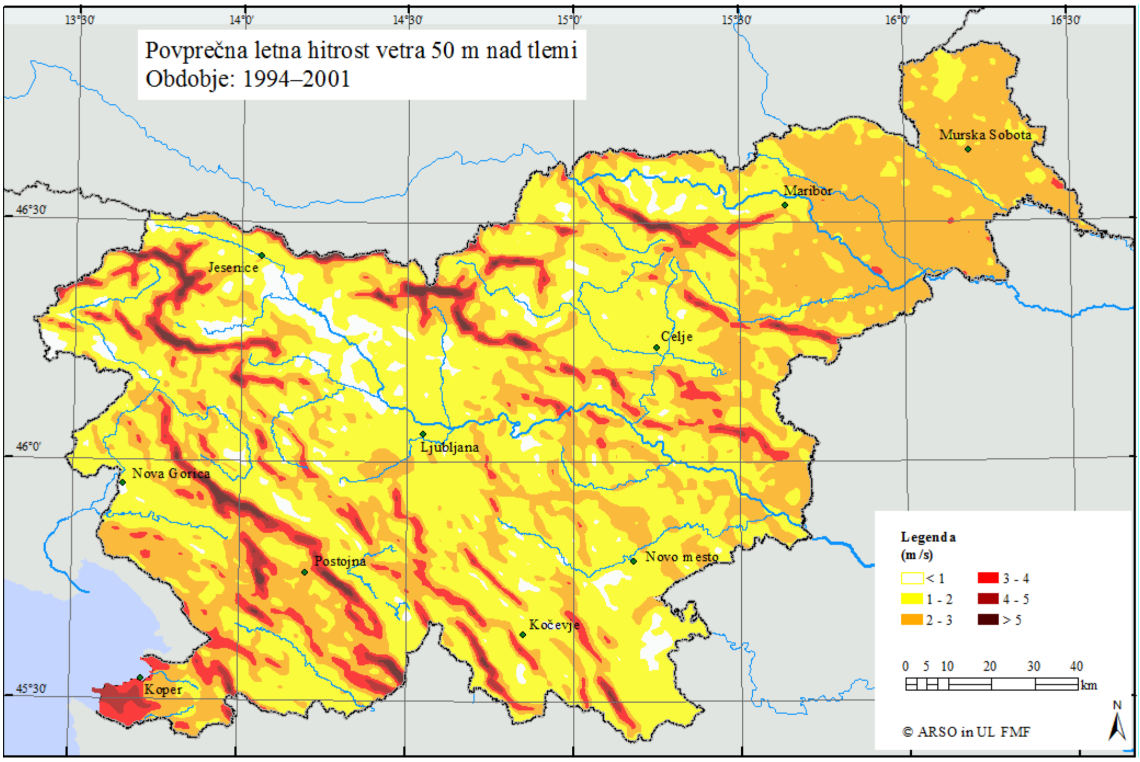


Figure 82 Mean annual wind speed at 50 meters, [50.].

In 2017, only 0.1% of electricity production in Slovenia was contributed by the wind power plants, in which it was generated 5,72 MWh of electricity. Current installed capacity of wind power plants in Slovenia is below 4 MW. Compared to the western Europe, Slovenia is not very windy and in general does not have many large areas with constant and high wind speed for the installation of very large efficient wind farms. In the areas with wind potential (coastal areas and smaller areas in other regions) that would be suitable for the installation of wind turbines, the exploitation of wind potential is mostly limited with the placement of wind turbines in the landscape as well as difficulties with obtaining all necessary legal permissions.

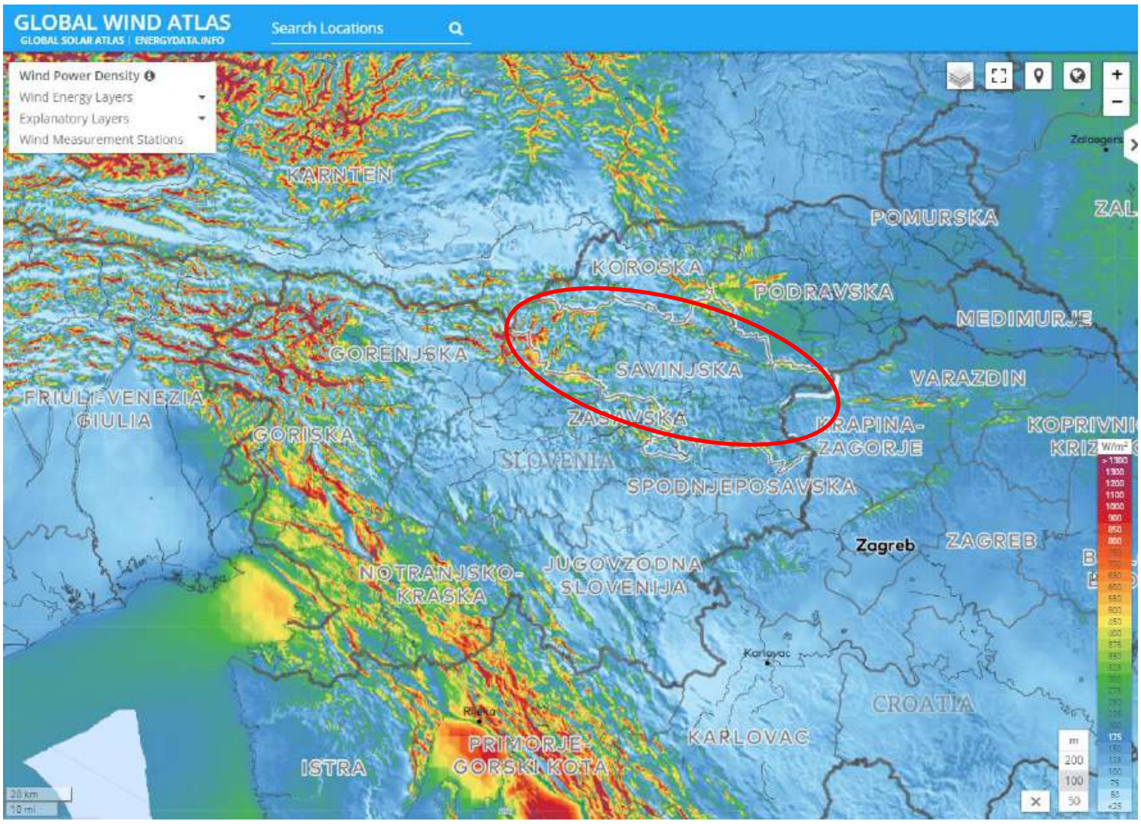


Figure Wind potential in Slovenia and Savinjska region, [5.], (W/m²).

4.2.9 Spain – Extremadura region

Current RES consumption

- Heat supply

There is no heat supply in Extremadura, at least not worth mentioning.

- Electricity supply

In this section, specific data must be used because Extremadura has a higher consumption of renewables compared to Spain. The renewable electric generation in the Spanish peninsula was 40.3% in 2016 and 33.7% in 2017.

Extremadura, due to its low population and low industry, is one of the regions that produce more electricity than it needs. Currently, 100% of Extremadura's consumption is covered with renewable energy. In 2017, Extremadura consumed 4.800 GWh and its renewable production was 4.768 GWh. And it is the European region with the highest solar energy produced per inhabitant.

The RES fuel mix in the electricity generation process indicates that the solar power outnumbers the other energy sources. Over 60% of total electricity production comes from solar power and is supplemented by hydro and biomass energy.

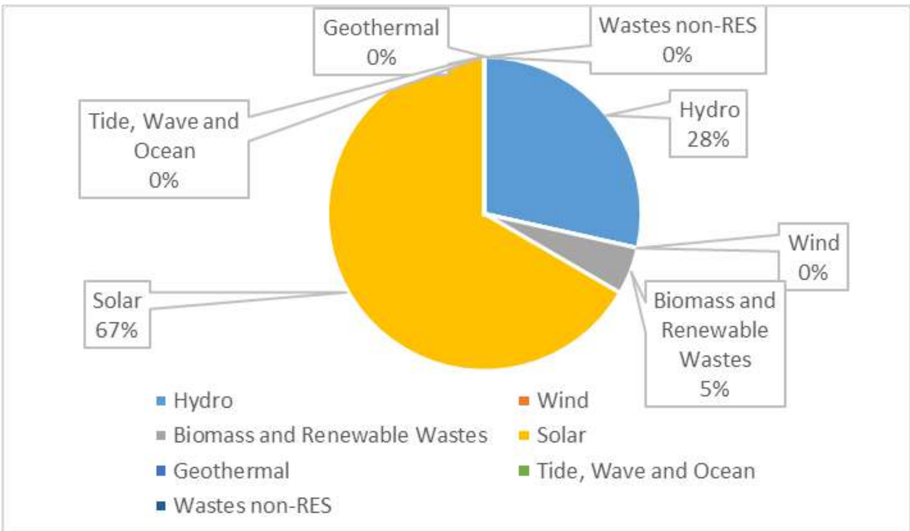


Figure 83 Electricity production using renewable energy sources the Extremadura region (GWh) according to general source [3.] (GWh/annum), 2016.

The electricity production from RES technologies have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in Extremadura. These are presented in the table below.

Electricity production using RES

	GWh	GWh/1000 of population
Hydro	1,350	1.3

Wind	0	0.0
Biomass and Renewable Wastes	250	0.2
Solar	3,200	3.0
Geothermal	0	0.0
Tide, Wave and Ocean	0	0.0
Wastes non-RES	0	0.0
Total RES electricity	4,768	4.5
Total electricity demand	4,800	4.8

Table 51 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the Extremadura region (GWh) according to general source [3.] (GWh/annum), 2016.

The total production in Extremadura in 2017 was 21.185 GWh, this means that 16.417,52 was produced with non-renewable sources, a nuclear power plant that is located in the north of the region. Our government is planning on closing it by 2030.

Overview of total RES potential

- Biomass, waste, solar energy

Extremadura has a high potential for biomass due to the amount of agriculture, olive bones, almond skin, etc. The results from the national data are the following graph. Please see 2 Glossary for the definitions of the presented energy sources.

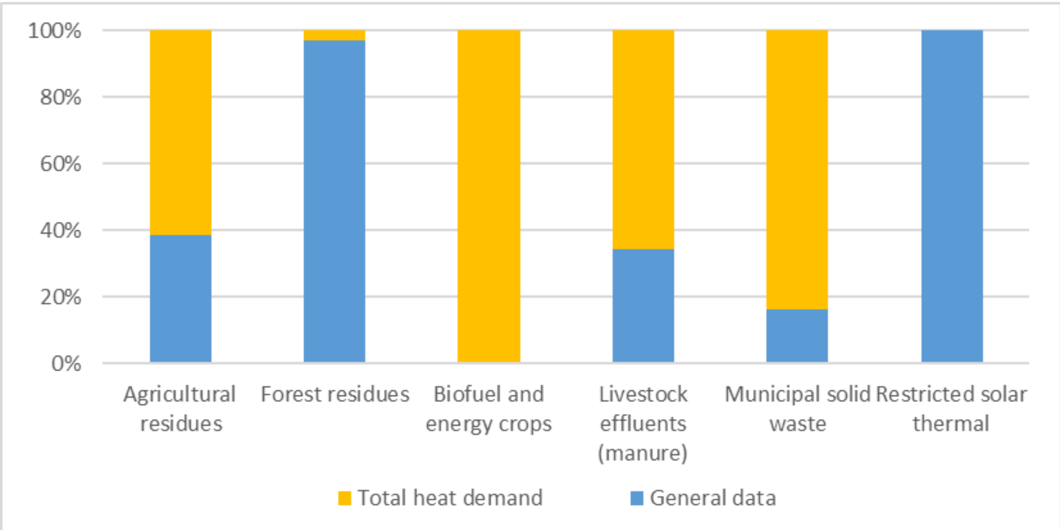


Figure 84 Heat production potential from renewable energy sources in proportion to the total heat demand in Extremadura region according to general source [2.] (%), 2016.

Extremadura has great resources for solar energy and has already 562 MW installed PV power (photovoltaic power) and 849 MW of CSP power (concentrated solar power). A proof of its potential is that there are 2.000 MW of PV power in process of development. From this, there is one plant that has just started construction works and will be the largest with 500 MW.

- Geothermal energy

Extremadura has few geothermal installations, and mostly for self-consumption. This is due to the lack of experience and know-how of the companies in the region and its high cost. Not a high potential has been identified for this renewable technology.

The thermal conditions of the deep ground in most of the Extremadura region, are rather ordinary. There are neither areas with the heat-flow density (HFD) above 90 mW/m^2 nor high temperature distribution (>50°C) below 1000 m.

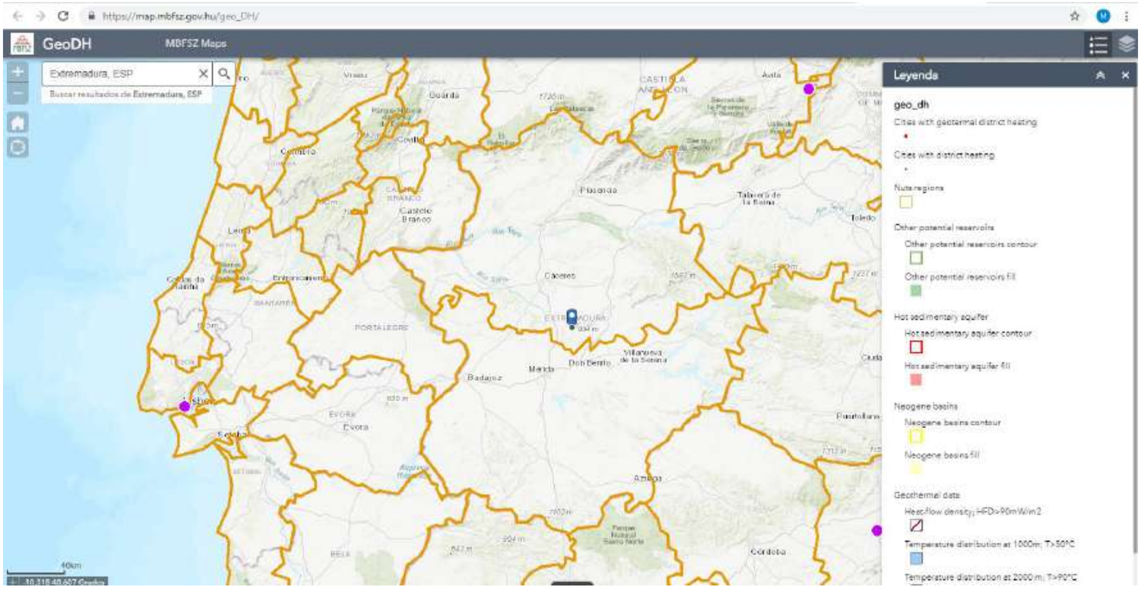


Figure 85 Geothermal energy potential in Extremadura region [11.].

- Excess heat

The other alternative for coal-based energy is an excess heat. This can be extracted from the industrial sites that are already in operation as e.g. waste combustion plants, water treatment plants and power plants. The estimated potential of heat production using different excess heat source is presented on the graph below.

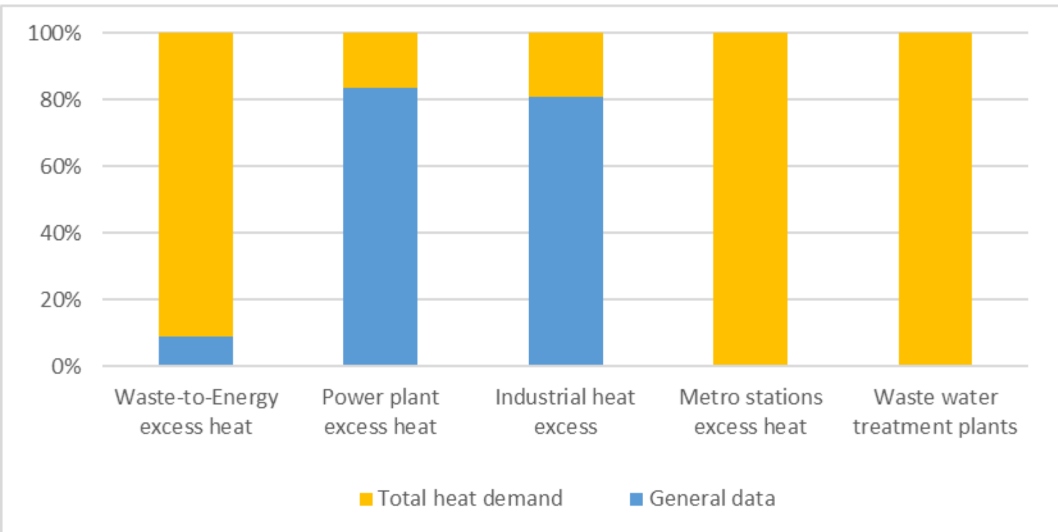


Figure 86 Excess heat potential in Extremadura region [12.].

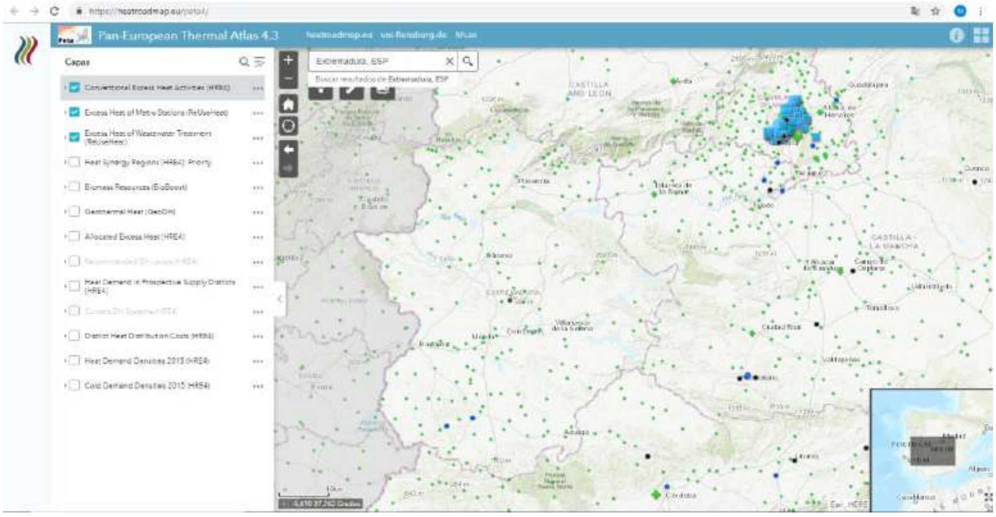


Figure 87 Waste energy potential in Extremadura region[12.].

- Wind power

Wind parameters in the region are listed in the table below.

Wind potential at 50 meters		
Average wind speed	2.1	m/s
Maximum wind speed	10.2	m/s
Minimum wind speed	0.4	m/s

Table 52 Wind power potential in Extremadura region. [2.], (m/s).

There is also a potential for wind energy, especially in the north of Extremadura. A new find farm of 40MW was deployed in the region in 2018 and started operating a few months ago. It hasn't been taken into account yet, but it will increase the renewables in the energy mix in the future. Studies are being developed to install new wind farms in the region.

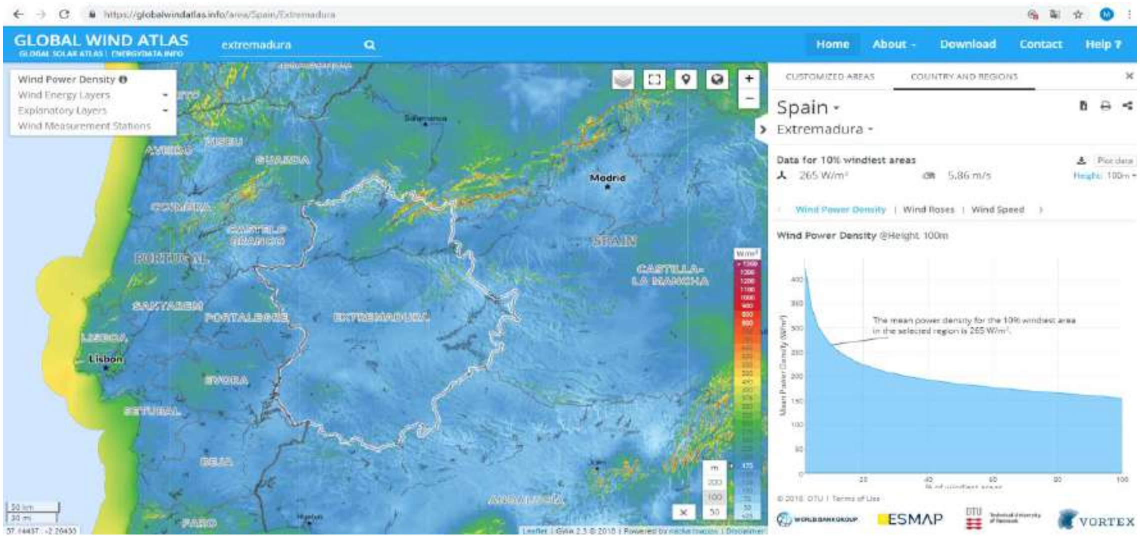


Figure 88. Wind potential in Extremadura region, [5.], (W/m²).

The typical wind energy density as can be concluded from the map below, is around 265 W/m^2 on the land and there is no access to the sea for the offshore installations.[5.]

4.3 Heat distribution infrastructure

4.3.1 Bulgaria – Yugoiztochen region

Based on the national figures standardized to the regional level using the population ratio, around 20% of total heat demand in Yugoiztochen is supplied through district heating.

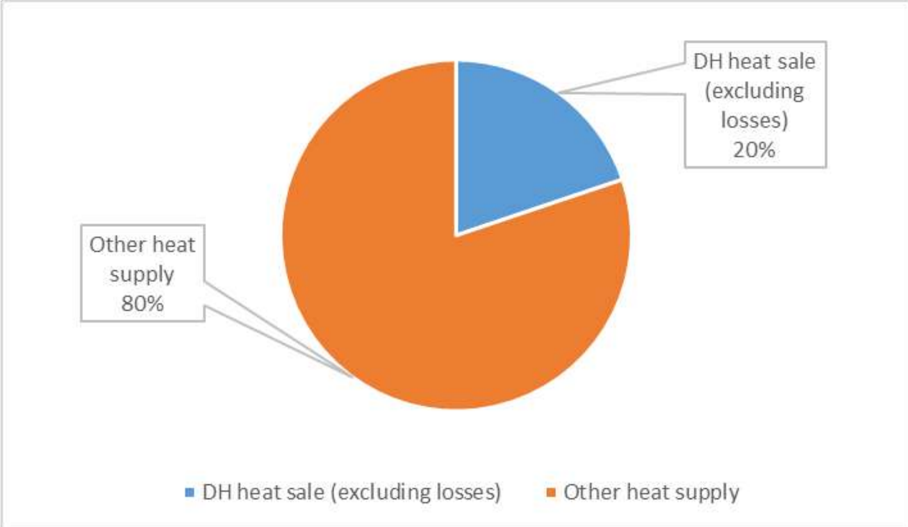


Figure 89 District heating supply to final customer in proportion to the total heat demand in Yugoiztochen region based on general source, [6.], (%), 2013.

The DH heat supply figures have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in the region. These are presented along with the energy annual volumes in the table below.

District heating supply

	GWh	GWh/1000 of population
DH heat sale	700	0.7
Other heat supply	3,000	2.9
Total heat demand	3,700	3.5
DH %	19%	N/A

Table 53 DH heat supply volumes and their proportion per 1000 of population in Yugoiztochen region on general source, [6.], (GWh/annum), 2016.

4.3.2 Denmark – Nordjylland region

A significant proportion as around 60% of total heat demand in Nordjylland is supplied through district heating. This was slightly underestimated using the general source which was mostly due to the figures being outdated (published in 2013).

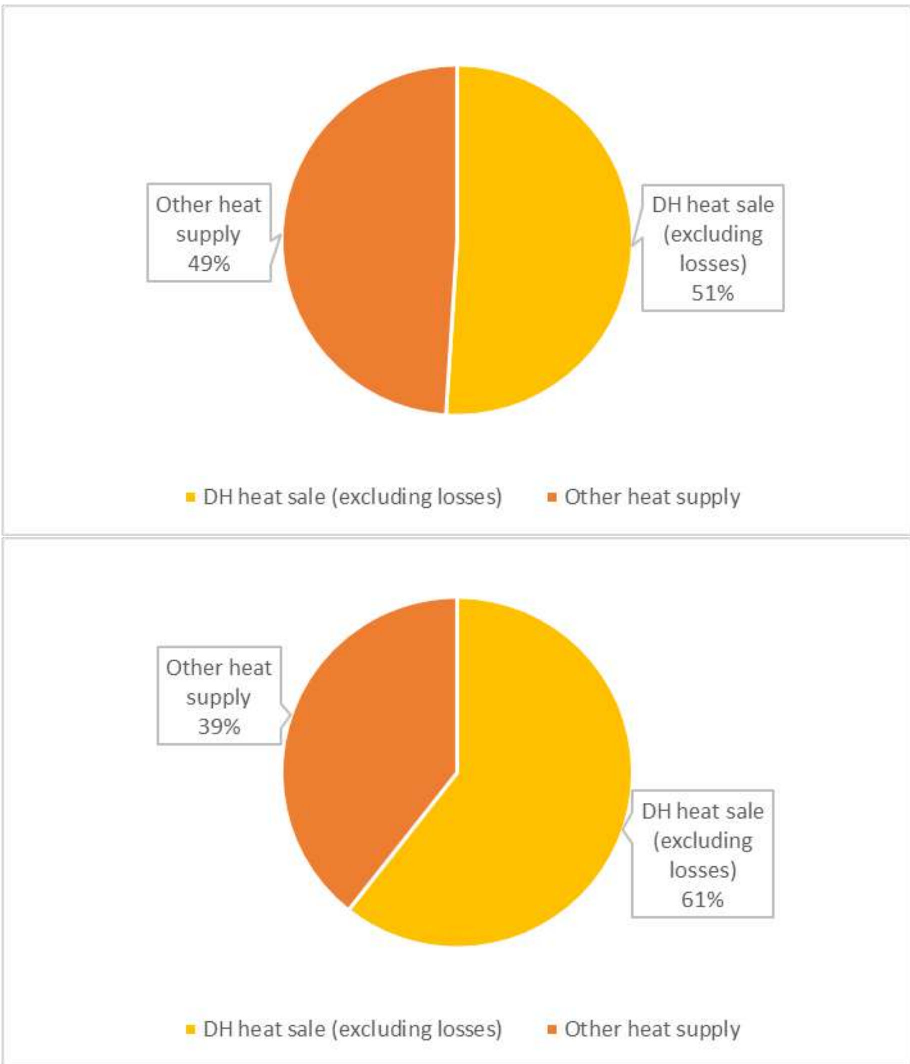


Figure 90 District heating supply to final customer in proportion to the total heat demand in Nordjylland region based on general source, 2013 [6.] and specific information, [4.] (%), 2016.

The annual heat supply volumes and their proportion of the district heat is presented in the following table.

The DH heat supply figures have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in Nordjylland. These are presented along with the energy annual volumes in the table below.

District heating supply	**General data**		**Specific data**	
	GWh	GWh/1000 of population	GWh	GWh/1000 of population
DH heat sale	3,000	5.1	3,620	6.2
Other heat supply	2,880	4.9	2,350	4.0
Total heat demand	5,880	10.0	5,970	10.2
DH %	51%	N/A	61%	N/A

Table 54 DH heat supply volumes and their proportion per 1000 of population in Nordjylland region based on general source, 2013 [6.] and specific information, [4.] (GWh/annum), 2016.

The overview of the heat energy centers along with their annual output which serve district heat networks in the Denmark is shown on the next figure. The Nordjylland region is highlighted in the red circle. The largest generator is the combined heat and power plant (largest red dot) located centrally in Aalborg city providing up to 1,500 GWh of heat per annum. The rest of district heat is supplied by dispersed decentralized plants (amber dots) and district heating plants (blue dots) with some utilization of excess heat from industrial sites (green dots). Most of the plant's thermal yearly output does not exceed 500 GWh.

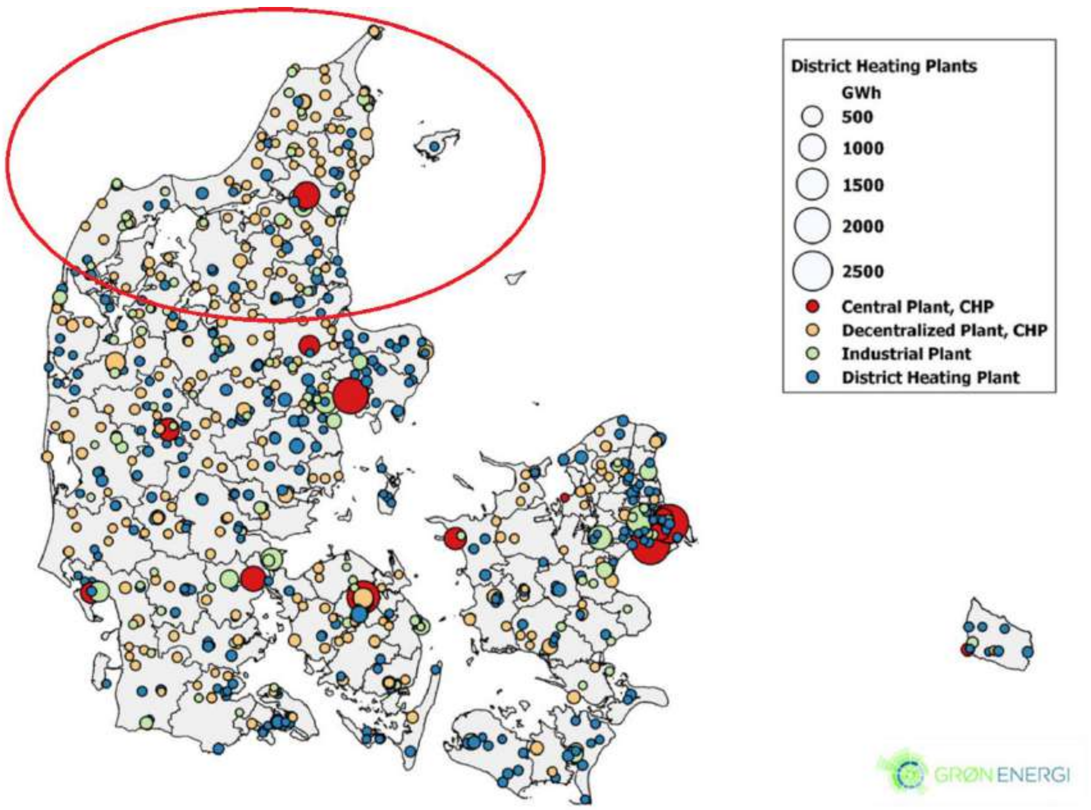


Figure 91 District heating plants by annual output in Nordjylland region based on the local data [7.], (GWh).

The opensource online tool HotMaps enables to estimate the overall capacity of district heating for the selected location. Potential of the heat supply via DH was estimated for different DH network requirements. This include the minimum heat demand in hectare of area that will be supplied using district heat network and the minimum heat output of single DH system.

A few different scenarios of DH requirements have been modelled and the range of total DH potential for Nordjylland was estimated. The results are illustrated on the following graph.

Each line indicates different size of DH that was allowed as minimum capacity of a single heat network that could be built. The DH potential (% of total heat demand) is presented in a function of a minimum heat demand required to occur per one hectare in order this area could be connected to the DH. For the current average heat density of 95 MWh/hectare the total DH contribution can reach between 70% and 80% of total heat demand depending how strict condition for minimum size of the network is set. Based on the existing ratio of DH in the region (~60%) this leaves another 10% - 20% of additional DH capacity.

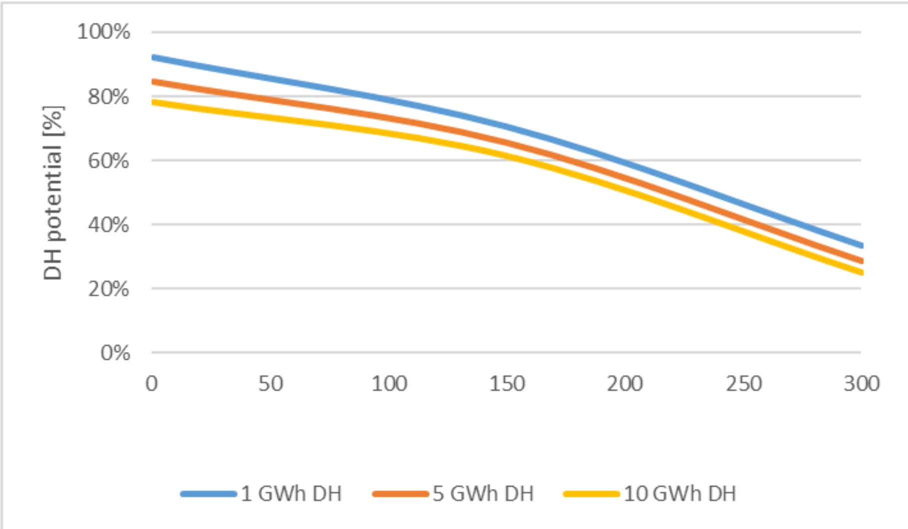


Figure 92 Heat supply potential via DH based on different minimum heat demand and supply requirements in Nordjylland region, [2.], (%).

4.3.3 Germany – Lausitz-Spreewald region

Only about 12% of total heat demand in Lausitz-Spreewald is supplied through district heating. This shows a 4% increase of DH installations since 2013 when the common source for all regions was published [6.]. Nevertheless, this indicates the large volumes of excess heat generated in the power plants and industrial facilities is not being currently utilized.

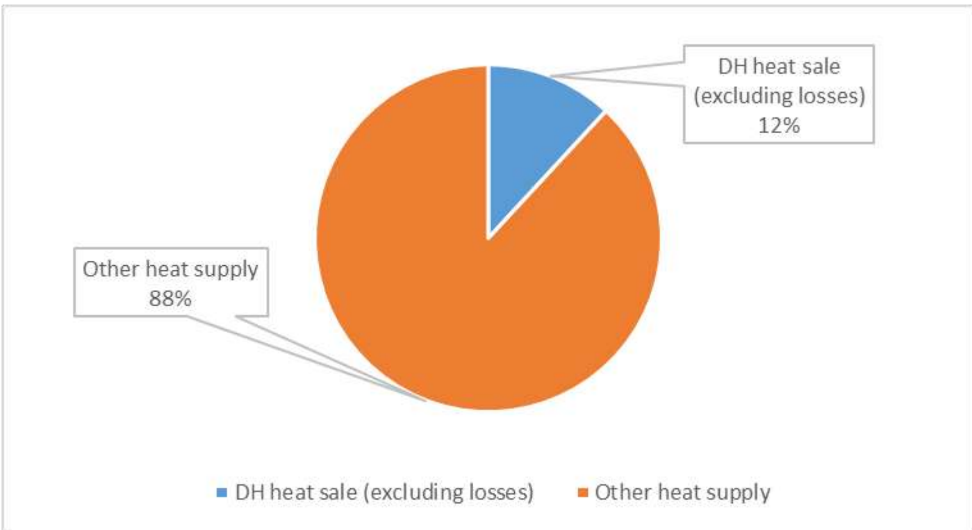


Figure 93 District heating supply to final customer in proportion to the total heat demand in Lausitz-Spreewald region based on local data, [14.], (%), 2016.

The annual heat supply volumes and their proportion of the district heat is presented in the following table.

The DH heat supply figures have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in Lausitz-Spreewald. These are presented along with the energy annual volumes in the table below.

District heating supply

	GWh	GWh/1000 of population
DH heat sale	700	1,2
Other heat supply	4.800	8,2
Total heat demand	5.500	9,4
DH %	13%	N/A

Table 55 DH heat supply volumes and their proportion per 1000 of population in Lausitz-Spreewald region based on specific information, [14.], (GWh/annum), 2016.

The opensource online tool HotMaps enables to estimate the overall capacity of district heating for the selected location. Potential of the heat supply via DH was estimated for different DH network requirements. This include the minimum heat demand in hectare of area that will be supplied using district heat network and the minimum heat output of single DH system.

A few different scenarios of DH requirements have been modelled and the range of total DH potential for Lausitz-Spreewald was estimated. The results are illustrated on the following graph.

Each line indicates different size of DH that was allowed as minimum capacity of a single heat network that could be built. The DH potential (% of total heat demand) is presented in a function of a minimum heat demand required to occur per one hectare in order this area could be connected to the DH.

For the current average heat density of 460 MWh/hectare the total DH contribution can reach between 10% and 15% of total heat demand depending how strict condition for minimum size of the network is set. Based on the existing ratio of DH in the region (~8%) this leaves another 2% - 7% of additional DH capacity.

By connecting less dense areas from the centralized plants or installing dispersed energy centers to supply smaller communities, the DH heat supply could reach up to 40%-60% of the total heat needs of the state.

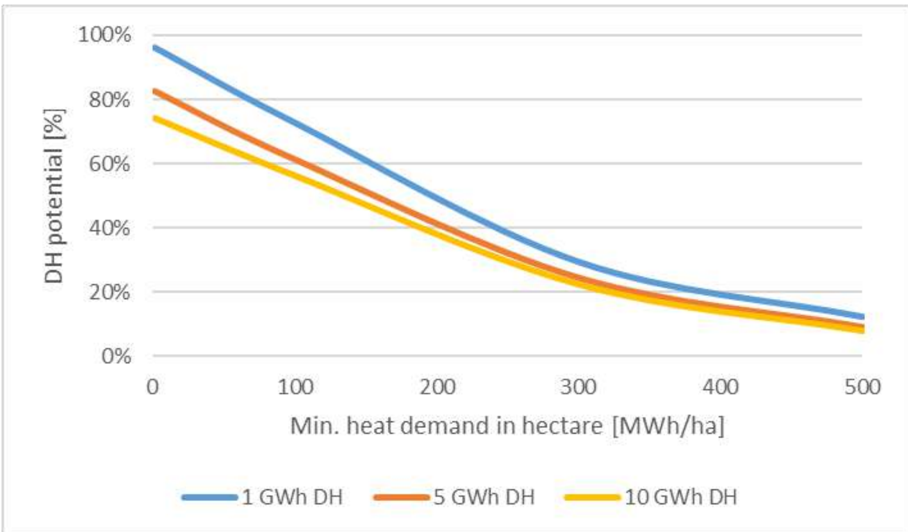
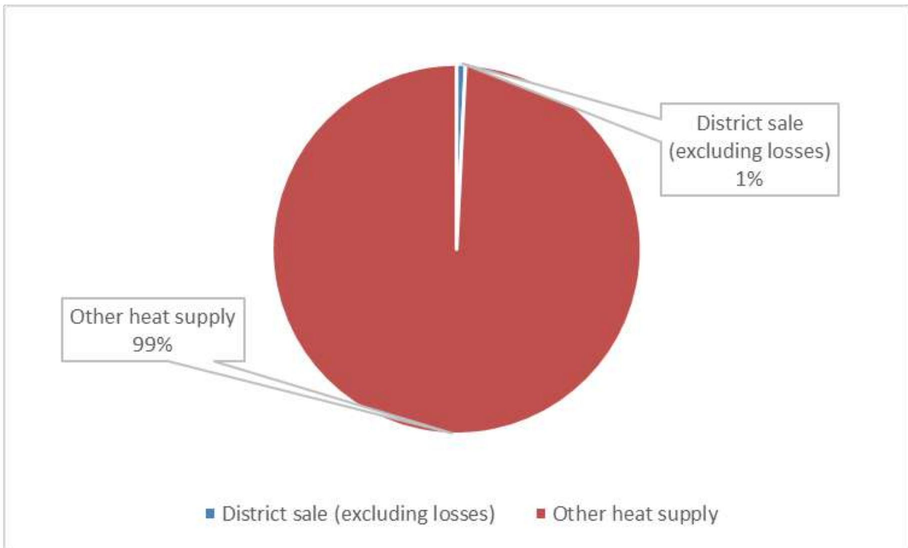


Figure 94 Heat supply potential via DH based on different minimum heat demand and supply requirements in Lausitz-Spreewald region, [2.], (%).

4.3.4 Greece – Western Macedonia region

The total heat demand which is covered by the different energy sources in Western Macedonia has not be registered resulting to the use of the estimated values of heating demand values. A significant point to be mentioned concerning this approach deals with "energy poverty", which is an increased issue nowadays in the region due to the national economic crisis and the local unemployment rate being one of the highest with EU. On the other hand, this approach could allow the estimation of the longer terms potential of DH in the region.



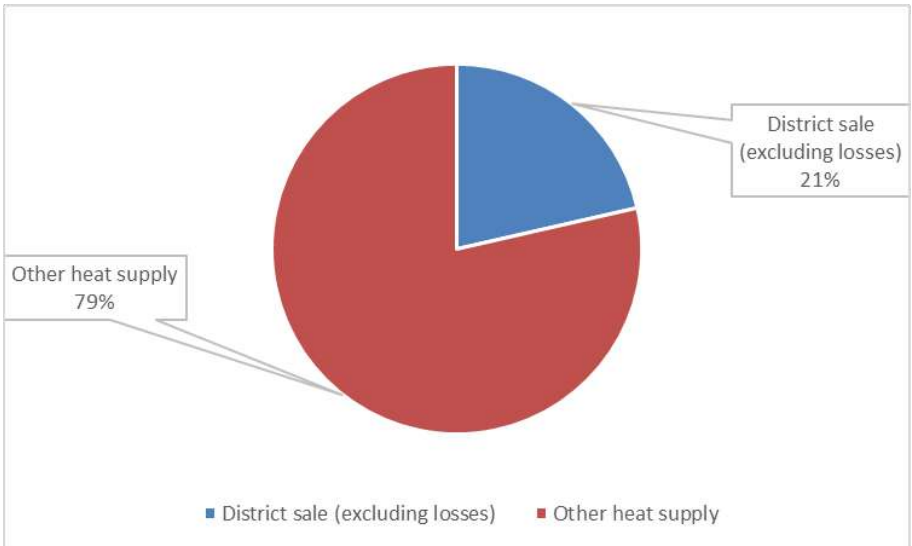


Figure 95 District heating supply to final customer in proportion to the total heat demand in Western Macedonia region based on general source, [6.], (%), 2013 and specific information, [26.],[28.], (%),2016.

The annual heat supply volumes and their proportion of the district heat is presented in the following table.

District heating supply	General data		Specific data	
	GWh	GWh/1000 of population	GWh	GWh/1000 of population
DH heat sale	15	0.0	485,7	1.82
Other heat supply	1923	7.0	1295	4.7
Total heat demand	1938	7.1	1781	5.5
DH %	0.8%	N/A	27.3%	N/A

Table 56 DH heat supply volumes and their proportion per 1000 of population in Western Macedonia region based on general source, [6.], (GWh/annum), 2013 and specific information, [26.],[28.], (GWh/annum),2016.

According to the opensource online tool HotMaps, an estimation of the regional overall capacity of district heating was carried out. Parameters of the analysis deals with minimum heat demand in hectare of the area that will be supplied using district heat network and the minimum heat output of single DH system, as illustrated on the following graph. Based on the analysis, the potential of the development of small scale district heating systems could be further examined in the region of Western Macedonia.

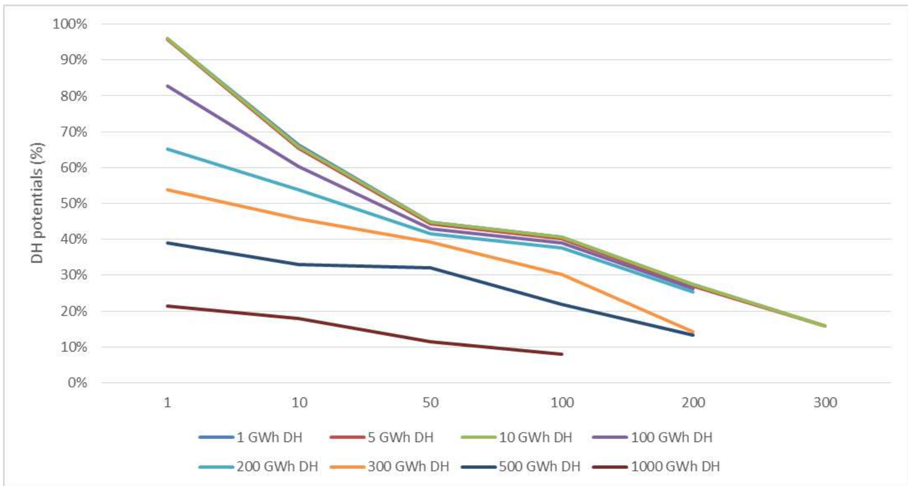


Figure 96 Heat supply potential via DH based on different minimum heat demand and supply requirements in Western Macedonia region, [2.], (%).

4.3.5 Hungary – Észak-Alföld region

Based on the national figures standardized to the regional level using the population ratio, around 15% of total heat demand in Észak-Alföld is supplied through district heating.

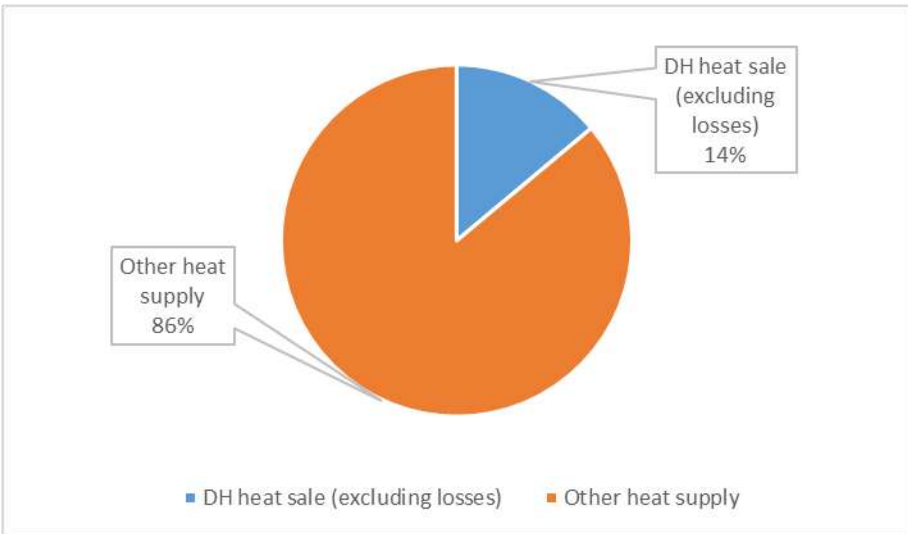


Figure 97 District heating supply to final customer in proportion to the total heat demand in Észak-Alföld region based on general source, [6.], (%), 2013.

The DH heat supply figures have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in the region. These are presented along with the energy annual volumes in the table below.

District heating supply

	GWh	GWh/1000 of population
DH heat sale	1,300	0.9
Other heat supply	7,900	5.4
Total heat demand	9,200	6.3
DH %	14%	N/A

Table 57 DH heat supply volumes and their proportion per 1000 of population in Észak-Alföld region based on general source, [6.], (GWh/annum), 2016.

4.3.6 Poland – Lodzkie region

Based on the national figures standardized to the regional level using the population ratio, nearly 1/3 of total heat demand in Lodzkie is supplied through district heating.

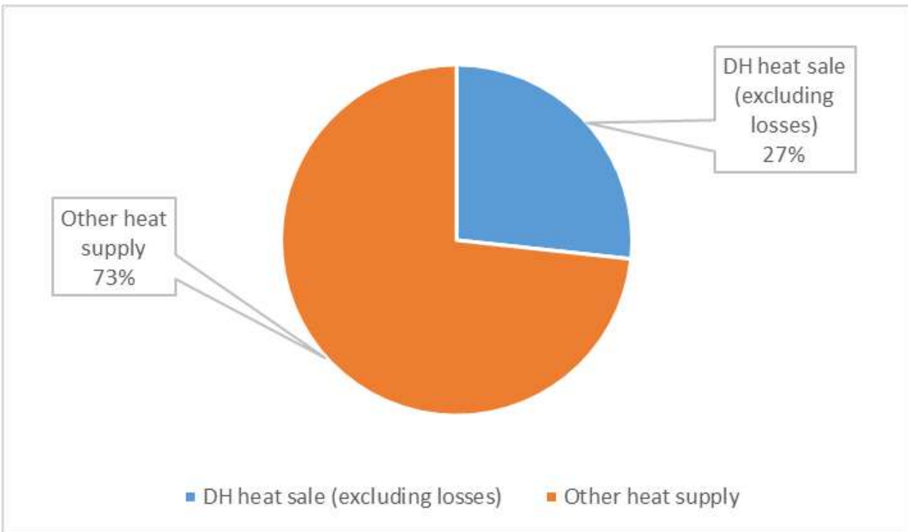


Figure 98 District heating supply to final customer in proportion to the total heat demand in Lodzkie region based on general source, [6.], (%), 2013.

The DH heat supply figures have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in the region. These are presented along with the energy annual volumes in the table below.

District heating supply

	GWh	GWh/1000 of population
DH heat sale	4,500	1.8
Other heat supply	12,300	5.0
Total heat demand	16,800	6.8
DH %	27%	N/A

Table 58 DH heat supply volumes and their proportion per 1000 of population in Lodzkie region based on general source, [6.], (GWh/annum), 2016.

A few different scenarios of DH requirements have been modelled and the range of total DH potential for Lodzkie was estimated. The results are illustrated on the following graph.

Each line indicates different size of DH that was allowed as minimum capacity of a single heat network that could be built. The DH potential (% of total heat demand) is presented in a function of a minimum heat demand required to occur per one hectare in order this area could be connected to the DH.

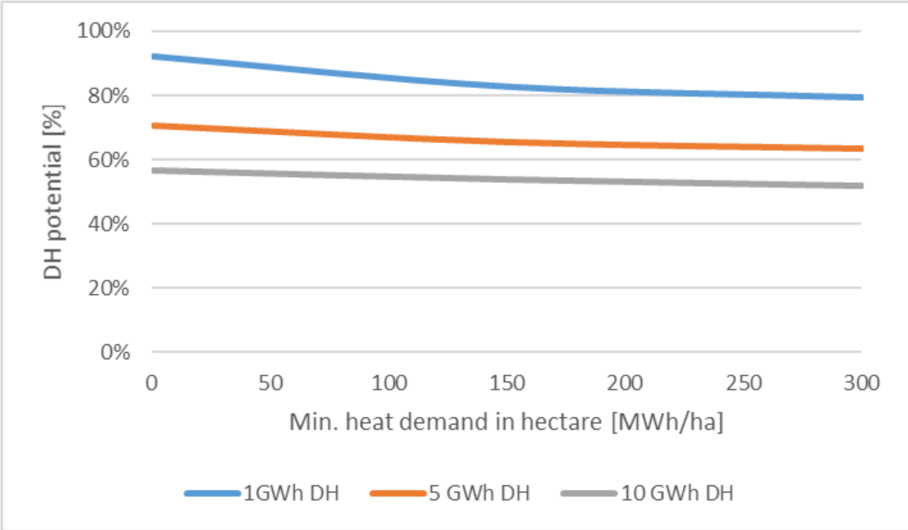


Figure 99. Heat supply potential via DH based on different minimum heat demand and supply requirements in Lodzkie Region, [2.], (%).

4.3.7 Romania – South-West Oltenia region

In South-West Oltenia, 8.90% of the national heating energy is supplied. The centralized urban heating and co-generation systems represent in Romania the most deficient energy sub-sector due to the physical and moral wear of the installations and equipments, the very large total energy losses between the source and the buildings (35 to 77%), insufficient financial resources for exploitation, maintenance, rehabilitation and modernization and the complex social problems related to the supportability of energy bills.

District heating supply system

Energy supply composition for District Heat generated - Recycled heat	98%
Energy supply composition for District Heat generated - Direct Renewables	2%
Percentage of citizens served by District Heating	23%
Number of District Heating systems	70
Total installed District Heating capacity	10,480 MW_{th}

Table 59 Information regarding DH heat system in Romania based on general source, [6.], 2016.

Oltenia has the lowest percentage (29.8%, well below the national average of 44.4%) of homes in which thermal energy (district heating and own heating) is distributed from the total conventional dwellings in the region, with the highest percentage being owned by the Bucharest-Ilfov region (86.2%). Percentages close to the national average have the North-West regions 44.0% and the South-East 42.3% and above the national average 49.5% and West 47.1%.

In the South-West Oltenia region, most homes with central heating (district heating or central heating), above the regional average, are located in Dolj county (36.4% of the total conventional dwellings of the county) followed by Vâlcea 30.9%, close to the Gorj regional average 29.3% and below the regional average, Mehedinţi 27% and Olt 21.2%.

Of all the homes where thermal energy is distributed both in the South-West Oltenia region and in all other regions and at the national level, most of them are located in urban areas and only a few are located in rural areas. In the urban area, compared to the national average of 73.2%, only the Bucharest-Ilfov region is situated above it (89.9%) and the Center (72.1%), South-East (72.7%), Nord-Est (71.1%) in an area close to it, with the South-Muntenia and West regions accounting for about 66% of the total number of dwellings located in the city, connected to district heating or central heating.

PlanEnergi

Fig 6.12 Procentul de locuințe cu energie termică pe medii de rezidență

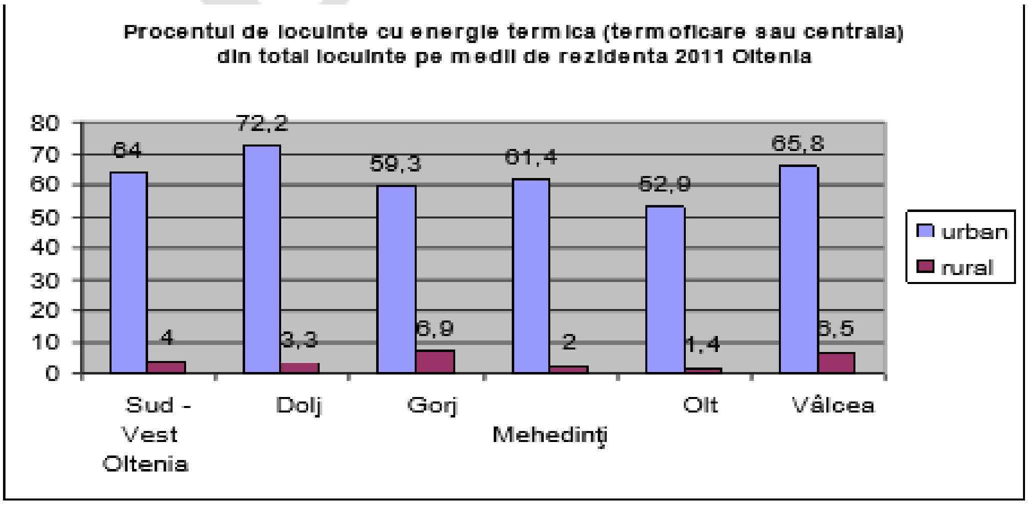


Figure 100 District heating supply to final customer in particular counties in South-West Oltenia region based on local source,[56.], (%), 2011/2012.

The lowest percentage is registered in Oltenia, where 64% of the dwellings located in the urban area had thermal energy (heating or central heating) in 2011, while in rural areas only 4% of the dwellings were in the same situation.

Approximately 90% of rural households and 15% of urban households are predominantly heated with firewood in ineffective stoves with incomplete combustion without particle filters. Domestic heating is usually partial, and thermal comfort low. There are about 3.5 million dwellings in total, plus tens of thousands of mining areas, heated directly by coal.

4.3.8 Slovenia – Savinjska region

Distribution systems in Savinjska region supplied nearly 20% of total heat through district heating, which is above the proportion of total heat demand supplied through district heating in the whole country (ca. 13%).

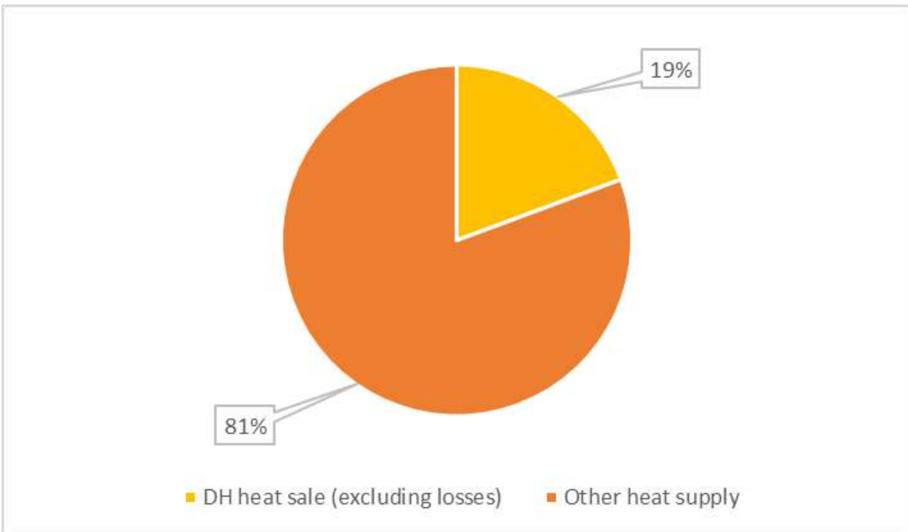


Figure 101 District heating supply to final customer in proportion to the total heat demand in Savinjska region based on general [4.] and specific information, [44.][44.], (%).

The following table presents the annual heat supply volumes and proportions of the district heat. The DH heat supply figures have been converted to the key performance indicators (KPIs) which indicate the energy share per one thousand of the population in Slovenia and Savinjska region. These are presented along with the energy annual volumes.

DH heat sale estimation for Savinjska region was based on the heat sale of two biggest districting heating systems in the region (Velenje and Celje) and the information on the number of remaining DH systems and average consumption by individual municipalities (9 systems, consumption < 10 GWh).

District heating supply	**Specific data (Slovenia)**		**Specific data (Savinjska region)**	
	GWh	GWh/1000 of population	GWh	GWh/1000 of population
DH heat sale	1,963	0.9	345	1.4
Other heat supply	13,770	6.7	1,463	5.7
Total heat demand	15,733	7.6	1,808	7.1
DH %	12%	N/A	19%	N/A

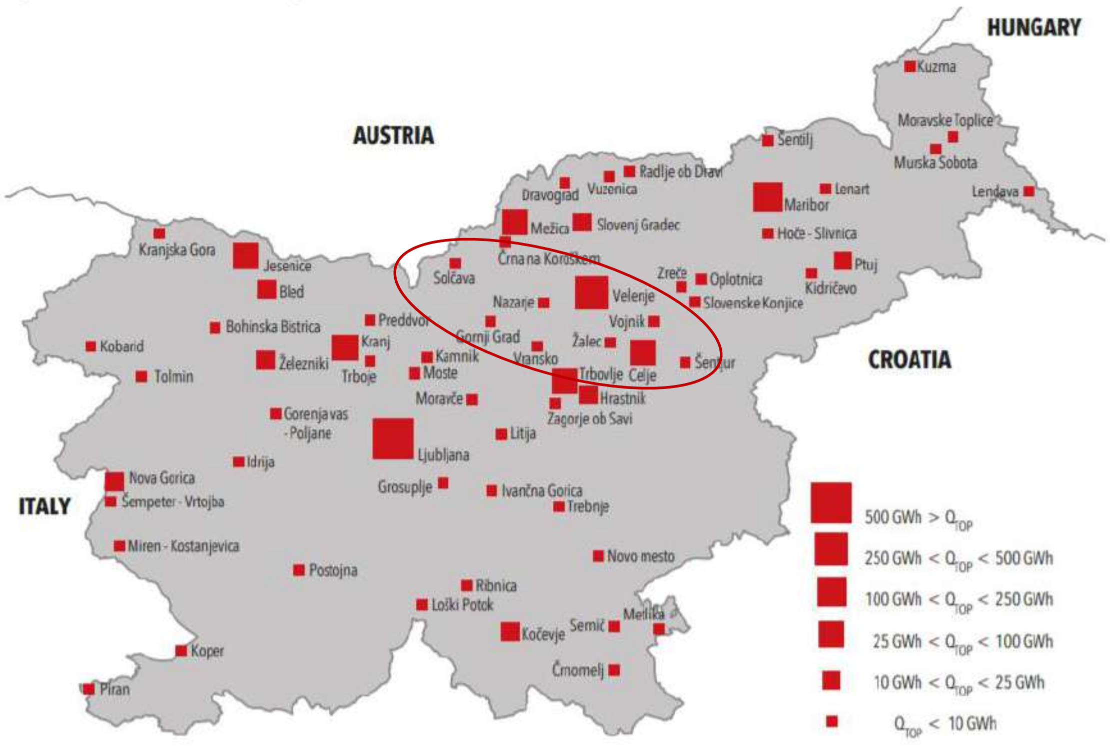
Table 60 DH heat supply volumes and their proportion per 1000 of population in Slovenia and Savinjska region based on general [4.] and specific information, [44.], (GWh/annum).

In 2017, in Slovenia supply of heat was provided from 93 distribution systems by 55 heat suppliers in 64 Slovenian municipalities. Heat distributors delivered 1,963.2 GWh of heat (excluding losses) to 106,292 consumers, where 36.2% of useful heat was used for 96.843

household consumers; 28.9% for the supply of 8305 business consumers, and 14.5% of heat for 1144 industrial consumers.

According to the structure of the primary energy products for heat generation, the primary energy source of heat production for the supply of heat distribution systems was coal with a 56.2% share (brown coal – 43.32%, lignite – 13.02%). Renewable energy sources were represented with a 12.8% share.

The overview of the heat distribution systems in Slovenia and Savinjska region along with their annual output is shown on the next figure. The Savinjska region is highlighted in the red circle. The largest generators in the region are Velenje (with Šoštanj) and Celje providing around 300 GWh per annum. The rest of the district heat in the region is supplied by smaller systems in the municipalities where yearly heat consumption does not exceed 10 GWh. The Velenje and Šoštanj system is also second longest system in the country (176.5 kilometers of a warm-water system), ranking right after Ljubljana, which is the largest and the longest system in the country.



Source: Energy Agency

Figure 102 Heat distribution systems in Slovenia in 2017 based on the local data, [44.], (GWh).

The overall capacity of district heating for the selected location was estimated with the opensource online tool HotMaps. Potential of the heat supply via DH was estimated for different DH network requirements. This include the minimum heat demand in hectare of area that will be supplied using district heat network and the minimum heat output of single DH system.

A few different scenarios of DH requirements have been modelled and the range of total DH potential for Savinjska region was estimated. The results are illustrated on the graph below.

Each line indicates different size of DH that was allowed as minimum capacity of a single heat network that could be built. The DH potential (% of total heat demand) is presented in a function of a minimum heat demand required to occur per one hectare in order this area could be connected to the DH. For the current average heat density of 86.86 MWh/hectare the total DH contribution can reach between 60% and 70% of total heat demand depending how strict condition for minimum size of the network is set. Based on the existing share of DH in total heat supply of the Savinjska region (~20%) this leaves around 40% to 50% of additional DH capacity.

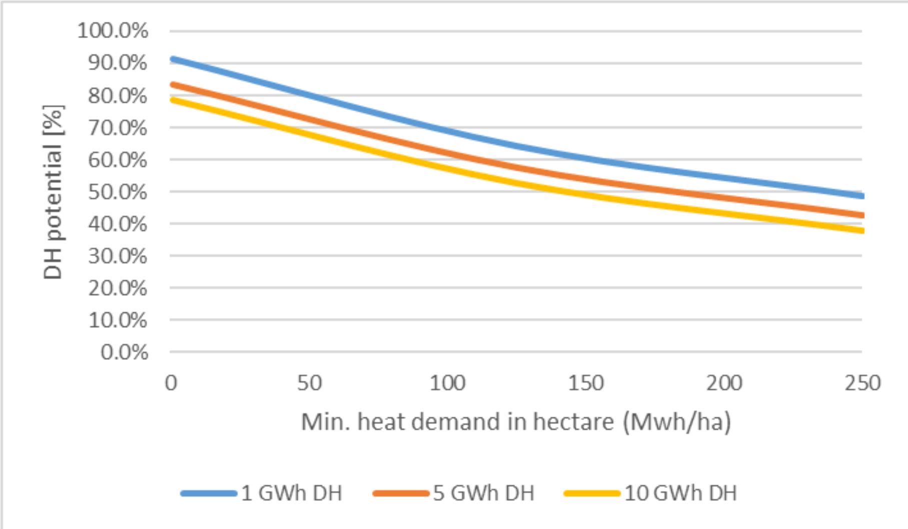


Figure 103 Heat supply potential via DH based on different minimum heat demand and supply requirements in Savinjska region, [2.], (%).

4.3.9 Spain – Extremadura region

District heating is not applicable in Extremadura. There are small installations for public buildings but not representatives as to give data or information.

The opensource online tool HotMaps enables to estimate the overall capacity of district heating for the selected location. Potential of the heat supply via DH was estimated for different DH network requirements. This include the minimum heat demand in hectare of area that will be supplied using district heat network and the minimum heat output of single DH system.

A few different scenarios of DH requirements have been modelled and the range of total DH potential for Lausitz-Spreewald was estimated. The results are illustrated on the following graph.

Each line indicates different size of DH that was allowed as minimum capacity of a single heat network that could be built. The DH potential (% of total heat demand) is presented in a function of a minimum heat demand required to occur per one hectare in order this area could be connected to the DH.

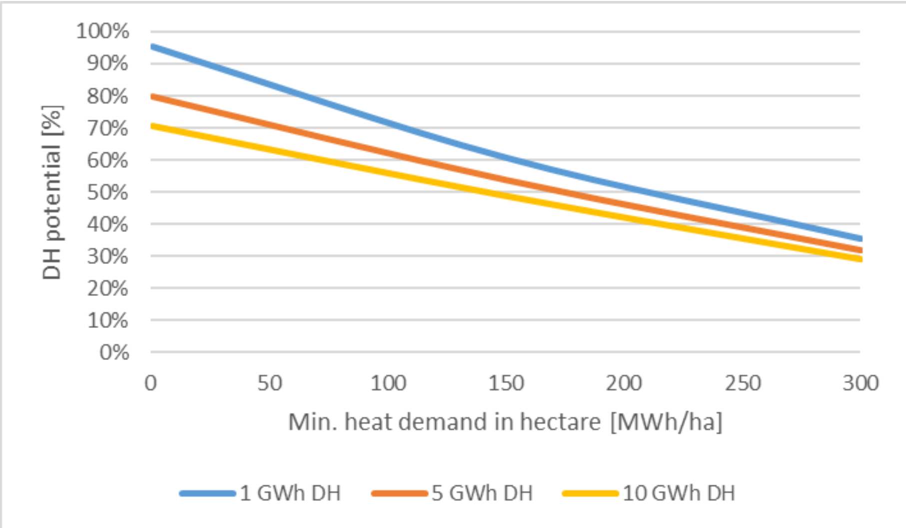


Table 61 Heat supply potential via DH based on different minimum heat demand and supply requirements in Extremadura region, [2.], (%).

4.4 Workplaces connected to coal value chains

4.4.1 Bulgaria – Yugoiztochen region

- Coal mining

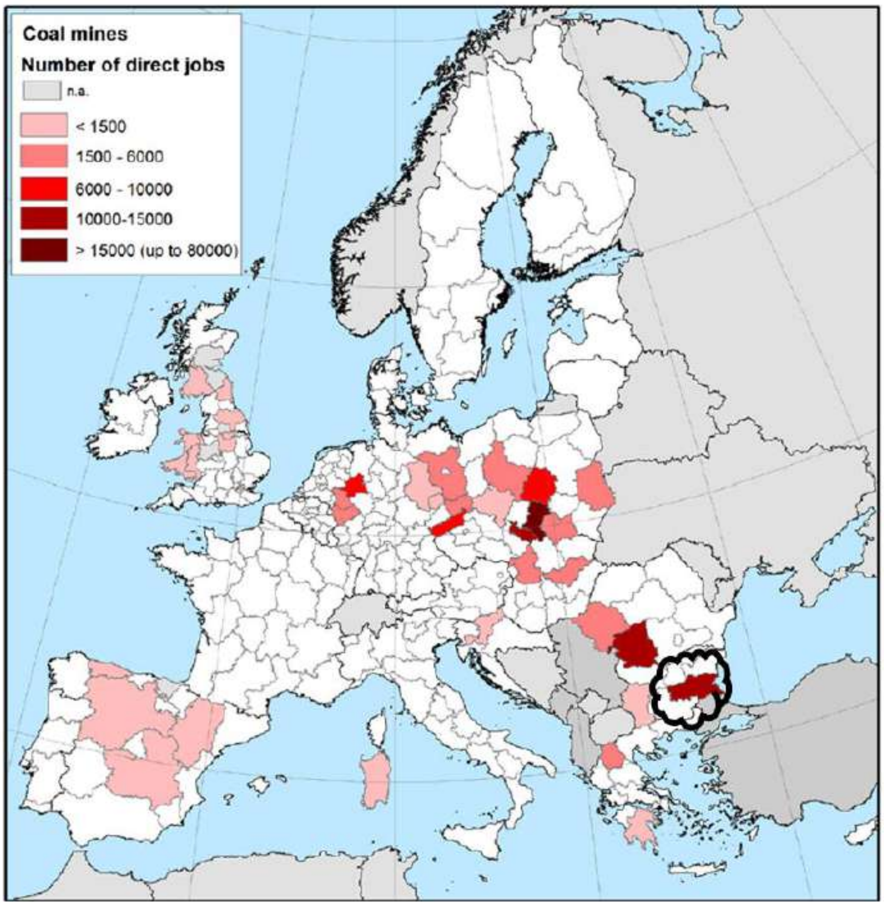


Figure 104 Overview of number of workplaces related to the coal mining by country (Yugoiztochen region is highlighted in circle) [8.].

- Coal power plants

The figures for coal-related work places have been converted to the key performance indicators (KPIs) which indicate the number of employees per one thousand of the population in Yugoiztochen. These are presented along with total number of jobs in the table below.

	Direct workplaces related to coal activities - Yugoiztochen	**No of employees**	**No of employees per 1000 of population**
	Plant O&M jobs	1,885	1.8
	Mining jobs	10,773	10.3
	Total	12,658	12.1

Table 62 Number of direct work positions related to coal industry and its share per 1000 of population in Yugoiztochen region [8.].

Indirect workplaces related to coal activities - Yugoiztochen	**No of employees**	**No of employees per 1000 of population**
Intra-regional jobs (within the region only)	12,063	11.5
Inter-regional jobs (accounts for trade connections between regions)	7,495	7.2
Total	19,558	18.7

Table 63 Number of indirect work positions related to coal industry and its share per 1000 of population in Yugoiztochen region [8.].

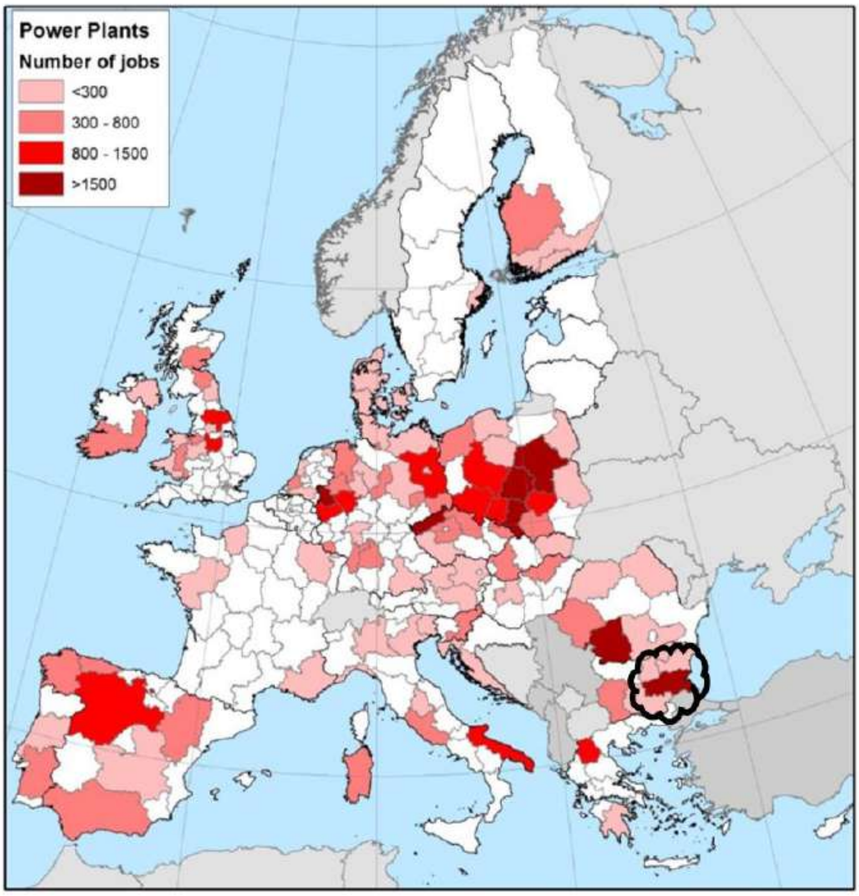


Figure 105 Overview of number of workplaces related to the coal-fired power plants by country (Yugoiztochen region is highlighted in circle) [8.].

4.4.2 Denmark – Nordjylland region

- Coal mining

In the entire Denmark and therefore in the Nordjylland region, there are neither existing coal mines nor workplaces and professions related to the lignite and hard coal mining sector. The entire coal consumption is sourced from import, mostly from Russia, Colombia and South Africa. This is indicated by white field (n.a. – not applicable) at the coal map for Europe shown on the following figure.

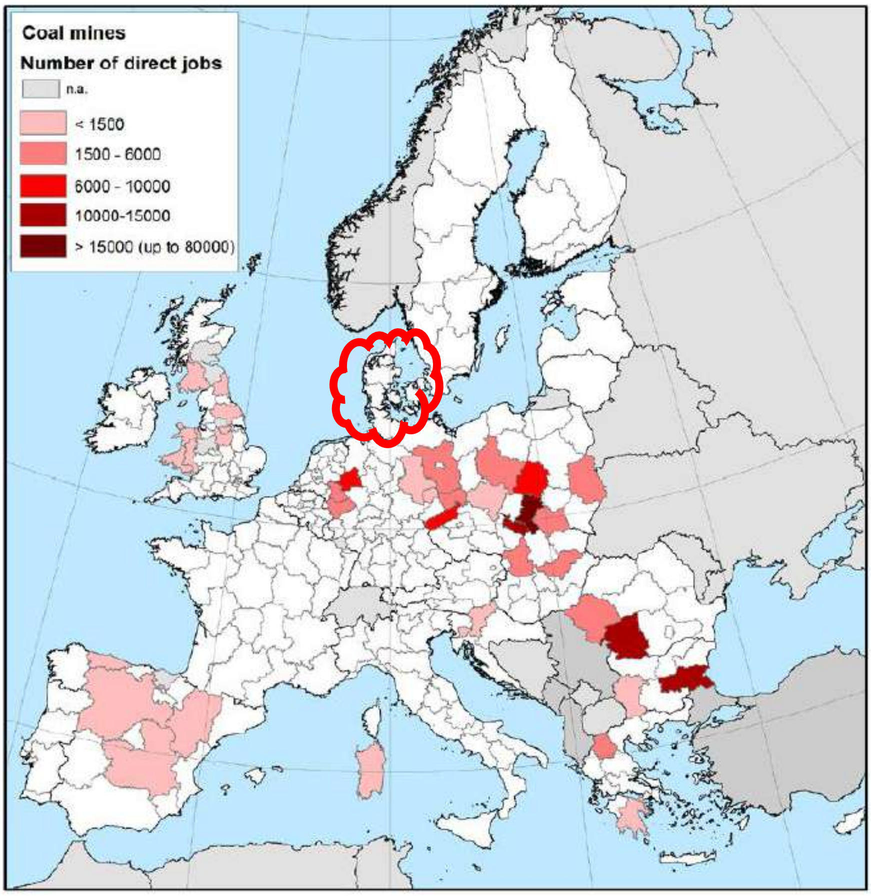


Figure 106 Overview of number of workplaces related to the coal mining by country (Denmark is highlighted in circle) [8.].

- Coal power plants

There is one coal-fired power plant in Nordjylland that have been operated circa 27 years, have 740 MW of installed electrical capacity and average 36% efficiency. It is planned to get decommissioned by 2025.

There is no more coal power plant under construction or planned for future development.

The overview of the work places directly corelated with the coal industry in the European countries shows there is no more than 300 jobs in entire Denmark.

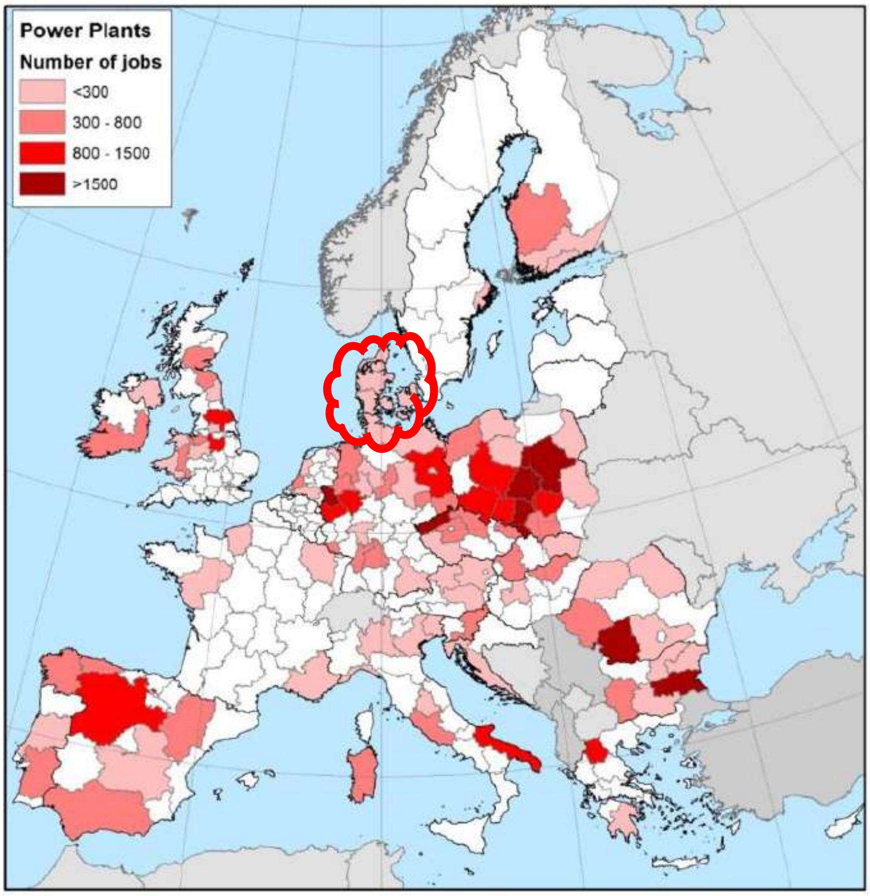


Figure 107 Overview of number of workplaces related to the coal-fired power plants by country (Denmark is highlighted in circle) [8.].

The work positions in the coal-oriented sector can be split into direct jobs – closely related to the coal production and power plants, and indirect jobs – which aggregate people working in the other industries, however, interfering with the coal sector (IT, administration, power trade, regulatory). These are summarized for the Nordjylland region in the next table.

The figures for coal-related work places have been converted to the key performance indicators (KPIs) which indicate the number of employees per one thousand of the population in Nordjylland. These are presented along with total number of jobs in the table below.

Direct workplaces related to coal activities - Nordjylland	**No of employees**	**No of employees per 1000 of population**
Plant O&M jobs	243	0.4
Mining jobs	0	0.0
Total	243	0.4

Table 64 Number of direct work positions related to coal industry and its share per 1000 of population in Nordjylland region [8.].

Indirect workplaces related to coal activities - Nordjylland	No of employees	No of employees per 1000 of population
Intra-regional jobs (within the region only)	316	0.5
Inter-regional jobs (accounts for trade connections between regions)	705	1.2
Total	1021	1.7

Table 65 Number of indirect work positions related to coal industry and its share per 1000 of population in Nordjylland region [8.].

According to the local information, the only existing coal-fired power plant in Nordjylland is Nordjyllandsværket, which is owned by Aalborg Municipality and covers 60% of the district heating requirement in Aalborg.

There is also a cement producing site, Aalborg Portland with nearly similar annual coal consumption as Nordjyllandsværket. The coal-fired boiler generates process heat for the industrial processes.

4.4.3 Germany –Lausitz-Spreewald region

- Coal mining

The Brandenburg Coal region has two above ground lignite mines, both located in the Lausitz-Spreewaldregion. Their maximum production capacity is 34 Mt and productivity of nearly 10,000 t/employee. Both mines are 110 m deep. There is no production and nearly no consumption of hard coal.

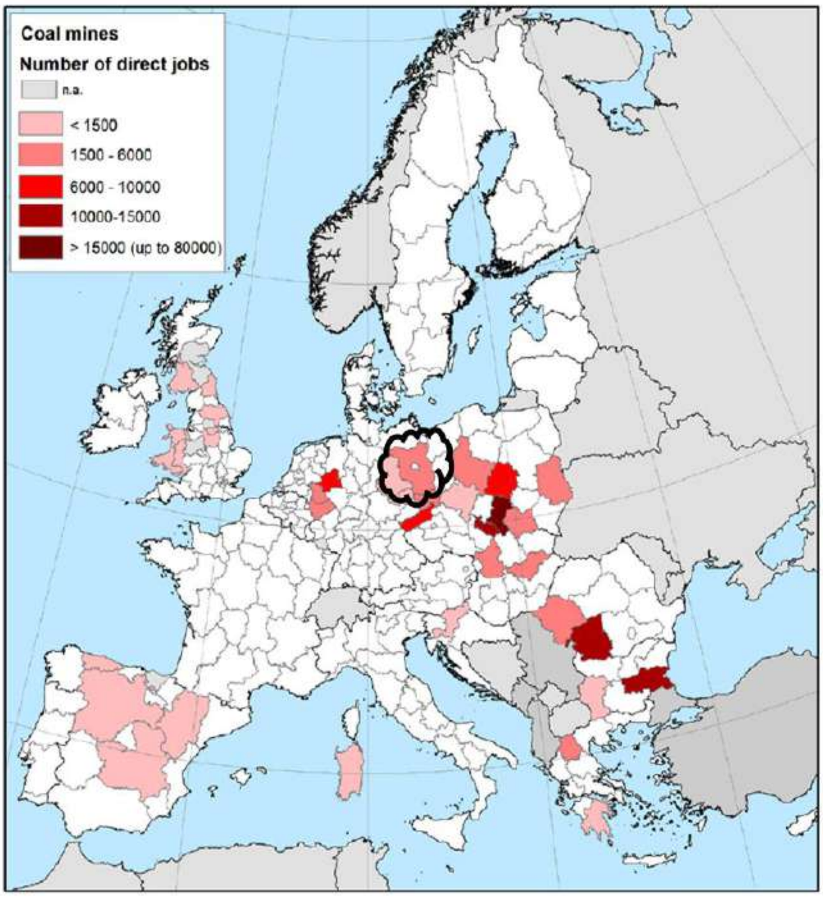


Figure 108 Overview of number of workplaces related to the coal mining by country (Brandenburg region is highlighted in circle, with the Coal areas located in the Lausitz-Spreewald state) [8.].

- Coal power plants

In the Brandenburg Coal region, coal-fired power plants have a total installed capacity of 4.390 MW (2790 MW Jänschwalde, 1800 MW Schwarze Pumpe, Cottbus) with average efficiency of 34% and 27 years of operation.

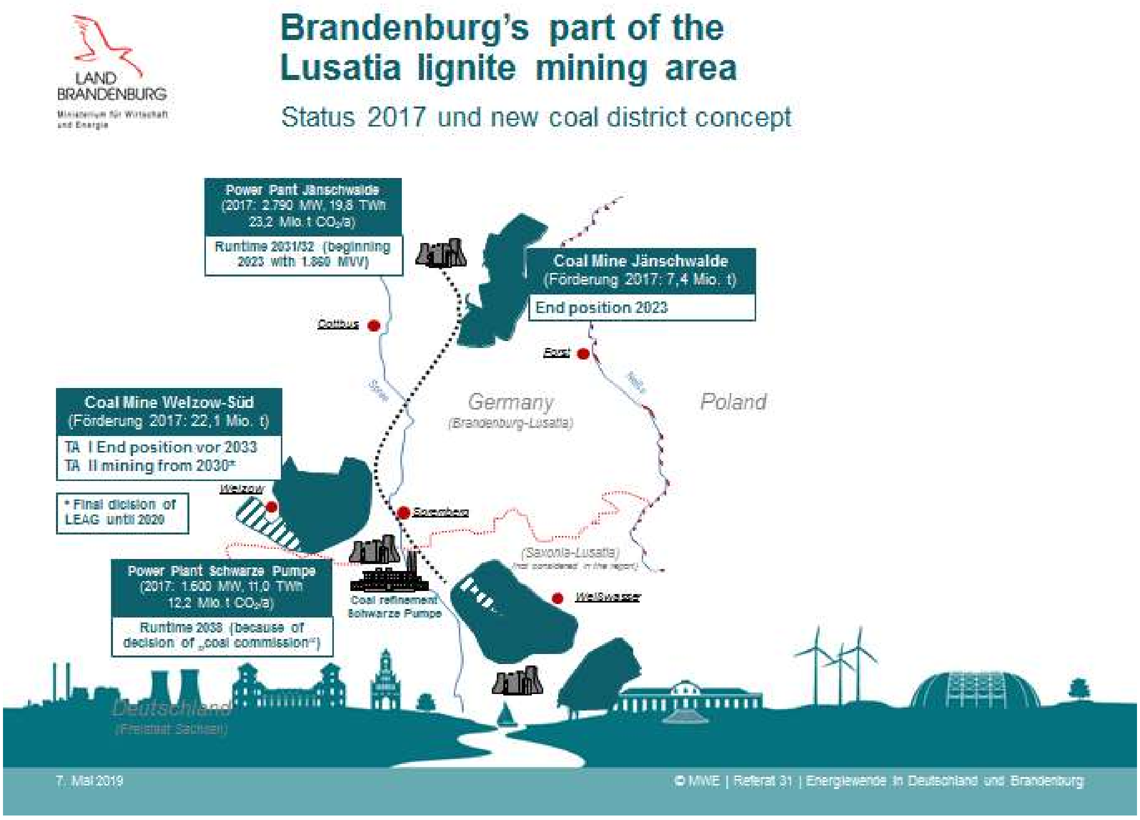


Figure 109 Mining areas [17.].

There is no more coal power plant in the whole Brandenburg region under construction or planned for future development.

The overview of the work places directly corelated with the coal industry in the European countries shows there is a high dependence on coal market. Around 4,500 jobs directly related to coal mining and coal-fired power plants is identified in Lausitz-Spreewaldregion.

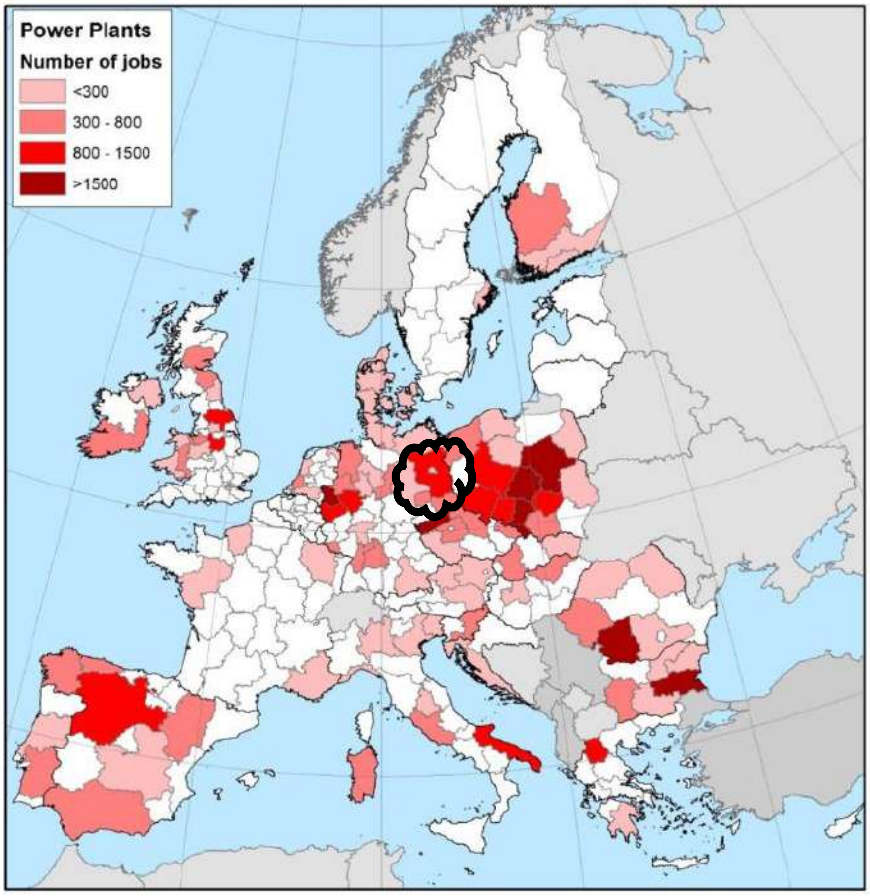


Figure 110 Overview of number of workplaces related to the coal-fired power plants by country (Brandenburg region is highlighted in circle, with the Coal areas located in the Lausitz-Spreewald state) [8.].

The work positions in the coal-oriented sector can be split into direct jobs – closely related to the coal production and power plants, and indirect jobs – which aggregate people working in the other industries, however, interfering with the coal sector (IT, administration, power trade, regulatory). These are summarized for the Lausitz-Spreewald region in the next table.

The figures for coal-related work places have been converted to the key performance indicators (KPIs) which indicate the number of employees per one thousand of the population in Lausitz-Spreewald. These are presented along with total number of jobs in the table below.

Direct workplaces related to coal activities - Lausitz-Spreewald	**No of employees**	**No of employees per 1000 of population**
Plant O&M jobs	1110	1.9
Mining jobs	3400	5.8
Total	4510	7.7

Table 66 Number of direct work positions related to coal industry and its share per 1000 of population in Lausitz-Spreewald region [8.].

The Lausitz-Spreewald region has also many industries which use coal for the manufacturing processes. This includes steel industries and small quantities used in the residential heating market. The exact coal consumption for the heavy-duty sector is unknown, however, this proportion is significant and at least 60 %

The new energy strategy for the Brandenburg region has to anticipate ceasing the coal sector in the affected Lausitz-Spreewald region until 2038. 3,000 MW out of total currently operated 4,300 MW power blocks is about to reach its lifespan and shut down by 2025 which entails over 700 redundancies. The reduction and eventually the cutoff of lignite mining activities will affect nearly 3,500 work places which based on the assessment of the performance of mining regions in comparison to other European regions [8.] places Brandenburg at medium risk level.

According to the local statistics demonstrated in the Fact Sheet on Economic Development in the Brandenburg part of Lusatiathe total number of employees in the mining and manufacturing industry amounts to nearly 28,500 people. ([19.], 2017)

4.4.4 Greece – Western Macedonia region

- Coal mining

Western Macedonia hosts the largest lignite mine activities in Greece, being one of the two regions exploiting this domestic solid energy source. Based on mining activity, Western Macedonia's energy axis of Kozani – Ptolemais - Florina is ranked first in the Balkans, second in Europe and sixth in the world. The mining areas of Greece are depicted in the following figure.

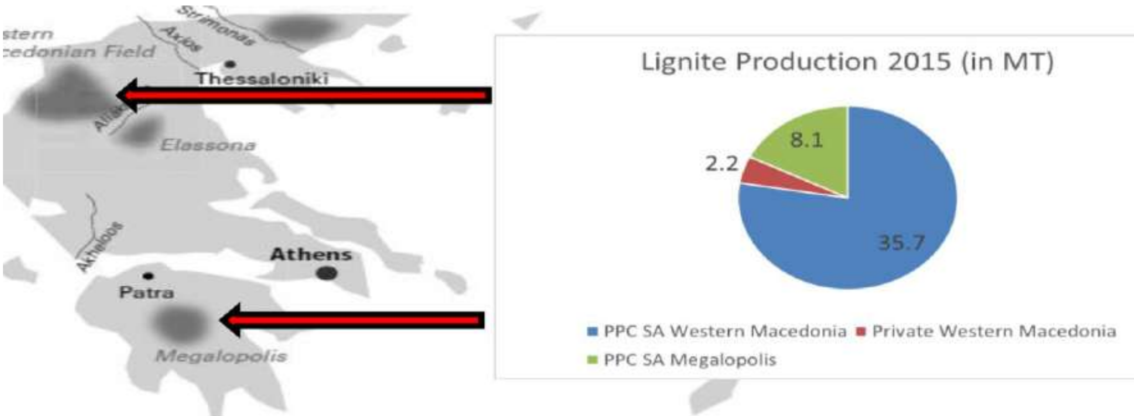


Figure 111 Mining areas and significance in Greece, [35.].

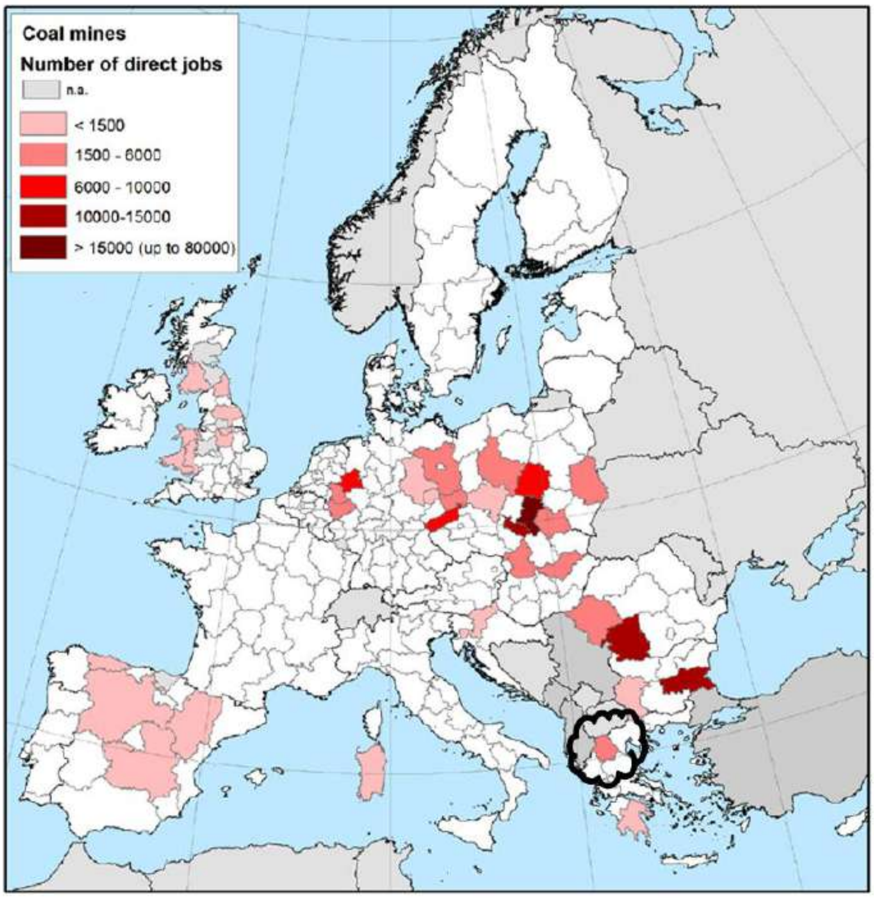


Figure 112 Overview of number of workplaces related to the coal mining by country (Western Macedonia region is highlighted in circle) [8.].

- Coal power plants

4 lignite fired power plants of 12 units are now days in operation in the region, representing the 40% of thermal units and 20% of the total installed net capacity of the interconnected system in Greece, as presented below.

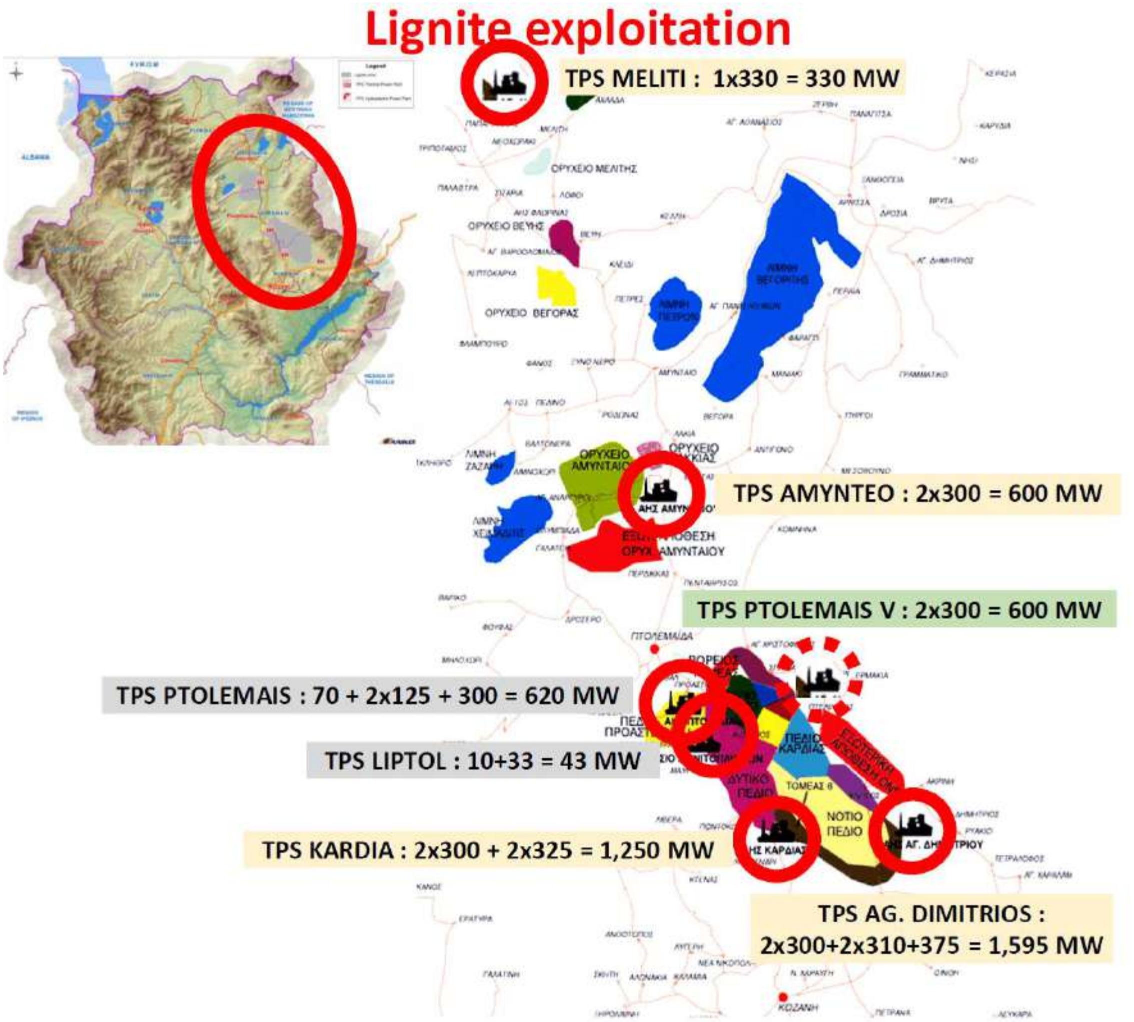


Figure 113 Overview of number of lignite mines and power plants in Western Macedona, [35.].

In regional level, taking into account the historical data of units' life and the expected end of their operation, three phase of lignite capacity reduction can be identified. The first phase of local lignite industry shrinkage has already occurred during the period 2010 – 2015, where 663 MW of the oldest lignite-fired units 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.

The effect of this capacity loss will be partially reduced by the commissioning of a new lignite power plant of 660 MW, which will start its operation by 2022. Finally, by 2030, 4 units of 1220 MW capacity will reach their lifetime, leaving only 30% of the initial lignite capacity in operation in the region. A schematic evolution of lignite capacity evolution in Western Macedonia is given in next figure.

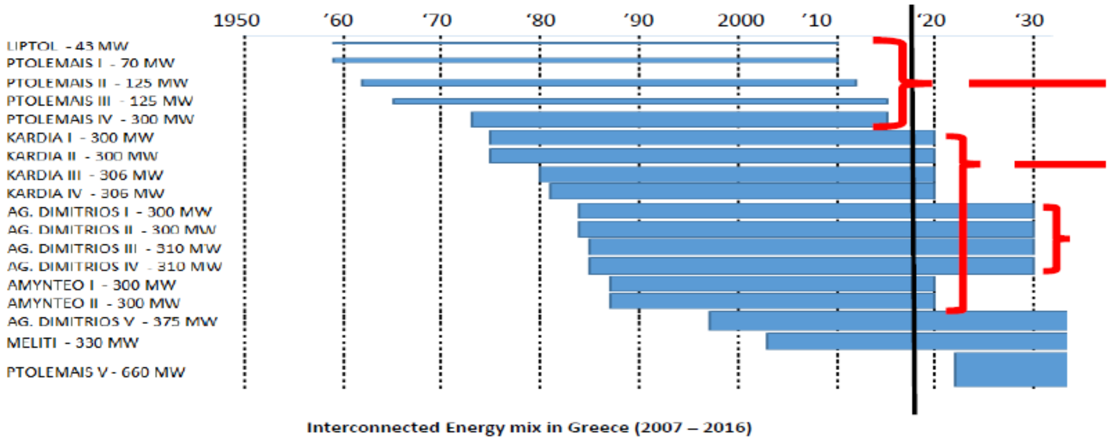


Figure 114: Evolution of lignite capacity in Western Macedonia, [35.].

Further to that, the lignite production is also, as already stated, in a continuous loss of its share in the energy mix. Since 2004, when it has reached its peak, the production of lignite and consequently lignite energy production has been steadily declining, with only 50% of the corresponding output in 2004. Estimations dealing with the next period indicate that this decline will continue. Lignite energy production follows similar trends.

The direct work positions related to the operation of the lignite industry in the region is presented in the next table.

Direct workplaces related to coal activities -	No of employees	No of employees per 1000 of population
Plant O&M jobs	1,398	5.1
Mining jobs	4,283	15.6
Total	5,681	20.7

Table 67 Number of direct work positions related to coal industry and its share per 1000 of population in Western Macedonia region [8.].

Indirect workplaces related to coal activities -	No of employees	No of employees per 1000 of population
Intra-regional jobs (within the region only)	1,640	6.0
Inter-regional jobs (accounts for trade connections between regions)	3,603	13.2
Total	5,243	19.1

Table 68 Number of indirect work positions related to coal industry and its share per 1000 of population in Western Macedonia region. [8.]

According to the above, the total work force related to the lignite industry amounts to 10924 workplaces representing 39.9 employees per 1000 of population in the region.

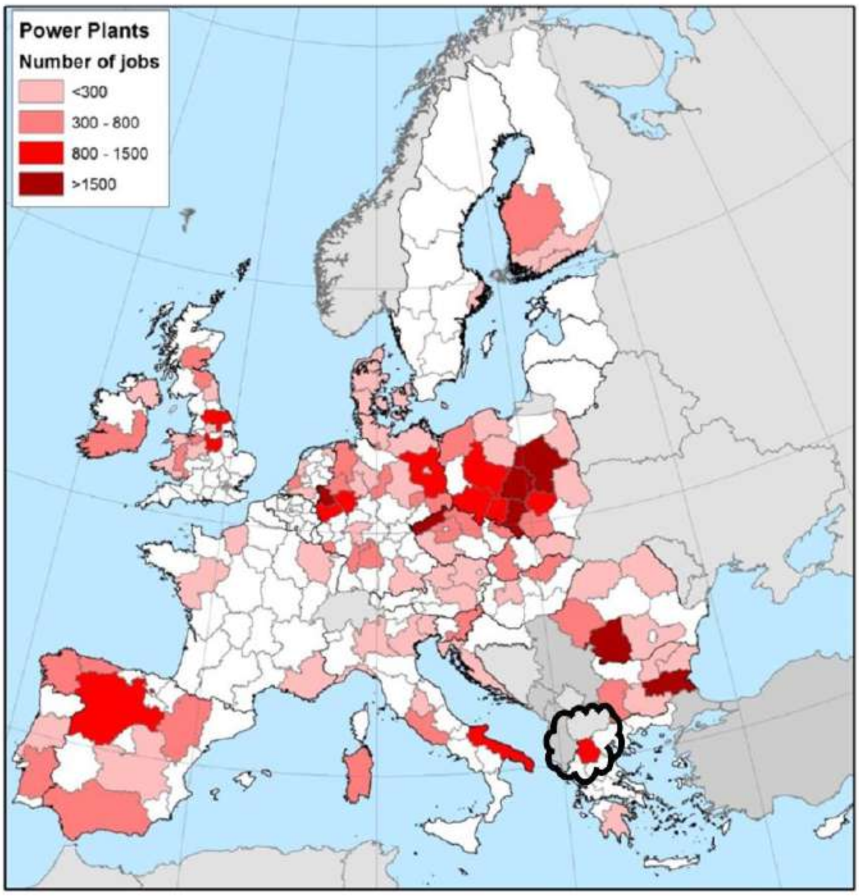


Figure 115 Overview of number of workplaces related to the coal-fired power plants by country (Western Macedonia region is highlighted in circle) [8.].

4.4.5 Hungary – Észak-Alföld region

There was no data provided.

- Coal mining

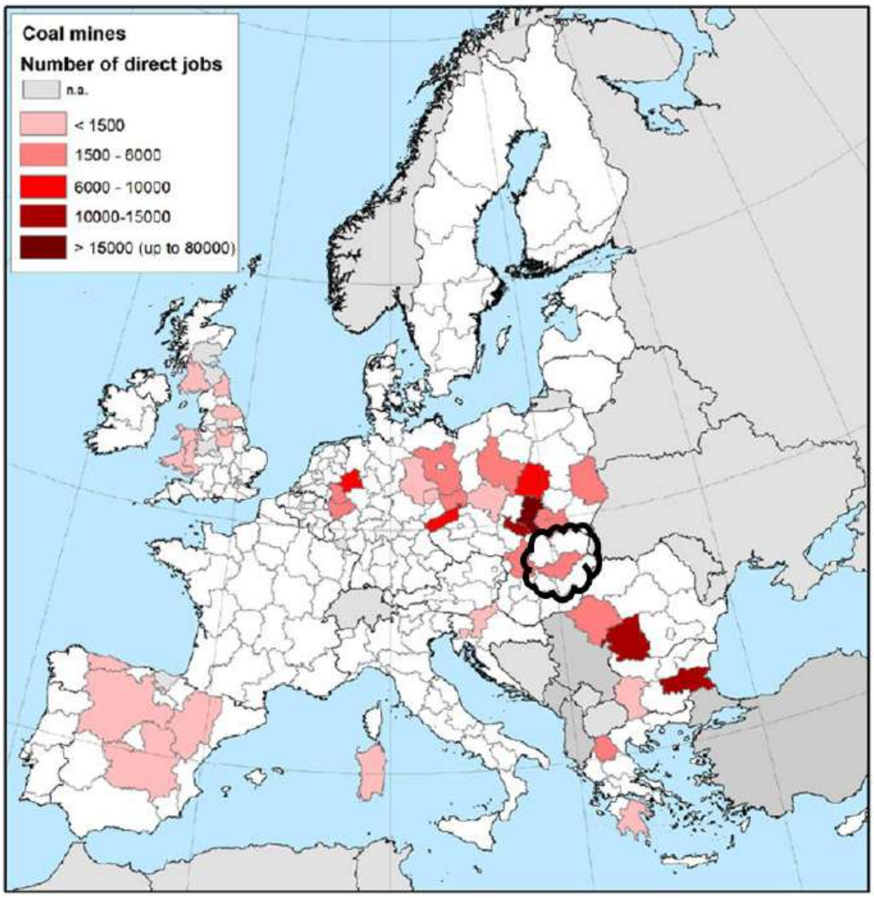


Figure 116 Overview of number of workplaces related to the coal mining by country (Észak-Alföld region is highlighted in circle) [8.].

- Coal power plants

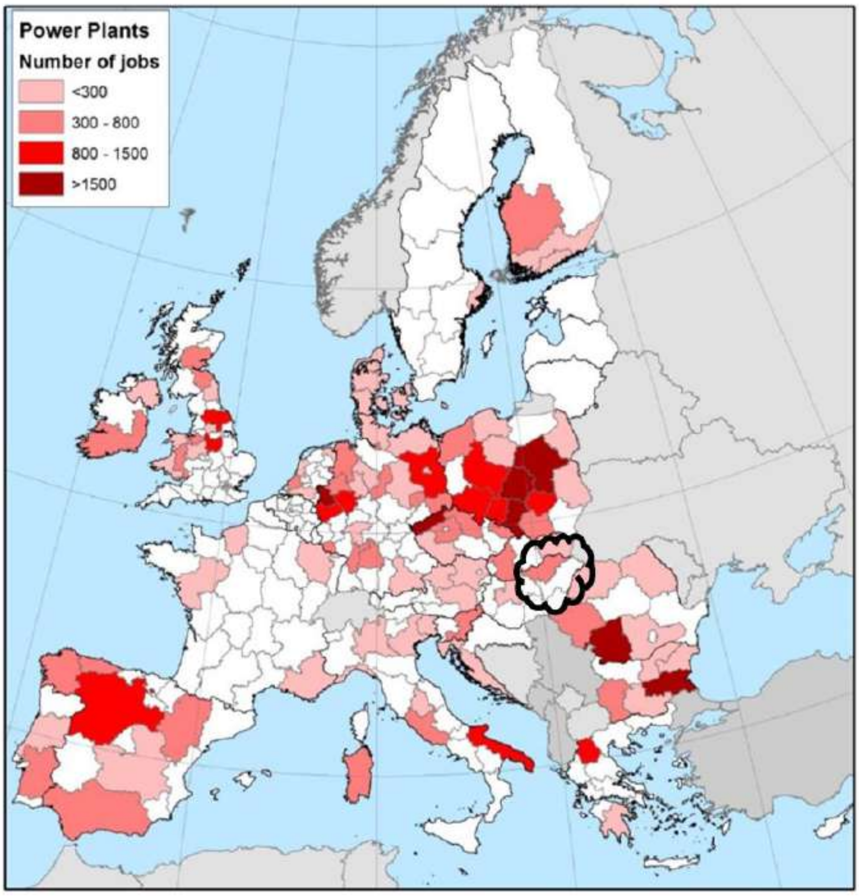


Figure 117 Overview of number of workplaces related to the coal-fired power plants by country (Észak-Alföld region is highlighted in circle) [8.].

Direct workplaces related to coal activities - Észak-Alföld	No of employees	No of employees per 1000 of population
Plant O&M jobs	632	0.4
Mining jobs	1,655	1.1
Total	2,287	1.6

Table 69 Number of direct work positions related to coal industry and its share per 1000 of population in Észak-Alföld region [8.].

Indirect workplaces related to coal activities - Észak-Alföld	No of employees	No of employees per 1000 of population
Intra-regional jobs (within the region only)	1,834	1.2
Inter-regional jobs (accounts for trade connections between regions)	3,863	2.6
Total	5,697	3.9

Table 70 Number of indirect work positions related to coal industry and its share per 1000 of population in Yugoiztochen region [8.].

4.4.6 Poland – Lodzkie region

- Coal mining

The Lodzkie region has one 300 m depth coal mine, with 6590 productivity (tonnes /employee).

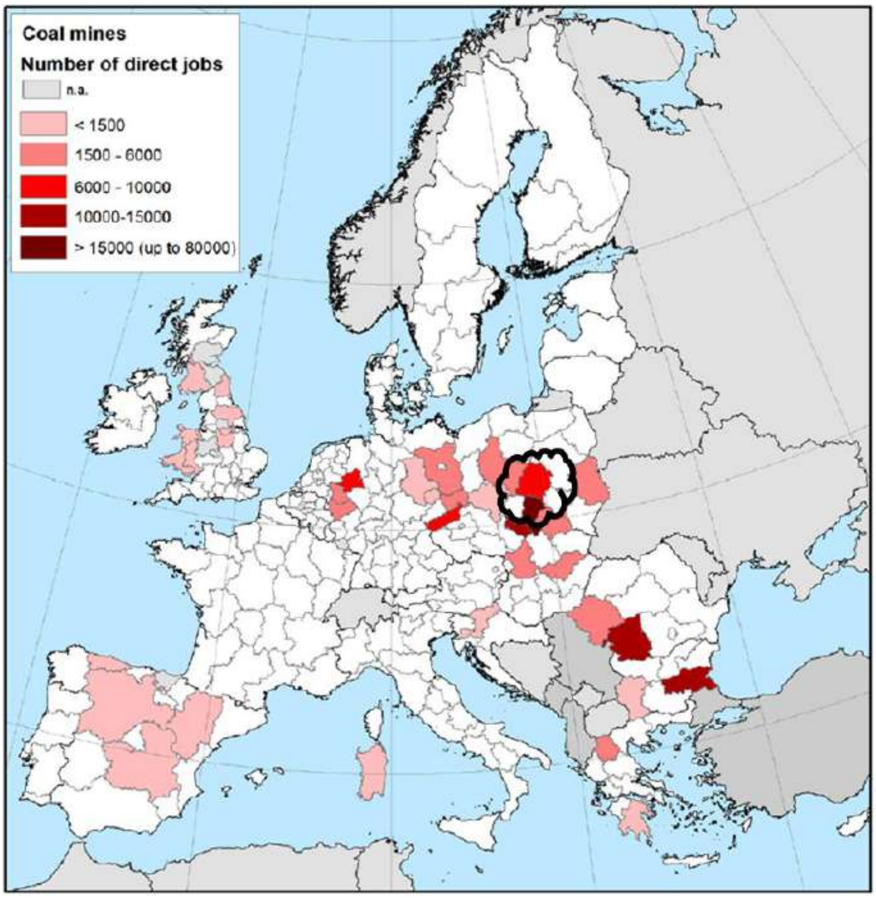


Figure 118 Overview of number of workplaces related to the coal mining by country (Lodzkie region is highlighted in circle) [8.].

- Coal power plants

Coal fire plant have an average age of 23, capacity of 4 960 MW with an efficiency of 36%.

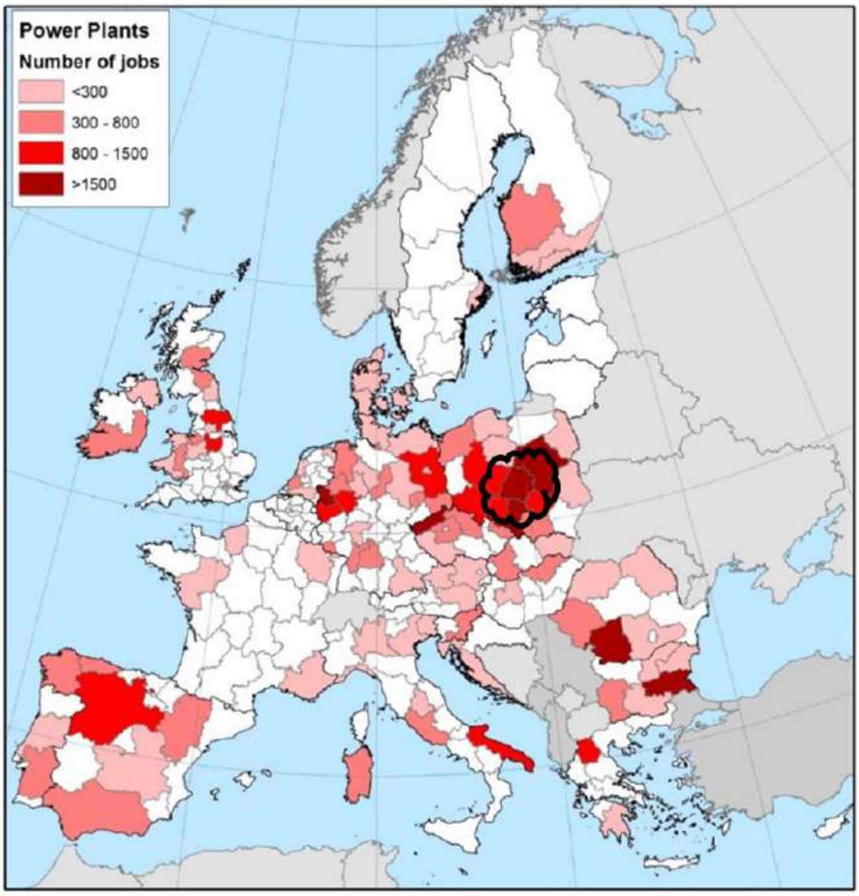


Figure 119 Overview of number of workplaces related to the coal-fired power plants by country (Lodzkie egion is highlighted in circle) [8.].

Direct workplaces related to coal activities - Lodzkie

		No of employees	No of employees per 1000 of population
	Plant O&M jobs	2,538	1.03
	Mining jobs	6,388	2.58
	Total	8,926	3.61

Table 71. Number of direct work positions related to coal industry and its share per 1000 of population in Poland, [8.].

Indirect workplaces related to coal activities - Lodzkie

		No of employees	No of employees per 1000 of population
	Intra-regional jobs (within the region only)	10,846	4.39
	Inter-regional jobs (accounts for trade connections between regions)	19,459	7.87
	Total	30,305	12.26

Table 72. Indirect workplaces related to coal activities in Poland, [8.].

4.4.7 Romania – South-West Oltenia region

- Coal mining

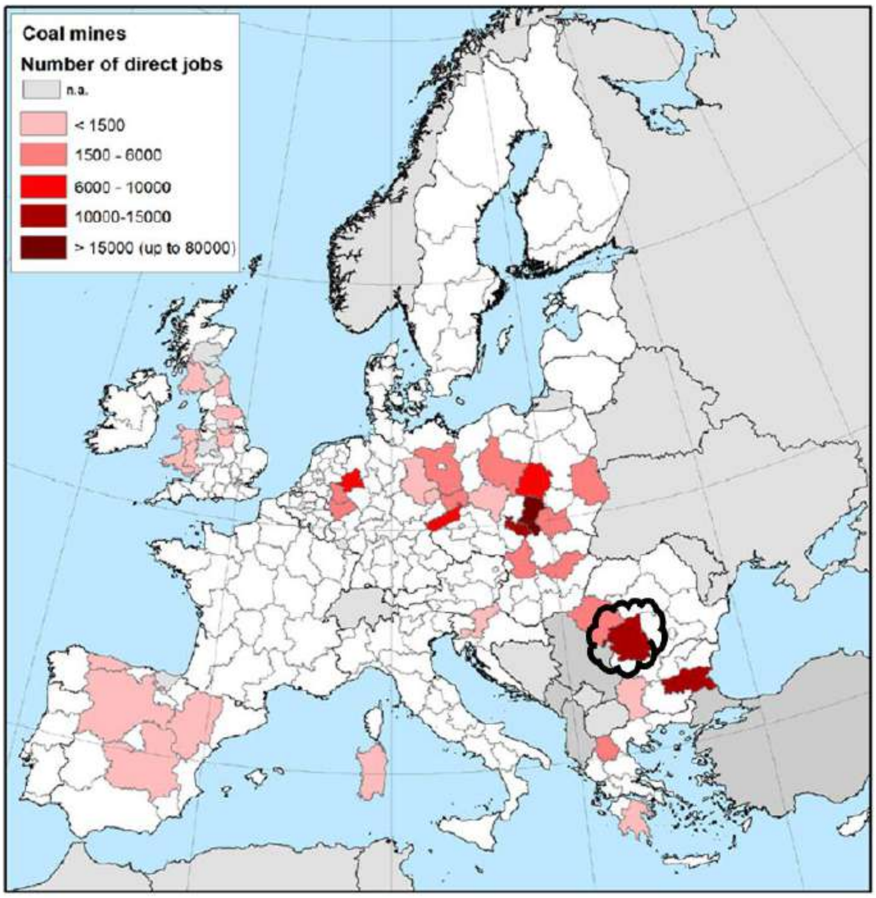


Figure 120 Overview of number of workplaces related to the coal mining by country in South-West Oltenia region is highlighted in circle) [8.].

The coal mining and coal-mining industry occupies the largest part of the population occupied in industry and mostly contributes to the county's GDP.

- Coal power plants

Number of jobs in coal power plants and coal mines:

Direct workplaces related to coal activities – South-West Oltenia -	**No of employees**	**No of employees per 1000 of population**
Jobs in coal power plants	3,600	1.9
Mining jobs	15,000	7.9
Total	18,600	9.8

Table 73 Number of direct work positions related to coal industry and its share per 1000 of population in South-West Oltenia region [8.].

Romania has regions with the highest overall employment in mining field. The distribution follows roughly the distribution of mining jobs, which accounts for the highest number of employees in the same regions.

In the top 20 regions ranked according to the number of coal-related direct jobs (both power generation and mining), South-West Oltenia region ranks the second place with a total number of 13,100 jobs.

Indirect workplaces related to coal activities - South-West Oltenia	**No of employees**	**No of employees per 1000 of population**
Intra-regional jobs (within the region only)	6,194	3.2
Inter-regional jobs (accounts for trade connections between regions)	10,101	5.3
Total	16,295	8.5

Table 74 Number of indirect work positions related to coal industry and its share per 1000 of population in South-West Oltenia region [8.].

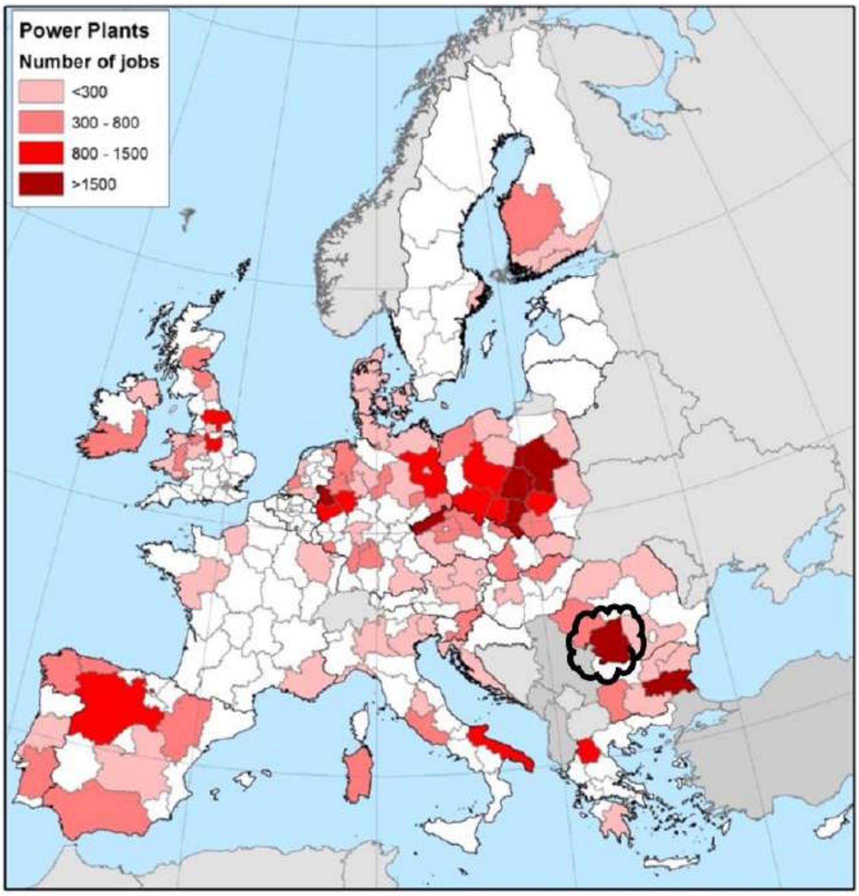


Figure 121 Overview of number of workplaces related to the coal-fired power plants by country (South-West Oltenia region is highlighted in circle) [8.].

The mining industry requires skilled workforce, trained in modern mining techniques and emerging high-tech fields, which requires appropriate programs in applied science universities, technical colleges and vocational schools. The mining industry requires skilled workforce, trained in modern mining techniques and emerging high-tech fields, which requires appropriate programs in applied science universities, technical colleges and vocational schools.

Structure of population occupied by sectors of activity 2011 is demonstrated in the following tables.

Indicator / year - total (thousands of people)	**South-West Region**
Production and supply of electric and thermal energy, gas, hot water	3%
Extractive industry	48%

Table 75 Structure of population occupied by sectors of activity in South-West Oltenia region.

Average number of employees	**South-West Region**
Production and supply of electric and thermal energy, gas, hot water	13.000
Extractive industry	19.000

Table 76 Average number of employees by sectors of activity in South-West Oltenia region [8.].

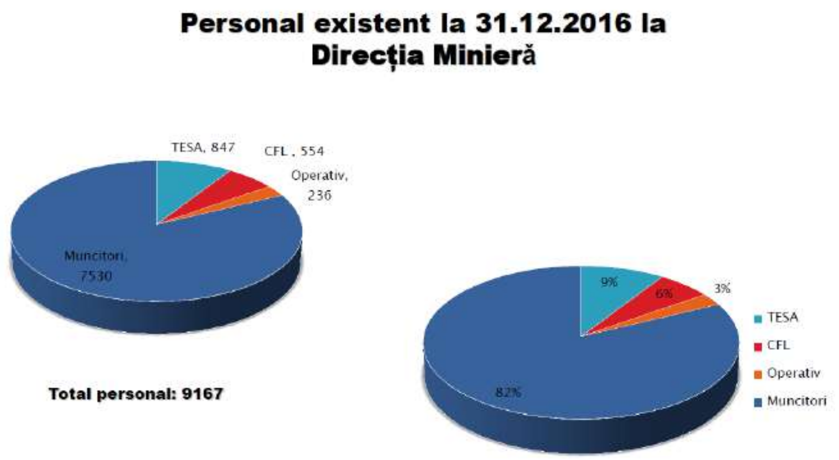


Figure 122 Overview of employment within coal-fired power plants in the South-West Oltenia region, [8.].

4.4.8 Slovenia – Savinjska region

- Coal mining

Velenje lignite mine Premogovnik Velenje, located in the Municipality of Velenje in Savinjska region, is the only operating coal mine in Slovenia. The Velenje Coal Mine belongs to the state-owned HSE Group (Holding Slovenske elektrarne) who also owns the nearby thermal power plant Termoelektrarna Šoštanj (TEŠ) and is the largest producer and seller of electricity from domestic sources on the wholesale market in Slovenia as well as the largest Slovenian producer of electricity from renewable sources. Velenje coal mine is with an over 140-year tradition in lignite mining firmly rooted in the Slovenian energy economics.

At today's mining output, there are enough deposits of the Velenje lignite for another four decades of the coal mine operation, however, mining sites will close before lignite reserves are exhausted due to changes in the energy industry and the envisaged changes in the operation of the thermal power plant.

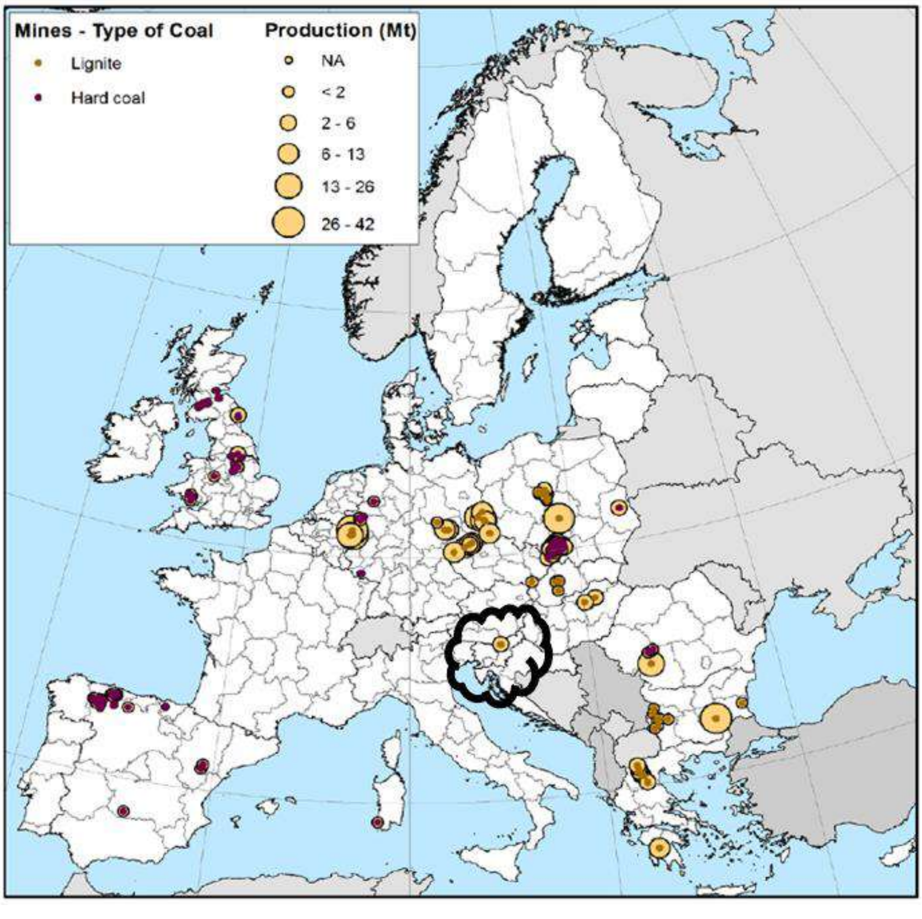


Figure 123 Location of operation coal mines in EU (Slovenia is highlighted in red circle), [8.].

In 2017, Velenje lignite mine produced 3.35 million tonnes of lignite and had 1.255 employees, which is the total number of workplaces related to the lignite and hard coal mining sector in Savinjska region as well as in the country. Most of the coal mine employees comes from nearby municipalities in Savinjska and Koroška region. All of Velenje mine lignite output is used at the Šoštanj thermal power plant (93.3% of lignite is sold for electricity generation and 2.5%

for heating generation). The image below shows the location of only operating coal mine in Slovenia.

- Coal power plants

There are two coal-fired power plants in Slovenia, Termoelektrarna Šoštanj (TEŠ) and Termoelektrarna Toplarna Ljubljana (TE-TOL). In 2017, they accounted for ca. 30% share of electricity generation in the country, with majority of electricity generated at TEŠ.

Thermal power plant Šoštanj, located in the Municipality of Šoštanj in the Savinjska region is the biggest thermal power plant in Slovenia with the installed power of 1029 MW:

- Unit 5, installed power: 345 MW, start year of operation: 1978 (shut down in 2015, revitalized in 2018).
- Unit 6, installed power: 600 MW, start year of operation: 2015.
- Gas unit 1, installed power: 42 MW, start year of operation: 2008.
- Gas unit 2, installed power: 42 MW, start year of operation: 2008.

The average annual electricity production ranges from 3,500 and 3,800 GWh and the average annual production of thermal energy used for district heating in the Šaleška dolina valley amounts to 300-350 GWh. The newest addition to the power plant was the construction of a modern, highly efficient (43%) BAT 600 MW unit with the intent to replace existing old, outdated and inefficient units and deliver CO2 emission reductions of 35%. Unit 6 which started operating in the spring 2015 was designed to be operational until 2054.

The second operating coal-fired power plant in Slovenia is TE-TOL, which is located in Osrednjeslovenska region and it’s the is the largest highly efficient cogeneration unit in Slovenia. TE-TOL is mostly important from the aspect of covering over 90% of the capital’s heat demand, while it accounts for 3% of country’s electricity power demand. TE-TOL power plant uses imported brown coal with very low sulfur and ash content, and since 2008 also wood biomass that replaced around 15% of coal. The entire coal consumption of TE-TOL is sourced from import from Indonesia. Highly efficient cogeneration at TE-TOL will be upgraded in in the future by a combined cycle gas turbine CHP unit, that will replace a part of coal technology and further improve air quality.

There is no more coal power plant under construction or planned for future development in Slovenia.

The image below shows the companies within the company Holding Slovenske elektrarne (the HSE), which represents the first energy pillar in the Slovenian wholesale market. Location of Velenje lignite mine and coal-fired thermal power plant Termoelektarna Šoštanj is highlighted in red.

Figure 124 Overview of companies within the company Holding Slovenske elektrarne (Savinjska regija is highlighted in circle), [51.].[8.]

The overview of the work places directly corelated with the coal industry Savinjska region shows that in 2017 there was 1,566 jobs directly related to coal activities. The number of employees at the end of 2017 in Velenje coal mine amounted to 1,255, while 311 people worked in Termoelektrarna Šoštanj.

The work positions in the coal-oriented sector can be split into direct jobs – closely related to the coal production and power plants, and indirect jobs – which aggregate people working in the other industries, however, interfering with the coal sector (IT, administration, power trade, regulatory). Direct workplaces related to coal activities for the Savinjska region are summarized in the next table.

Direct workplaces related to coal activities - Savinjska	**No of employees**	**No of employees per 1000 of population**
Plant O&M jobs	311	1.22
Mining jobs	1,255	4.93
Total	1,566	6.15

Table 77 Number of direct work positions related to coal industry and its share per 1000 of population in Savinjska region, [52.], [53.].

The figures for indirect coal-related work places have been converted to the key performance indicators (KPIs) which indicate the number of employees per one thousand of the population in Vzhodna Slovenija. These are presented along with total number of jobs in the table below.

Indirect workplaces related to coal activities – Vzhodna Slovenija	**No of employees**	**No of employees per 1000 of population**
Intra-regional jobs (within the region only)	1,270	1.16
Inter-regional jobs (accounts for trade connections between regions)	1,833	1.68
Total	3,103	2.84

Table 78 Number of indirect work positions related to coal industry and its share per 1000 of population in Vzhodna Slovenija region, [8.].

The data linked to the indirect workplaces related to coal activities were available only for the Vzhodna Slovenija region, one of two NUTS2 regions in Slovenija that is divided to 8 regions on NUTS3 level (part of the Vzhodna Slovenija is also Savinjska region). The total workforce indirectly related to the lignite activities in Vzhodna region amounts to 3,103 workplaces.

4.4.9 Spain – Extremadura region

This section does not apply to the Extremadura case as there is no coal-based energy production nor mining. This is demonstrated on the flowing maps.

- Coal mining

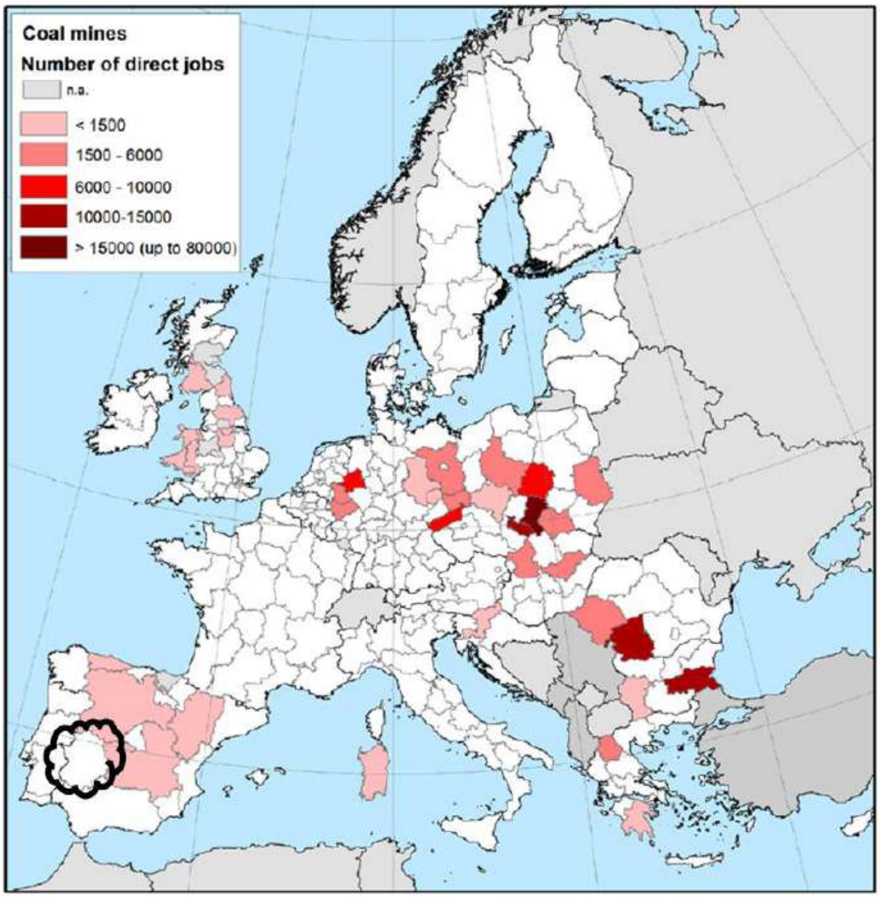


Figure 125 Overview of number of workplaces related to the coal mining by country (Extremadura region is highlighted in circle) [8.].

- Coal power plants

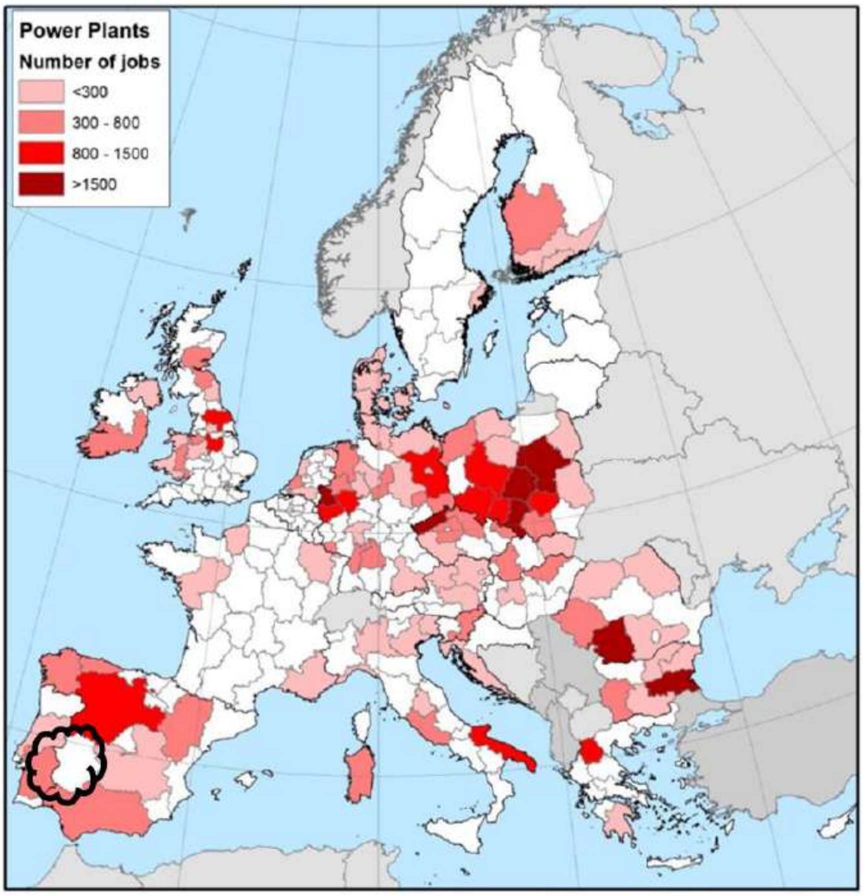


Figure 126 Overview of number of workplaces related to the coal-fired power plants by country (Extremadura region is highlighted in circle) [8.].

4.5 General employment pattern

4.5.1 Bulgaria – Yugoiztochen region

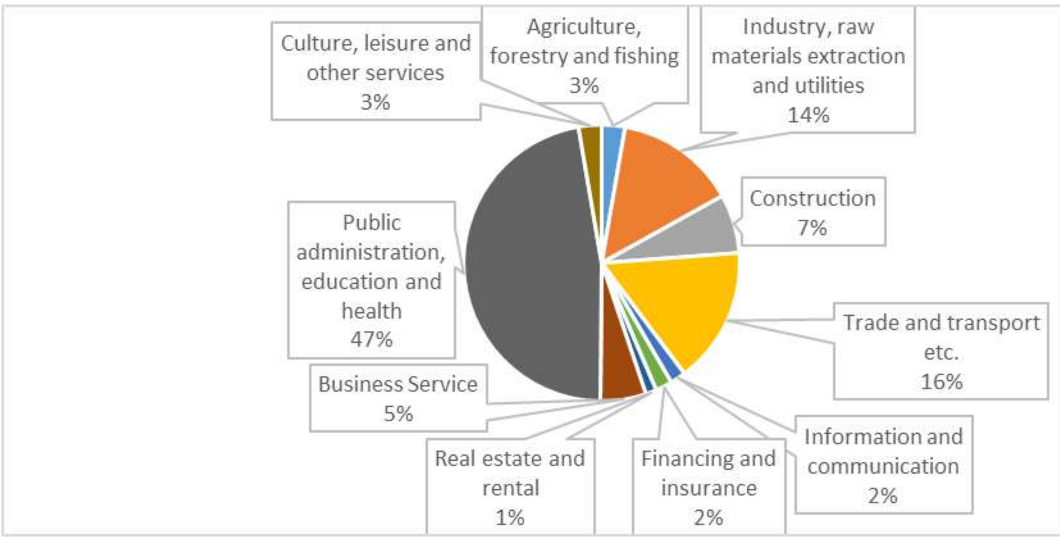


Figure 127 General employment pattern in Yugoiztochen region based on the general data, [1.], 2017.

Quantitative overview of the employment by sector and KPIs is presented in the table below.

Employment by activity (Yugoiztochen)	**General data**		**Specific data**	
	No of employees	No of employees per 1000 of population	No of employees	No of employees per 1000 of population
Agriculture, forestry and fishing	33,200	31.70	5,600	5
Industry, raw materials extraction and utilities	114,900	110	29,000	28
Construction	32,800	31	14,100	13
Trade and transport etc.	124,300	119	32,600	31
Information and communication	4,200	4	3,700	4
Financing and insurance	5,100	5	4,000	4
Real estate and rental	N/A	N/A	2,600	2
Business Service	26,500	25	10,900	10
Public administration, education and health	80,200	77	96,400	92
Culture, leisure and other services	14,100	13	5,500	5
Total employment	437,600	418	204,400	195

Table 79 Employment overview by sector compared with the total number of employees in v region based on the general data, [1.], and the local information, 2017.

4.5.2 Denmark – Nordjylland region

The engineering and industry related professions in Nordjylland constitute around 25% of total workforce. Nearly 50% (35% based on general source) of all employees in the region work in the public administration, education and health. The proportion of the employees in the different sectors is illustrated on the following graph. The figures extracted from the general source and the local statistics are compared.

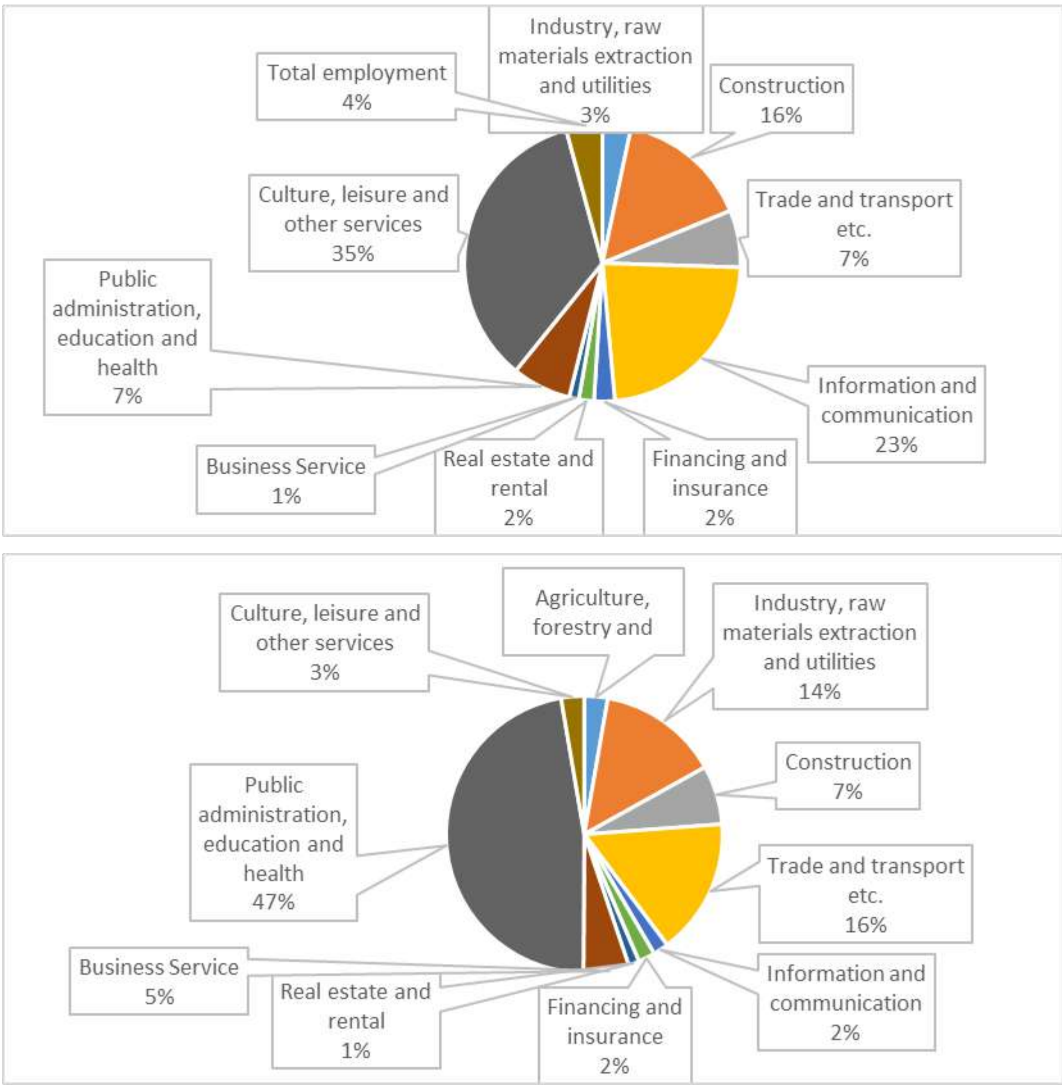


Figure 128 General employment pattern in Nordjylland region based on the general data (top graph), 2017 [1.] and the local information (bottom graph), 2016. [9.]

The work place figures have been converted to the key performance indicators (KPIs) which indicate the number of employees per one thousand of the population in Nordjylland. These are presented along with total number of jobs in the table below.

Employment by activity (Nordjylland)	**General data**		**Specific data**	
	No of employees	No of employees per 1000 of population	No of employees	No of employees per 1000 of population
Agriculture, forestry and fishing	8,800	15	5,600	10
Industry, raw materials extraction and utilities	41,000	70	29,000	49
Construction	17,700	30	14,100	24
Trade and transport etc.	61,100	104	32,600	56
Information and communication	6,400	11	3,700	6
Financing and insurance	4,700	8	4,000	7
Real estate and rental	3,000	5	2,600	4
Business Service	18,300	31	10,900	19
Public administration, education and health	92,600	158	96,400	164
Culture, leisure and other services	11,200	19	5,500	9
Total employment	264,800	451	204,300	348

Table 80 Employment overview by sector compared with the total number of employees in Nordjylland region based on the general data, [1.], 2017 and the local information, [9.], 2016.

It is estimated that 15.000 people in Nordjylland are employed within the broader field of energy. Divided into sectors the numbers are as follows:

- Wind sector: 5000.
- Solar sector: 2000.
- Energy conservation in buildings: 2000.
- Energy production, storage and distribution: 3000.
- Energy sustainable technology: 2000.
- Indirect job: 1000.

4.5.3 Germany – Lausitz-Spreewald region

The engineering and industry related professions in Lausitz-Spreewald constitute around 15% of total workforce. Nearly 1/3 (31% based on general source) of all employees in the region work in the public administration, education and health. The proportion of the employees in the different sectors is illustrated on the following graph. The figures extracted from the general source for the region Brandenburg has been scaled down using electricity generation factor.

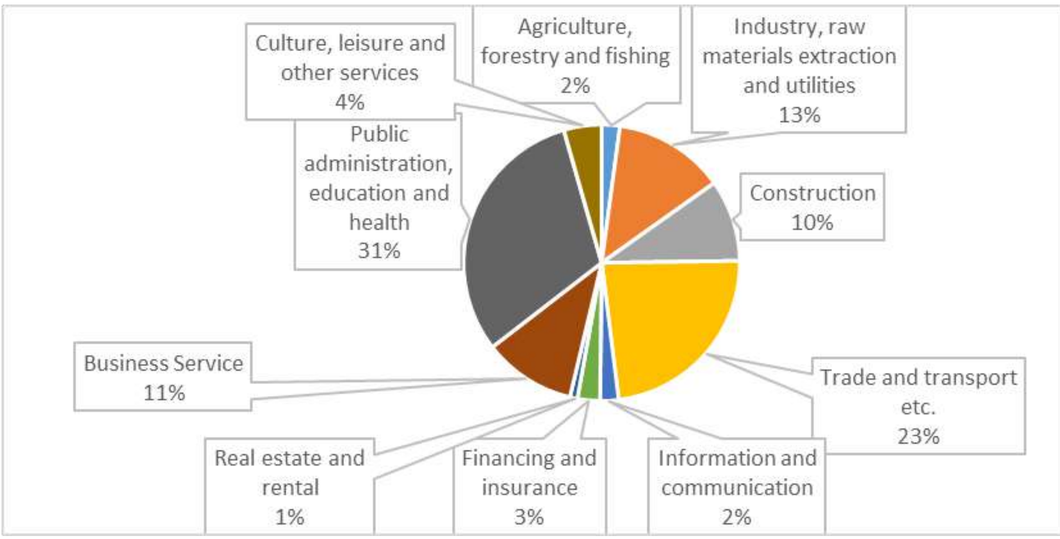


Figure 129 General employment pattern in Lausitz-Spreewald region based on the general data, [1.], 2017.

The work place figures have been converted to the key performance indicators (KPIs) which indicate the number of employees per one thousand of the population in Lausitz-Spreewald. These are presented along with total number of jobs in the table below.

Employment by activity (Lausitz-Spreewald)	**General data**	
	No of employees	No of employees per 1000 of population
Agriculture, forestry and fishing	2,000	3
Industry, raw materials extraction and utilities	12,200	21
Construction	8,900	15
Trade and transport etc.	21,700	37
Information and communication	2,000	3
Financing and insurance	2,500	4
Real estate and rental	800	1
Business Service	10,100	17
Public administration, education and health	28,900	49
Culture, leisure and other services	4,100	7
Total employment	93,200	159

Table 81 Employment overview by sector compared with the total number of employees in Lausitz-Spreewald region based on the general data, [1.], 2017.

It is estimated that 15.000 people in Lausitz-Spreewald are employed within the broader field of energy. Divided into sectors the numbers are as follows ([18.], 2015):

- Wind sector: 610
- Solar sector: 190
- Bioenergy, biofuels: 590
- Hydro power: 5
- Geothermal energy: 40

4.5.4 Greece – Western Macedonia region

Due to lack of data on information/communication and real estate sectors, the full representation of the current employment status in the region of Western Macedonia is not possible. Despite of this fact, trade & transport, public administration, education and health as well as agriculture and industry shares the most significant position in the region, illustrated on the following graph.

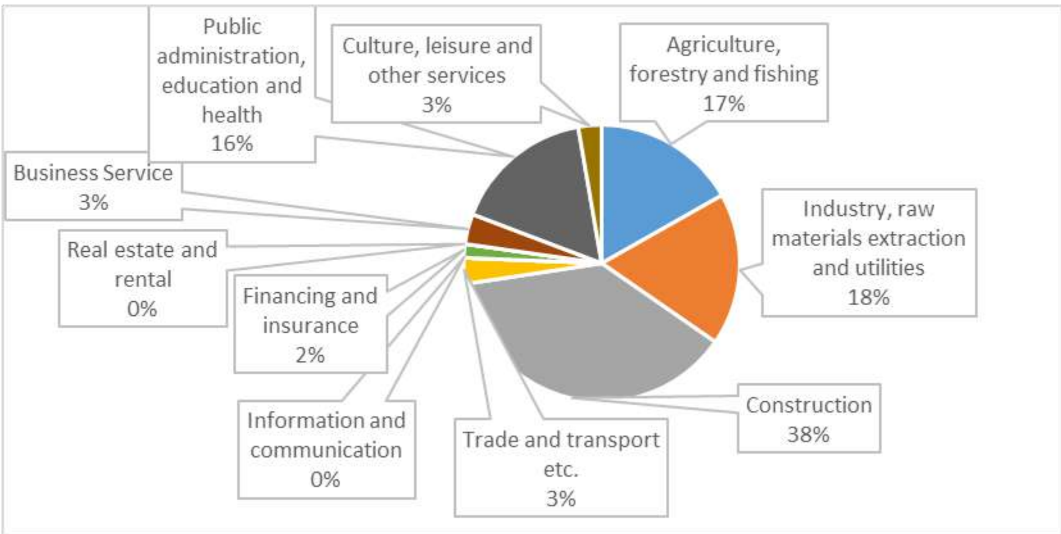


Figure 130 General employment pattern in Western Macedonia region based on the general data, [1.], (%), 2017.

The work place figures have been converted to the key performance indicators (KPIs) which indicate the number of employees per one thousand of the region population as presented in the table below.

Employment by activity	**General data**	
	No of employees	No of employees per 1000 of population
Agriculture, forestry and fishing	16,700	61
Industry, raw materials extraction and utilities	17,700	65
Construction	37,700	11
Trade and transport etc.	3,000	75
Information and communication	N/A	
Financing and insurance	1,600	6
Real estate and rental	N/A	
Business Service	3,500	13
Public administration, education and health	16,400	60
Culture, leisure and other services	2,700	10
Total employment	99,300	366

Table 82 Employment overview by sector compared with the total number of employees in Western Macedonia region based on the general data, [1.], 2017 .

4.5.5 Hungary – Észak-Alföld region

There was no data provided.

4.5.6 Poland – Lodzkie region

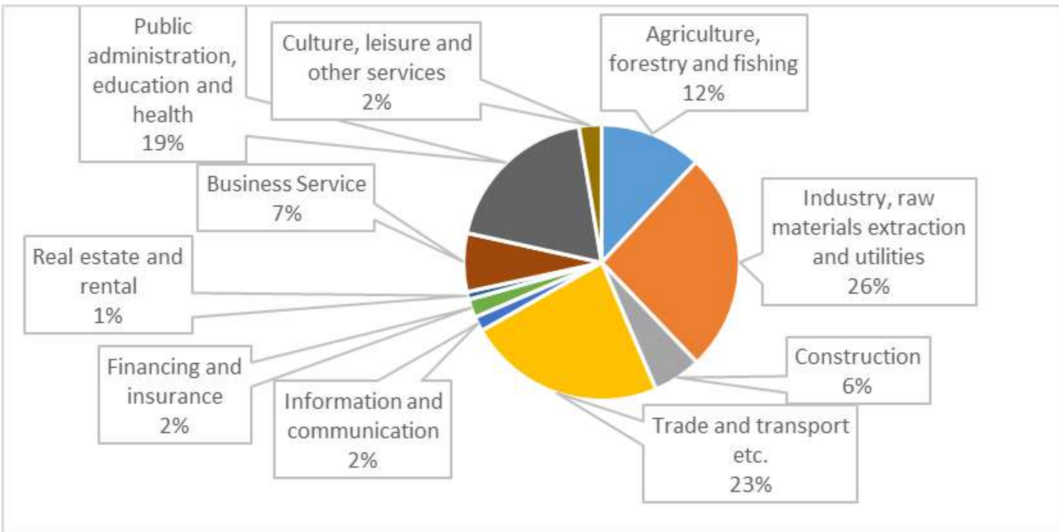


Figure 131 General employment pattern in Lodzkie region based on the general data, [1.], 2017.

Employment by activity (Lodzkie)	**General data**	
	No of employees	No of employees per 1000 of population
Agriculture, forestry and fishing	131,300	53.1
Industry, raw materials extraction and utilities	283,300	114.6
Construction	62,300	25.2
Trade and transport etc.	254,000	102.3
Information and communication	18,900	7.6
Financing and insurance	23,700	9.6
Real estate and rental	9,900	4.0
Business Service	75,300	30.5
Public administration, education and health	206,800	83.7
Culture, leisure and other services	29,000	11.8
Total employment	1,094,500	442.8

Table 83 Employment overview by sector compared with the total number of employees in Lodzkie region based on the general data, [1.], 2017.

4.5.7 Romania – South-West Oltenia region

A developed economy implies a predominance of the employed population in services, a lower proportion of the employed population in the secondary sector (industry and construction) and a very small proportion of the employed population in agriculture, in the South-West Oltenia region being recorded a reversal of percent, most of whom are still busy in subsistence agriculture.

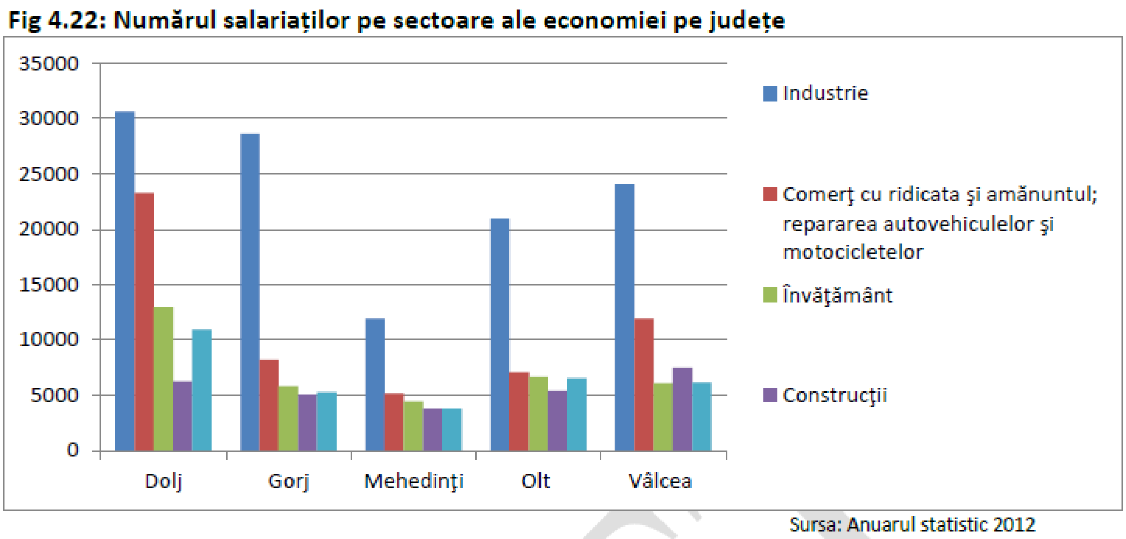


Figure 132 General employment pattern in South-West Oltenia region based on the local data, [56.][1.], 2012.

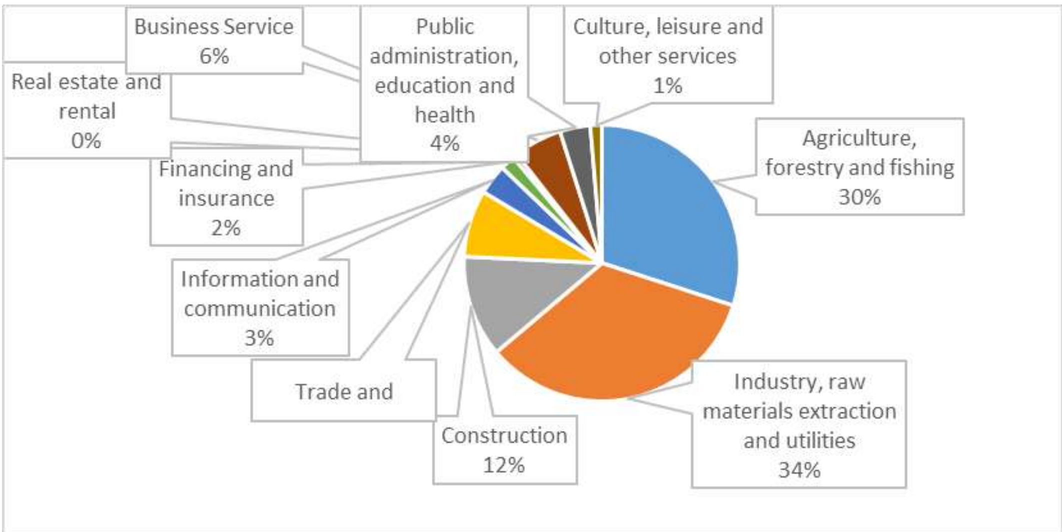


Figure 133 General employment pattern in South-West Oltenia region based on the general data, [1.], 2017.

Employment by activity (South-West Oltenia) **General data**

	No of employees	No of employees per 1000 of population
Agriculture, forestry and fishing	1,742	0.9
Industry, raw materials extraction and utilities	1,967	1
Construction	691	0.3
Trade and transport etc.	456	0.2
Information and communication	206	0.1
Financing and insurance	101	0.05
Real estate and rental	32	0.01
Business Service	329	0.2
Public administration, education and health	207	0.1
Culture, leisure and other services	78	0.04
Total employment	5,809	3.1

Table 84 Employment overview by sector compared with the total number of employees in South-West Oltenia region based on the general data, [1.], 2017.

4.5.8 Slovenia – Savinjska region

Employment pattern in Savinjska region shows that the highest share of a workforce, nearly one third of employees in Savinjska region (31 %), works in the industry, raw materials extraction and utilities sector. This share is followed by 22 % of total workforce employed in trade and transport and 15 % in public administration. Sectors with the smallest share of employees are financing and insurance (1 %), information and communication (1 %) and real estate (0,4 %).

Compared to the national employment pattern, the proportion of employees in different sectors is very similar. Sectors with the highest share of employees are industry (23 %), trade and transport (21 %), public administration (19 %) and the sectors that employed smallest share of workforce same as in Savinjska region employment pattern.

The highest difference in share of employees is in the leading sector; Savinjska region with the 31 % of the professions related to industry is above national average. The proportion of the employees in the different sectors is illustrated on the following graph.

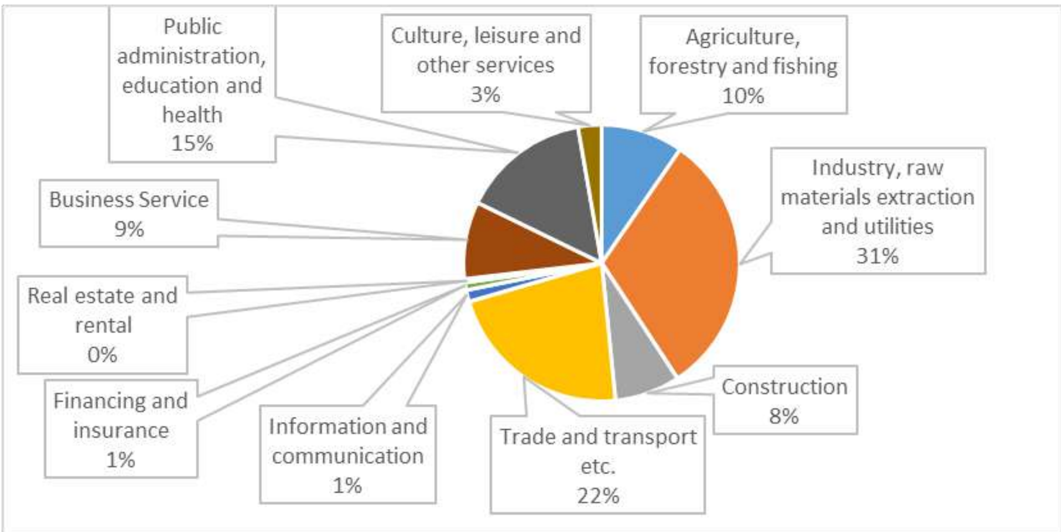


Figure 134 General employment pattern in Savinjska region based on the specific data, [42.], 2017.

The work place figures have been converted to the key performance indicators (KPIs) which indicate the number of employees per one thousand of the population in Slovenia and Savinjska region. These are presented along with total number of jobs in the table below.

Employment by activity	**Specific data (Slovenia)**		**Specific data (Savinjska)**	
	No of employees	No of employees per 1000 of population	No of employees	No of employees per 1000 of population
Agriculture, forestry and fishing	73,513	36	11,536	45
Industry, raw materials extraction and utilities	224,548	109	37,293	146
Construction	63,547	31	9,166	36

Trade and transport etc.	211,927	103	26,480	104
Information and communication	29,816	14	1,635	6
Financing and insurance	21,967	11	1,040	4
Real estate and rental	6,137	3	523	2
Business Service	131,159	63	10,833	43
Public administration, education and health	186,370	90	18,026	71
Culture, leisure and other services	38,806	19	3,298	13
Total employment	987,790	478	119,830	470

Table 85 Employment overview by sector compared with the total number of employees in Slovenia and Savinjska region based on the local information, [42.], 2016. [42.]

4.5.9 Spain – Extremadura region

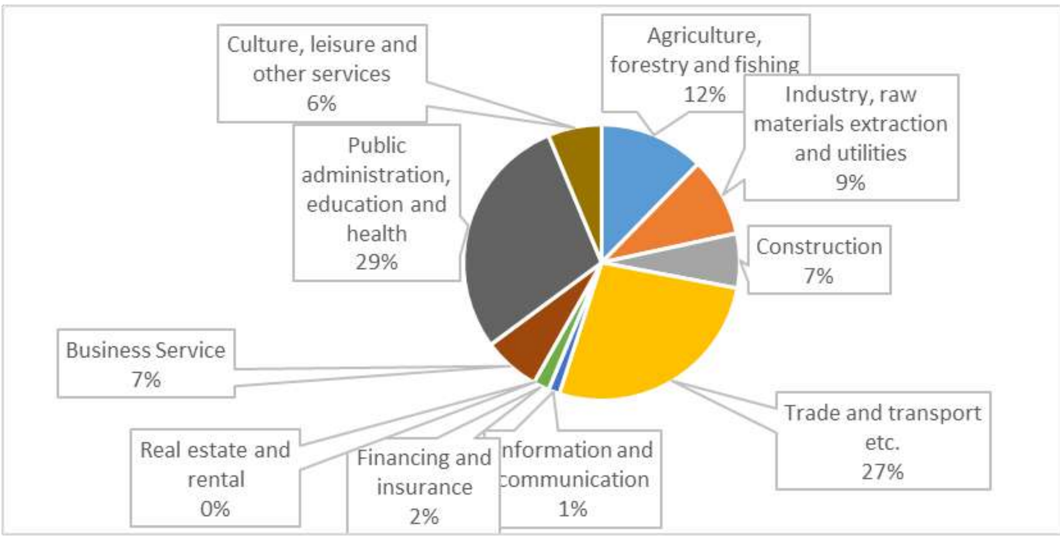


Figure 135 General employment pattern in Extremadura region based on the general data, [1.], 2017.

Employment by activity (Extremadura)	**General data**	
	No of employees	No of employees per 1000 of population
Agriculture, forestry and fishing	44,500	18
Industry, raw materials extraction and utilities	33,600	14
Construction	23,100	9
Trade and transport etc.	97,600	39
Information and communication	4,800	2
Financing and insurance	6,800	3
Real estate and rental	N/A	N/A
Business Service	24,100	10
Public administration, education and health	104,300	42
Culture, leisure and other services	22,800	9
Total employment	151,200	140

Table 86 Employment overview by sector compared with the total number of employees in Extremadura region based on the general data, [1.], 2017.

4.6 Educational and research capacities

4.6.1 Bulgaria – Yugoiztochen region

The cumulative figures have been converted to the key performance indicators (KPIs) which indicate the number of students per one thousand of the population in Yugoiztochen. These are presented along with total number of students by education level in the table below. Please refer to 2 Glossary for education level definition.

Students enrolment in higher education

	No of students	No of students per 1000 of population
Short-cycle tertiary education	N/A	N/A
Bachelor's or equivalent level	10,021	9.6
Long-cycle (Master's or equivalent level)	3,997	3.8
Doctoral or equivalent level	187	0.2
Total enrollment of higher education students	14,205	13.6

Table 87 Number of students enrolled in tertiary education by level in Yugoiztochen based on the general data, [1.], 2017.

Currently, there is around 1540 of R&D staff in Yugoiztochen which represent 1.5 researcher per 1000 of inhabitants and just below 1% of the all employees in the region.

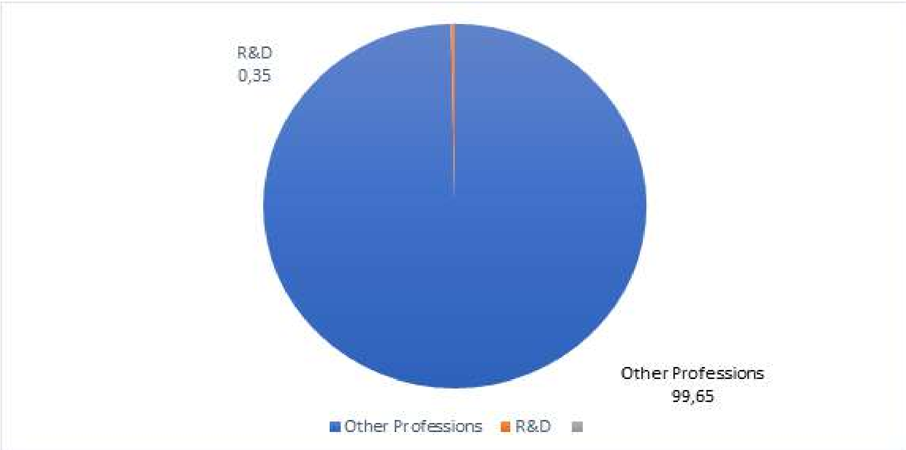


Figure 136 Proportion of employees working actively in the R&D activities among all the staff in Yugoiztochen, [1.], 2015.

The total figures along with the KPI factor for R&D personnel are collated in the following table.

Number of employees in the research and development activities

	R&D personnel	1,543
	Total employment	437,600
	Proportion of R&D personnel in total employment	0.35%
	No of R&D personnel per 1000 of population	1.5

Table 88 Number of employees working actively in the R&D activities among all the staff in Yugoiztochen.

4.6.2 Denmark – Nordjylland region

The overall figures for student currently involved in the higher education in the region show that around 85 people per 1000 is actively studying. Nearly half of them, undertook the long-cycle education (Master's degree). The numbers collected from the general source slightly stray from the local statistics as shown in the following table.

The cumulative figures have been converted to the key performance indicators (KPIs) which indicate the number of students per one thousand of the population in Nordjylland. These are presented along with total number of students by education level in the table below. Please refer to 2 Glossary for education level definition.

Students enrolment in higher education	**General data**		**Specific data**	
	No of students	No of students per 1000 of population	No of students	No of students per 1000 of population
Short-cycle tertiary education	3,800	6.5	17,900	30.5
Bachelor's or equivalent level	20,400	34.7	7,100	12.1
Long-cycle (Master's or equivalent level)	6,900	11.7	23,900	40.7
Doctoral or equivalent level	1,000	1.7	1,700	2.9
Total enrollment of higher education students	32,100	54.7	50,600	86.2

Table 89 Number of students enrolled in tertiary education by level in Nordjylland based on the general data, 2017 [1.] and the local information, [10.], 2017.

The technical and science related faculties have the highest popularity at the PhD programs and in the short-cycle tertiary education as between 30% and 40%. Only circa 15% of students enrolled in Bachelor and Master programs study engineering and science.

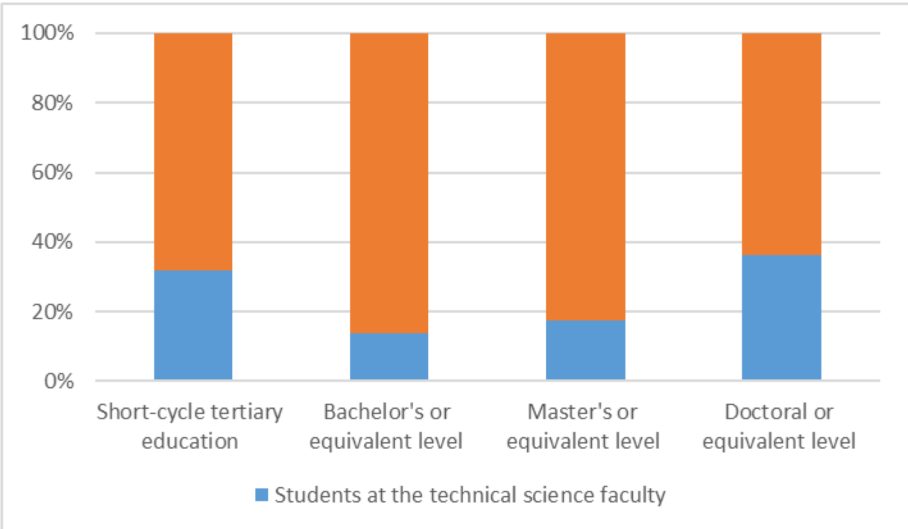


Figure 137 Proportion of students enrolled in technical science faculty in Nordjylland, [10.], 2017.

Majority of young population in Nordjylland chose the vocational schools which provide professional education for the skilled and blue-collar workers (as carpenters, nurse, hairdresser, builders). Students participating at technical and engineering related faculties constitute over 1/3 of all pupils that are enrolled in the vocational course.

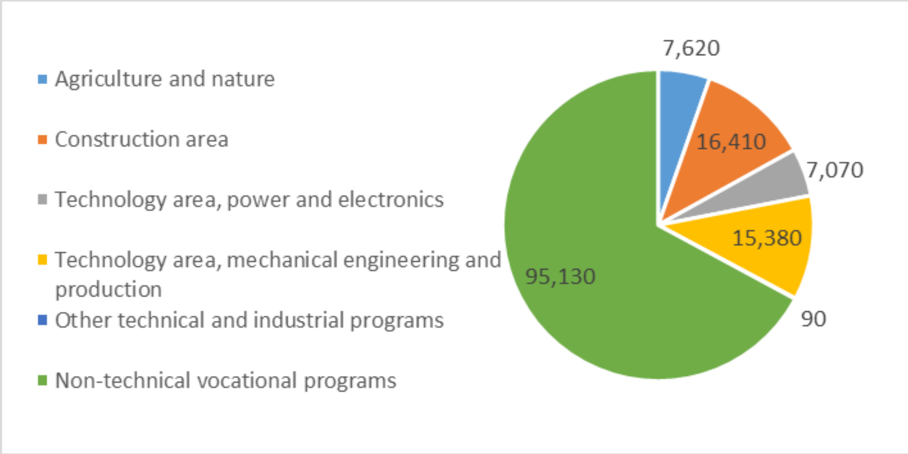


Figure 138 Proportion of people enrolled in technical programs at the vocational education in Nordjylland, [10.], 2017.

Currently, there is over 3,000 of R&D staff in Nordjylland which represent 5 researchers per 1000 of inhabitants and just above 1% of the all employees in the region.

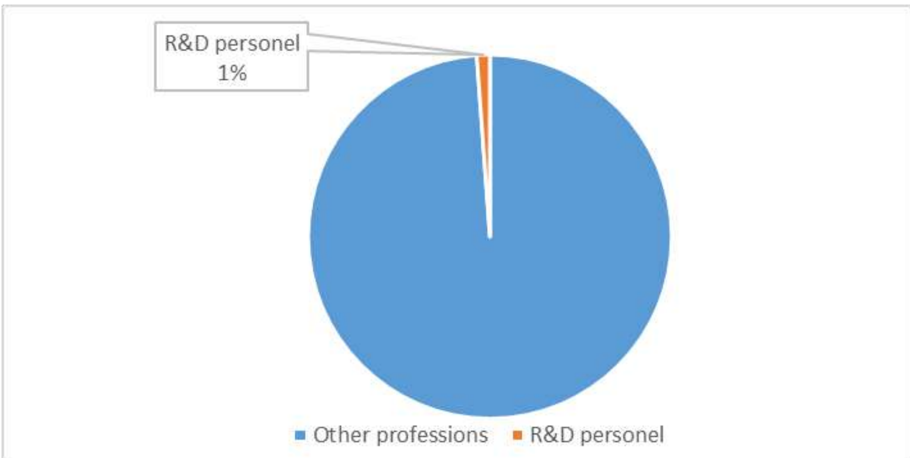


Figure 139 Proportion of employees working actively in the R&D activities among all the staff in Nordjylland, 2016.

The total figures along with the KPI factor for R&D personnel are collated in the following table.

Number of employees in the research and development activities

	R&D personnel	3,125
	Total employment	267,500
	Proportion of R&D personnel in total employment	1.2%
	No of R&D personnel per 1000 of population	5.3

Table 90 Number of employees working actively in the R&D activities among all the staff in Nordjylland.

Nordjylland has four educational institutions with programs related to the field of energy. All four institutions provide additional training for people already having an education in order for them to reskill themselves or better themselves in a familiar or new work area.

- Aalborg University (ISCED level 6-8) which in 2017 had 2.560 students, 400 phd researchers and 1570 employees on the following programs on the Faculty of Engineering:

Urban, Energy and Environmental Planning Energy Engineering Techno-Anthropology Building Energy Design Electro-Mechanical System Design Electrical Power Systems and High Voltage Engineering Fuel Cells and Hydrogen Technology Mechatronic Control Engineering	Power Electronics and Drives Thermal Energy and Process Engineering Wind Power Systems Entrepreneurial Engineering Indoor Environmental and Energy Engineering Cities and Sustainability Sustainable Energy Planning and Management

  According to US News World Ranking and the 2018 MIT Report , Aalborg University ranks as no. 4 in the world, and no. 1 in Europe, within the field of Engineering. According to Shanghai/ARWU World Rank, Aalborg University is no. 7 in the world within the field of Electronic and Electrical Engineering.

- University College Nordjylland (ISCED level 6) which in 2017 had 270 students and 23 employees on the following programs:
  - Energy management
  - Energy technology
- Martec (ISCED level 5- 6) which in 2017 had xx students and xx employees on the following program:
  - Technology management
- Techcollege (ISCED level 5) which in 2017 had xx students and xx employees on the following programs:
  - Heat and ventilation operator
  - Wind turbine operator

4.6.3 Germany – Lausitz-Spreewald region

The overall figures for student currently involved in the higher education in the region show that around 10 people out of 1000 is actively studying. Nearly half of them, undertook the long-cycle education (Master's degree).

The cumulative figures have been converted to the key performance indicators (KPIs) which indicate the number of students per one thousand of the population in Lausitz-Spreewald. These are presented along with total number of students by education level in the table below. Please refer to 2 Glossary for education level definition.

Students enrolment in higher education

	No of students	No of students per 1000 of population
Short-cycle tertiary education	0	0.0
Bachelor's or equivalent level	1,570	2.7
Long-cycle (Master's or equivalent level)	2,410	4.1
Doctoral or equivalent level	1,550	2.6
Total enrollment of higher education students	5,530	9.4

Table 91 Number of students enrolled in tertiary education by level in Lausitz-Spreewald based on the general data, [1.], 2017.

Currently, there is around 750 of R&D staff in Lausitz-Spreewald which represent 1.5 researcher per 1000 of inhabitants and just below 1% of the all employees in the region.

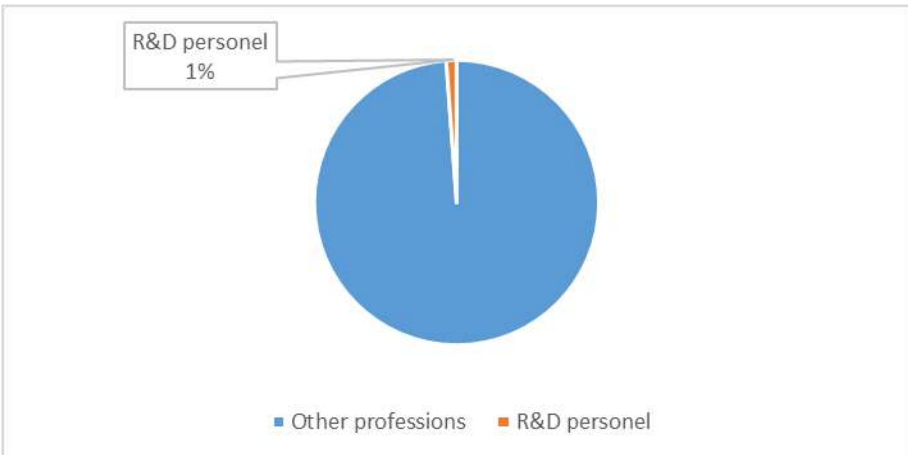


Figure 140 Proportion of employees working actively in the R&D activities among all the staff in Lausitz-Spreewald, [1.], 2015.

The total figures along with the KPI factor for R&D personnel are collated in the following table.

Number of employees in the research and development activities

	R&D personnel	750
	Total employment	93,200
	Proportion of R&D personnel in total employment	0.8%
	No of R&D personnel per 1000 of population	1.3

Table 92 Number of employees working actively in the R&D activities among all the staff in Lausitz-Spreewald.

Technical and science related universities and colleges:

- Brandenburgische Technische Universität Cottbus–Senftenberg (BTU): Approximately 7,280 students are enrolled at the BTU of which 2,190 come from abroad. China, India, Poland and Nigeria represent the biggest country groups of the more than 110 different nations. 183 professors (including guest, junior and deputy professors) • 652 academic employees of which 294 are financed by third party funds, Budget funds 2018 (basic allocation of state funds): approx. 89,5 million euros, Third party funding revenue 2018: approx. 32,2 million euros. The University has 4 faculties with technical and scientific backgrounds.
- TH Wildau: 3,646 students, 20% of which are international students, 2 faculties, over 100 professors, over 350 members of staff, Specialisms among other things: Engineering, Natural sciences, Information technology, one of the strongest research universities in Germany since 2001, third-party funding in 2017: 11 million euros.
- Upper school centre Lusatia has three departments, Department 1 in Schwarzheide: Chemical technician, process mechanic, dual apprenticeship, dual education,t echnical college for electrical and mechanical engineering , Vocational grammar school, focus on technology and economics, Department 2 in Sedlitz: occupational fields including economics and nutrition, Department 3 Lauchhammer: mining and metalworking professions
- "WEGE"(”WAYS”) - an initiative of the Economic Region of Lusatia (Wirtschaftsregion Lausitz, WRL) : Qualification in the context of technological innovations through structural change to secure skilled workers

4.6.4 Greece – Western Macedonia region

According to the Eurostat statistics, the majority of the students enrolled in the higher education in Western Macedonia, focused on Bachelor or equivalent degree with limited prospects for higher levels of education. These are presented along with total number of students by education level in the table below, where data of sort cycle education is not available.

Students enrolment in higher education	**General data**	
	No of students	No of students per 1000 of population
Short-cycle tertiary education		
Bachelor's or equivalent level	26,787	97.8
Long-cycle (Master's or equivalent level)	1,241	4.5
Doctoral or equivalent level	165	0.6
Total	28,193	103.0

Table 93 Number of students enrolled in tertiary education by level in Western Macedonia based on the general data, 2017 [1.]

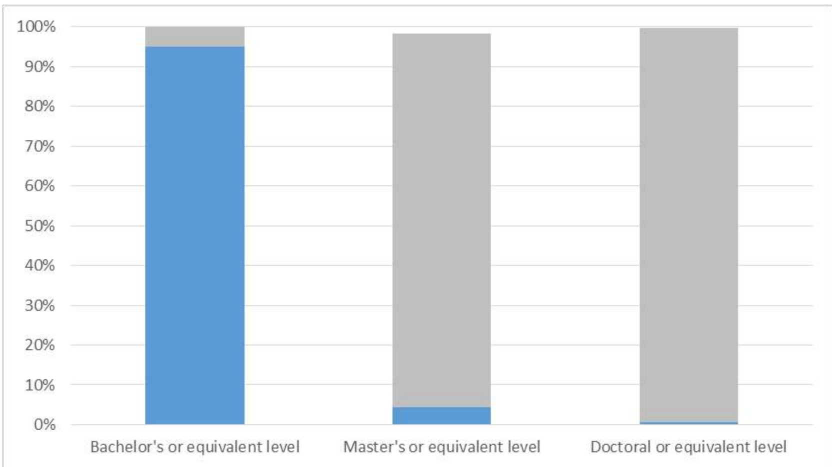


Figure 141 Proportion of students enrolled in technical science faculty in Western Macedonia, 2017. [10.]

In Western Macedonia two higher education and one research institute involving energy topics in their operation. University of Western Macedonia was founded providing under and post graduate studies. The University have the following faculties and departments:

- Faculty of Engineering.
- Department of Mechanical Engineering.
- Department of Informatics and Telecommunications Engineering.
- Department of Environmental Engineering.
- Faculty of Education.
- Department of Primary Education.
- Department of Early Childhood Education.

- Faculty of Fine Arts.
- Department of Applied and Visual Arts.

The Higher Technological Education Centre of Kozani was established in 1976 and nowadays provides under and post graduate studies according to the above structure:

SCHOOL OF ENGINEERING

- Department of Mechanical Engineering and Industrial Design.
- Division of Mechanical Engineering.
- Division of Industrial Design.
- Department of Electrical Engineering.
- Department of Environmental Engineering.
- Division of Environmental Geotechnology.
- Division of Pollution Control Technologies.
- Department of Informatics Engineering.
- Department of Digital Media and Communication.

SCHOOL OF BUSINESS AND FINANCE

- Department of Business Administration.
- Department of Accounting and Finance.
- Department of Business Administration.
- Division of Business Administration.
- Division of Tourist Management and Hospitality.
- Department of International Trade.

SCHOOL OF AGRICULTURE TECHNOLOGY, FOOD TECHNOLOGY AND NUTRITION

- Department of Agricultural Technology.

SCHOOL OF HEALTH AND WELFARE

- Department of Midwifery.

The Institute for Solid Fuels Technology and Applications (ISFTA) was established in 1987 and since 2002, it is one of the five institutes of the National Centre for Research and Technology Hellas (CERTH) focusing on basic and applied research, to develop novel technologies and products and to pursue scientific and technological excellence in selected advanced areas of Chemical Engineering, including Energy, Environment, Materials and Process Technologies.

It has also to be mentioned the operation of the Regional Development Agency ANKO, which is a part of the Enterprise Europe Network, and was created by the local authorities, the State, the agricultural cooperatives and Chambers of Commerce, in order to act as a ‘pioneering’ organisation for regional development. Moreover the Cluster of Bioenergy and Environment of Western Macedonia (CluBE) was established among local actors and stakeholders of the Region of Western Macedonia covering the entire triple helix of the regional bioenergy and environment sector.

4.6.5 Hungary – Észak-Alföld region

There was no data provided.

4.6.6 Poland – Lodzkie region

The cumulative figures have been converted to the key performance indicators (KPIs) which indicate the number of students per one thousand of the population in Lodzkie. These are presented along with total number of students by education level in the table below. Please refer to 2 Glossary for education level definition.

Students enrolment in higher education

	No of students	No of students per 1000 of population
Short-cycle tertiary education	N/A	N/A
Bachelor's or equivalent level	61,110	24.7
Long-cycle (Master's or equivalent level)	34,090	13.8
Doctoral or equivalent level	2,667	1.1
Total enrollment of higher education students	97,87	39.6

Table 94 Number of students enrolled in tertiary education by level in Lodzkie based on the general data, [1.], 2017.

Currently, there is around 6,050 of R&D staff in Lodzkie which represent 2.4 researcher per 1000 of inhabitants and just below 1% of the all employees in the region.

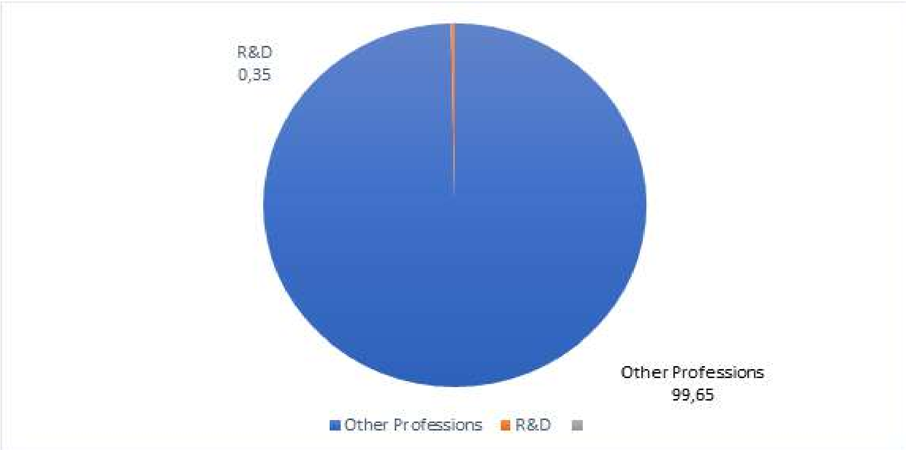


Figure 142 Proportion of employees working actively in the R&D activities among all the staff in Lodzkie, [1.], 2015.

The total figures along with the KPI factor for R&D personnel are collated in the following table.

Number of employees in the research and development activities

R&D personnel	6,053
Total employment	1,094,500
Proportion of R&D personnel in total employment	0.6%
No of R&D personnel per 1000 of population	2.4

Table 95 Number of employees working actively in the R&D activities among all the staff in Lodzkie.

In Lodzkie Region two higher education and one research institute involving energy topics in their operation.

Technical University Of Łódź

DEPARTMENT OF PROCESS ENGINEERING AND ENVIRONMENTAL PROTECTION

- Faculty of Chemical Engineering
- Faculty of Bioprocess Engineering
- Faculty of Process Thermodynamics
- Faculty of Occupational Safety Engineering
- Faculty of Environmental Engineering
- Faculty of Molecular Engineering

FACULTY OF CONSTRUCTION, ARCHITECTURE AND ENVIRONMENTAL ENGINEERING

- Institute of Architecture and Urban Planning
- Faculty of Material Mechanics
- Faculty of Building Physics and Building Materials
- Faculty of Structural Mechanics
- Faculty of Concrete Construction
- Department of Geotechnics and Engineering Structures
- Institute of Environmental Engineering and Building Systems

FACULTY OF ELECTRICAL ENGINEERING, ELECTRONICS, COMPUTER SCIENCE AND AUTOMATICS

- Institute of Power Engineering

University Of Lodz

DEPARTMENT OF BIOLOGY AND ENVIRONMENTAL PROTECTION

- Institute Of Experimental Biology
- Faculty Of Molecular Biotechnology And Genetics
- Faculty Of Plant Ecophysiology

4.6.7 Romania – South-West Oltenia region

The training of an energetic, regardless of his place of work or the type of graduate studies, is complex. Increasing the number of professionals in the field of energy implies increasing the quality and attractiveness of the specialized education.

Developing and cultivating the skills and abilities of the energy community means developing specific educational packages at all levels: high schools and public and dual-level vocational schools, in-service training, faculties, master programs and doctoral schools in the field. The energy sector faces an acute shortage of professionals. Qualified staff are aging and some of the actively qualified staff chose to leave Romania.

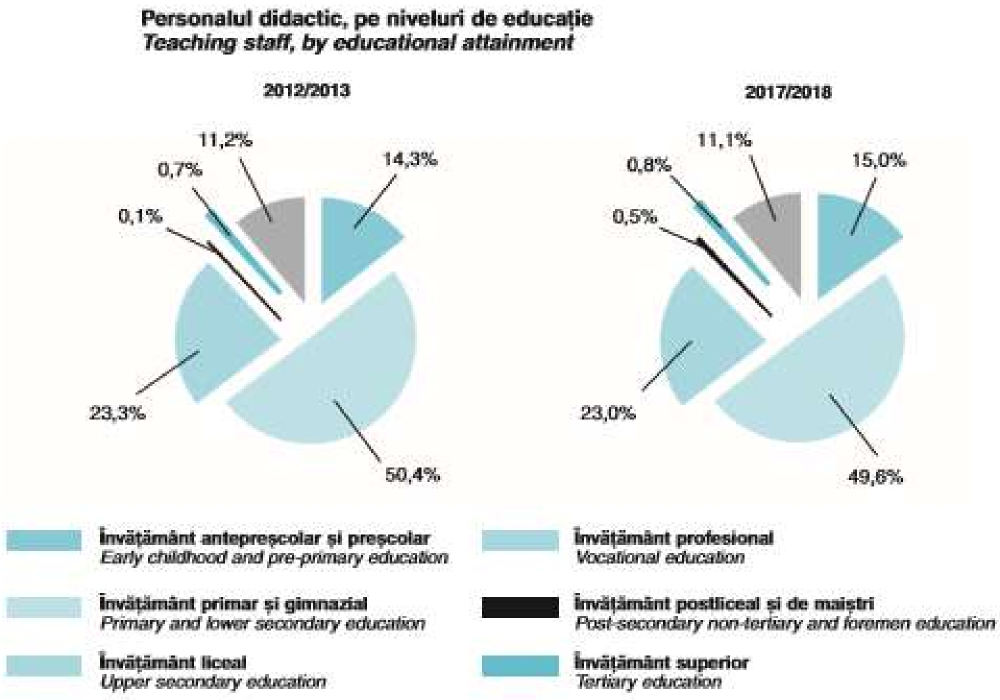


Figure 143 Teaching staff by type of educational institution in South-West Oltenia region based on the local data, 2012/2013 and 2017/2018.

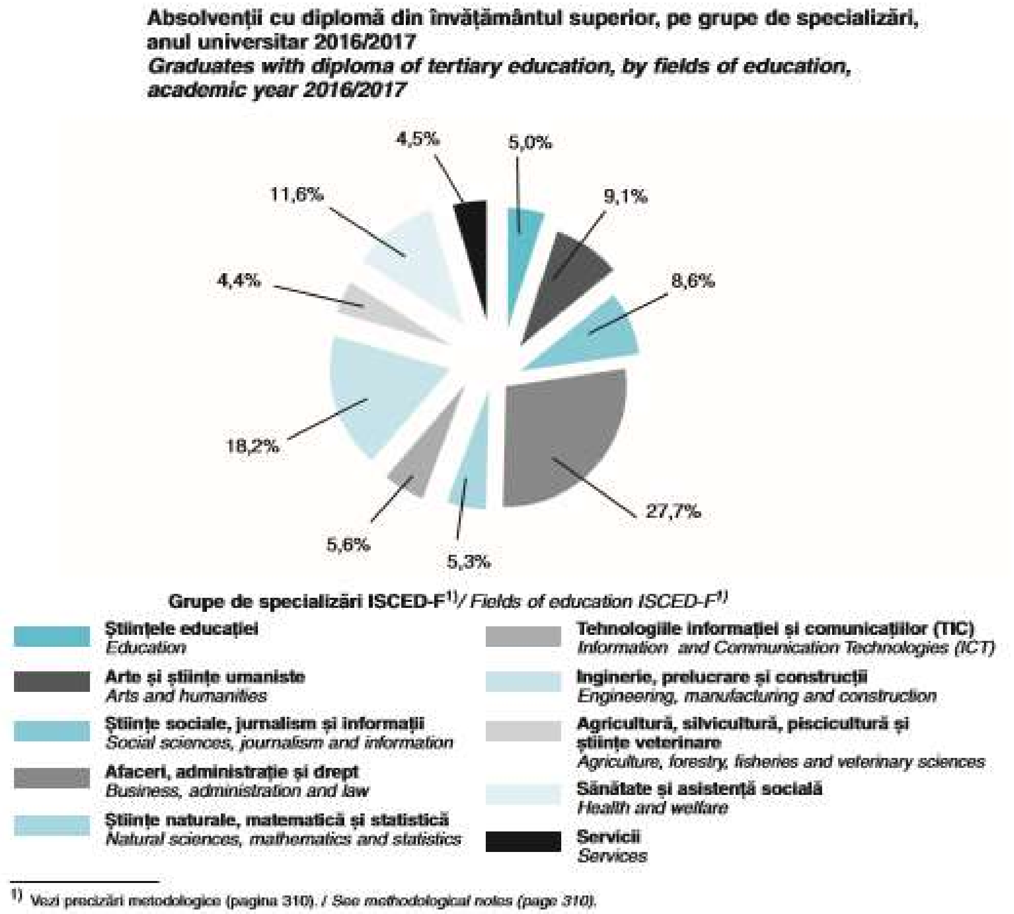


Figure 144 Graduation level of students in a tertiary education in South-West Oltenia region based on the local data, 2016/2017.

Învățământul profesional, postliceal și de maiștri, pe tipuri de școli și profiluri de pregătire
Vocational, post-secondary non-tertiary and foremen education, by type of school and training track

	Elevi înscriși / *Students enrolled*						Absolvenți / *Graduates*				
	2012/ 2013	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2012/ 2013	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017
Școli profesionale ***Vocational schools***	**18106**	**25673**	**49479**	**65221**	**79735**	**84852**	**4401**	**11403**	**10942**	**9752**	**18620**
Construcții de mașini *Engineering*	3441	4510	7360	9243	10841	11125	736	1888	1599	1323	2361
Electrotehnică și electronică *Electrotechnics and electronics*	1015	1096	2200	3246	4056	3845	216	564	431	337	1045
Mine *Mines*	28	148	-	-	75	-	-	24	-	-	43
Petrol *Oil*	127	97	265	479	435	387	20	60	52	86	70
Metalurgie *Metallurgy*	-	7	19	25	18	13	-	-	7	11	-
Energetic *Energy*	190	165	208	345	508	437	-	61	48	23	115

Figure 145 Students and graduates of the engineering and energy related faculties in South-West Oltenia region based on the local data, 2017.

The highest share of the school population in the region is represented by the primary and secondary school population - 43.66%, followed by the 26.75% share of high school education. The lowest share is the vocational education, with a share of only 0.35%.

At the county level, almost half of the school population in each county of the region is engaged in primary and secondary education. The highest share of high school students was registered in Gorj County and Olt County, and the lowest in Mehedinţi County.

In Dolj county there is a higher share of schoolchildren in higher education (21.9%) than that of schoolchildren in high school (20.59%).

Tab 4.28: Populația școlara pe tipuri de învățământ în regiunea SV Oltenia, pe județe în 2011

Nivelul de educâtie	SV Oltenia		Dolj	Gorj	Mehedinți	Olt	Vâlcea
	Total	Feminin					
Total	**381.465**	**185.999**	**126.783**	**71.358**	**46.812**	**72.638**	**63.874**
Preșcolar	66.297	32.378	19.740	12.221	8.288	13.576	12.472
Primar și gimnazial	166.530	79.691	50.510	30.835	21.239	34.388	29.558
Liceal	102.060	48.766	28.364	21.408	13.308	20.761	18.219
Profeșional	1.351	572	196	466	238	237	214
Postliceal și Maistri	12.465	7.731	4.485	2.118	2.170	3.083	608
Superior	32.762	16.861	23.488	4.310	1.569	593	2.802

Figure 146 School population in the particular counties in South-West Oltenia region based on the local data,[56.], 2011.

Both in the South West Oltenia Region and at the county level, the school population in vocational education and apprentices and in post-secondary and post-secondary education registered a share of less than 4% of the total school population. The highest share of students was recorded in Dolj County, over 69% of the number of students at the regional level, due to the University of Craiova, a university center with tradition. The lowest share of students was registered in Olt County, of only 1.60% of the total number of students at regional level.

There are 3 state universities in the Oltenia Region (2 in Craiova - University of Craiova and the University of Medicine and Pharmacy and one in Târgu Jiu - Constantin Brancusi State University), the University of Craiova being with over 31,000 students at 16 faculties and 14 doctoral schools, the most powerful academic center in southwestern Romania. As a number of students, Oltenia ranks 7th in comparison with the other regions.

The cumulative figures have been converted to the key performance indicators (KPIs) which indicate the number of students per one thousand of the population in South-West Oltenia. These are presented along with total number of students by education level in the table below. Please refer to 2 Glossary for education level definition.

Students enrolment in higher education

	No of students	No of students per 1000 of population
Short-cycle tertiary education	N/A	N/A
Bachelor's or equivalent level	352,721	185.5
Long-cycle (Master's or equivalent level)	165,245	86.9
Doctoral or equivalent level	17,252	9
Total enrollment of higher education students	535,218	281.5

Table 96 Number of students enrolled in tertiary education by level in South-West Oltenia based on the general data, [1.], 2017.

4.6.8 Slovenia – Savinjska region

Analysis of the figures for a students' enrolment to tertiary education level shows that around 36 people per 1000 coming from Savinjska region is actively studying. Approximately one third of them undertook the long-cycle education (Master's degree) and 1 student per 1000 of population enroll for the doctoral study program.

The cumulative figures have been converted to the key performance indicators (KPIs) which indicate the number of students per one thousand of the population in Savinjska region. These are presented along with total number of students by education level in the table below. Please refer to 2 Glossary for education level definition.

Students enrolment in higher education	**Specific data**	
	No of students	No of students per 1000 of population
Short-cycle tertiary education	1,320	5.2
Bachelor's or equivalent level	5,137	20.2
Long-cycle (Master's or equivalent level)	2,508	9.8
Doctoral or equivalent level	228	0.9
Total enrollment of higher education students	9,193	36.1

Table 97 Number of students enrolled in tertiary education by level in Savinjska region based on the local information,[42.], 2017.

The graph below shows the comparison of the overall figures for students enrolled to tertiary education on national and regional level. The percentages of students enrolled in different levels of education are very much alike in both cases, the highest difference that occurs is for the doctoral or equivalent level. In general, 1.2% more students on national level decide for the PhD programs.

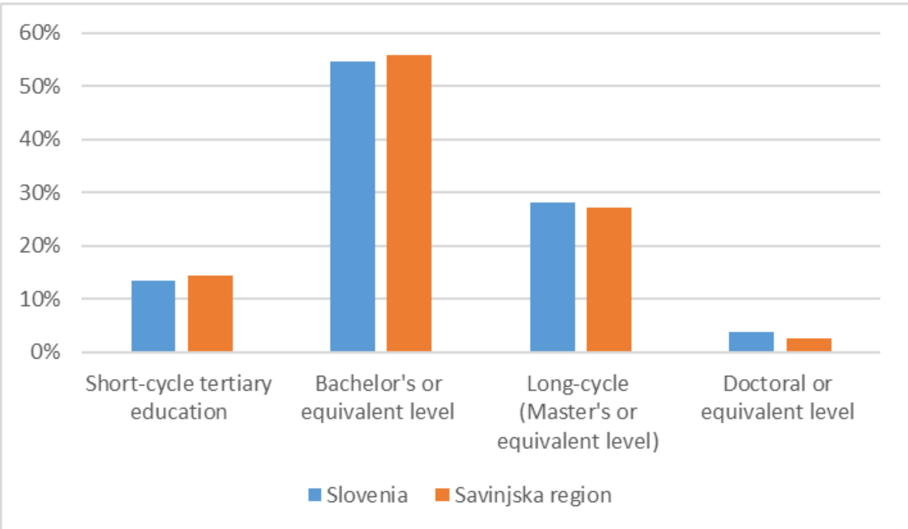


Figure 147 Proportion of students enrolled in tertiary education by level in Slovenia and Savinjska region, [42.], 2017. [42.]

Currently there 4 bigger universities in Slovenia (University of Ljubljana, University of Maribor, University of Primorska, University of Nova Gorica) and 50 smaller independent and private education institutions. Majority of all high-school graduates enroll to the programs of one of the 4 public universities and none of them located in Savinjska region, however there are few smaller tertiary education institutions and dislocated universities' units in the regions for example Faculty of Energy Technology (University of Maribor) with dislocated unit in Velenje. The data presented below are based on national analysis of higher education applications and enrollments for the academic year 2018/2019. The chart shows that University of Ljubljana and University of Maribor receive a greater share of all applications, around 85 %.

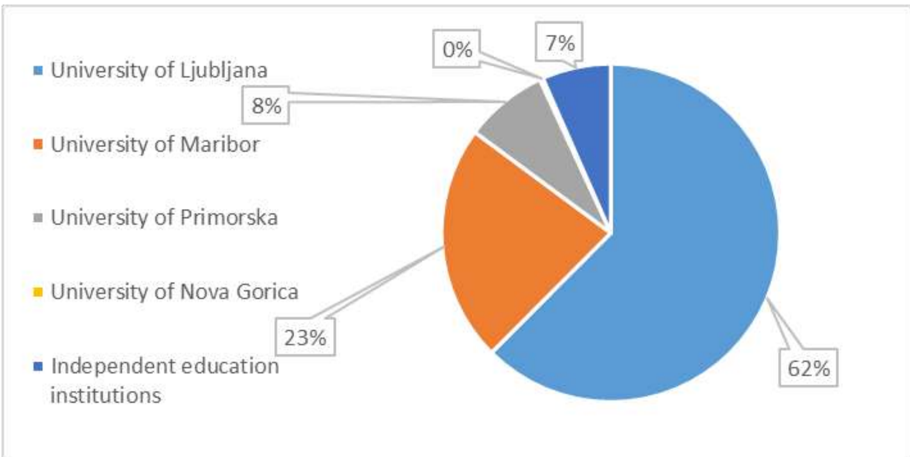


Figure 148 Proportion of first-year enrollment to universities in Slovenia,[54.], 2019.

The number of students that enrolled in the first year of energy technology and electrical/mechanical engineering related programs in the two top ranked universities in Slovenia, University of Ljubljana (UL) and University of Maribor (UM), is presented in the table below. Of the total of 12,473 students that enrolled to first year in UL and UM; 1,125 of students, which presents around 9%, enrolled to studies strongly associated with professions in coal mining and energy sector.

Students enrolment in higher education

	No of students
Faculty of Natural Sciences and Engineering (UL)	
Geotechnology and the environment (UN)	2
Geotechnology and mining (VS)	6
Faculty of Mechanical Engineering (UL)	
Professional Study Program in Mechanical Engineering (VS)	220
Academic Study Program in Mechanical Engineering (UN)	200
Faculty of Electrical Engineering (UL)	
Applied electrical engineering (VS)	186
Electrical engineering (UN)	153
Faculty of Electrical Engineering and Computer Science (UM)	
Electrical engineering (UN)	39
Electrical engineering (VS)	92
Faculty of Energy Technology (UM)	

Professionally Oriented Study Program Energy Technology (VS)	39
Academic Study Program Energy Technology (UNI)	7
Faculty of Mechanical Engineering (UM)	
Professional Study Program in Mechanical Engineering (VS)	105
Academic Study Program in Mechanical Engineering (UN)	76
Total	1,125

Table 98: Students' enrolment to specific programs offered by University of Ljubljana and University of Maribor,[54.] , 2019.

Analysis of the R&D sector shows that in 2017 there was around 1,660 of R&D staff in Savinjska region, which represent 6 researchers per 1000 of inhabitants and 1.4 % of the all employees in the region.

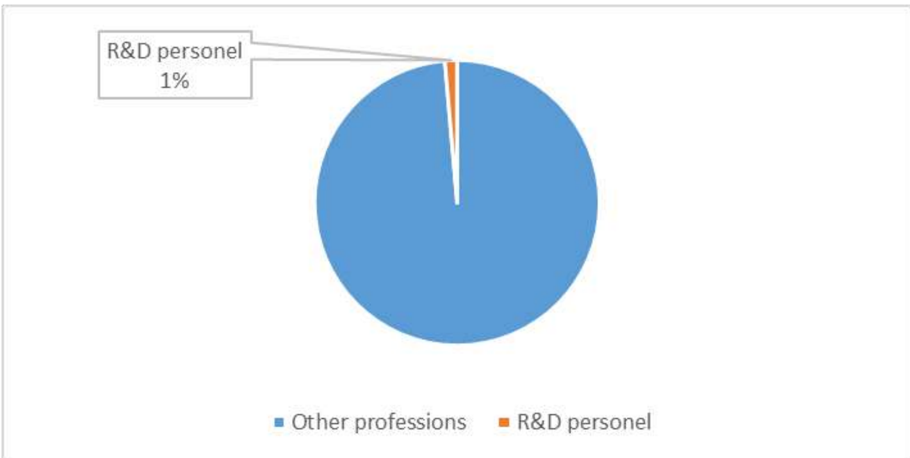


Figure 149 Proportion of employees working actively in the R&D activities among all the staff in Savinjska region, [42.], 2017. [42.]

The total figures along with the KPI factor for R&D personnel are collated in the following table.

Number of employees in the research and development activities

	R&D personnel	1,662
	Total employment	119,830
	Proportion of R&D personnel in total employment	1.4%
	No of R&D personnel per 1000 of population	6.5

Table 99 Number of employees working actively in the R&D activities among all the staff in Savinjska region, [42.], 2017.

4.6.9 Spain – Extremadura region

The cumulative figures have been converted to the key performance indicators (KPIs) which indicate the number of students per one thousand of the population in Extremadura. These are presented along with total number of students by education level in the table below. Please refer to 2 Glossary for education level definition.

Students enrolment in higher education

	No of students	No of students per 1000 of population
Short-cycle tertiary education	8,958	8.3
Bachelor's or equivalent level	20,545	19.1
Long-cycle (Master's or equivalent level)	3,919	3.6
Doctoral or equivalent level	793	0.7
Total enrollment of higher education students	34,215	31.8

Table 100 Number of students enrolled in tertiary education by level in Extremadura based on the general data, [1.], 2017.

Currently, there is around 1,890 of R&D staff in Extremadura which represent 1.8 researcher per 1000 of inhabitants and 0.5% of the all employees in the region.

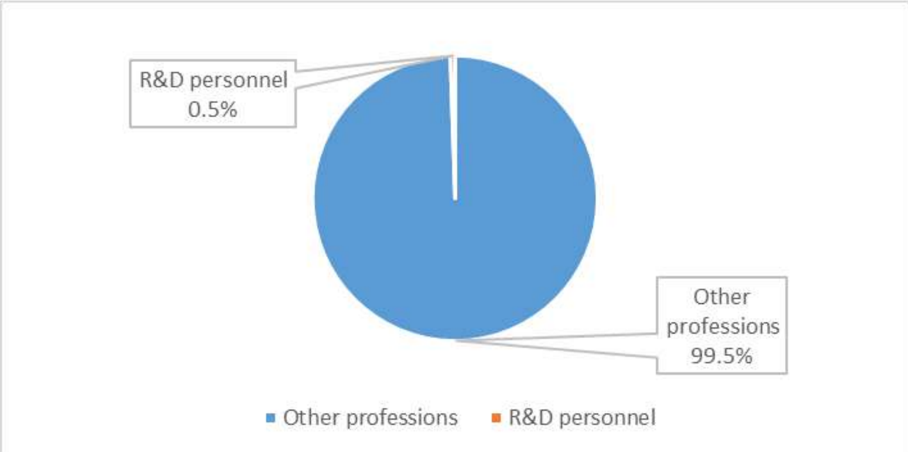


Figure 150 Proportion of employees working actively in the R&D activities among all the staff in Extremadura, [1.], 2015.

The total figures along with the KPI factor for R&D personnel are collated in the following table.

Number of employees in the research and development activities

	R&D personnel	1,886
	Total employment	362,400
	Proportion of R&D personnel in total employment	0.5%
	No of R&D personnel per 1000 of population	1.8

Table 101 Number of employees working actively in the R&D activities among all the staff in Extremadura.

4.7 Innovation culture and experience in private sector

4.7.1 Bulgaria – Yugoiztochen region

Over a half of the total staff employed in the R&D sector in Yugoiztochen region works for entrepreneurs and private businesses.

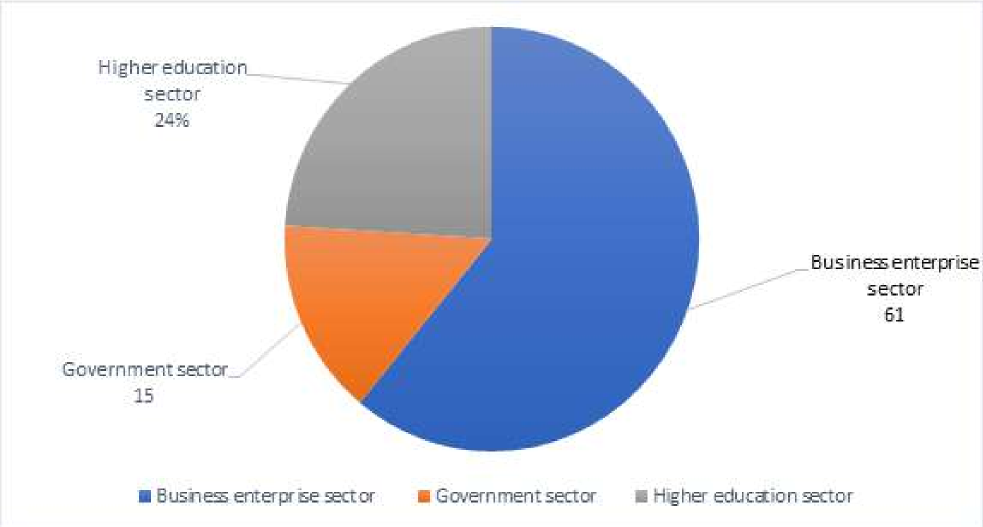


Figure 151 Breakdown of R&D personnel and researches among all R&D staff in Yugoiztochen, [1.].

R&D personnel and researchers by sectors	**No of employees**	**No of employees per 1000 of population**
Business enterprise sector	935	0.9
Government sector	240	0.2
Higher education sector	368	0.4
Private non-profit sector	0	0.0

Table 102 Number of R&D personnel and researchers by sector among all the R&D staff in Yugoiztochen, [1.].

The annual expenditures on the R&D activities of 17 mEUR (extracted earlier) have been converted to spending per one inhabitant in the region. This for Yugoiztochen and the population of 1,046,125 was estimated at 16,25 EUR/person.

4.7.2 Denmark – Nordjylland region

Nearly half of the total staff employed in the R&D sector in Nordjylland works for entrepreneurs and private businesses.

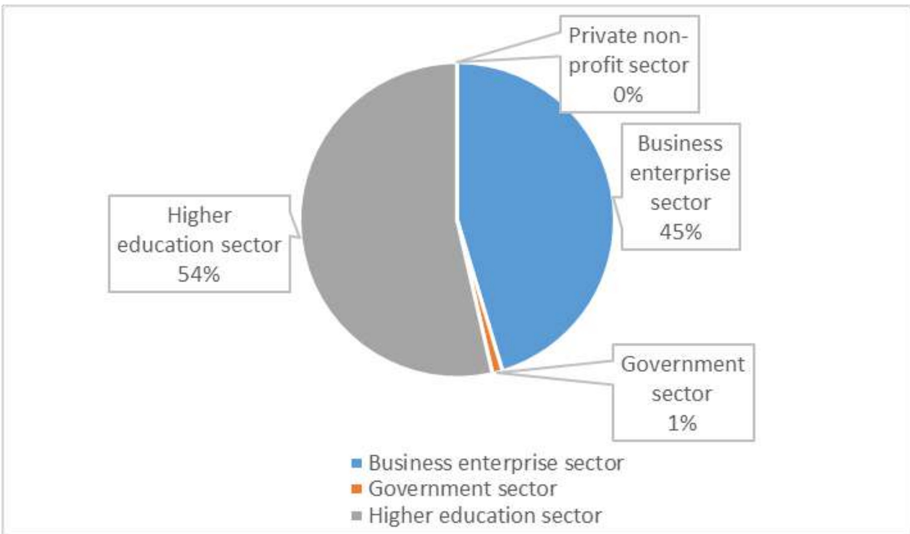


Figure 152 Breakdown of R&D personnel and researches among all R&D staff in Nordjylland, [1.].

The work place figures have been converted to the key performance indicators (KPIs) which show the number of R&D employees per one thousand of the population in Nordjylland. These are presented along with total number of jobs in the table below.

R&D personnel and researchers by sectors	**No of employees**	**No of employees per 1000 of population**
Business enterprise sector	1,417	2.4
Government sector	33	0.1
Higher education sector	1,675	2.9
Private non-profit sector	0	0.0

Table 103 Number of R&D personnel and researchers by sector among all the R&D staff in Nordjylland, [1.].

The annual expenditures on the R&D activities in all four sectors listed earlier reached in 2016 circa 400 million EUR which is equivalent of 680 EUR per inhabitant in the Nordjylland region. [1.]

There is a number of ongoing or completed research and innovation projects that have been funded as part of EU scheme Horizon 2020. These aid the creation and improvement of clean energy technologies, such as smart energy networks, tidal power, and energy storage.

The key innovation and research activities related to buildings, heating and cooling and industry undertaken in Nordjylland includes projects:

- Integrated solutioNs for ambitiOus energy refurbishment of priVATE housing.
- Heating and Cooling: Open Source Tool for Mapping and Planning of Energy Systems.
- Robust Internal Thermal Insulation of Historic Buildings.

- SmartHeat – An eco-innovative solution towards zero-carbon household heating.
- MC grouting tube system.

There is a number of companies in the region related to the energy industry. The key one related to the businesses that specialize in and promote low carbon and renewable technologies, energy efficiency measures for buildings, district heating or energy storage are:

- ABB.
- Bladt Industries.
- Desmi.
- Logstor.
- Scanel International.
- and Siemens Wind Power.

In addition, approximately 300 energy and climate-oriented SMEs are based in the region.

Decarbonization in Nordjylland is not a diametrical change in neither the regional nor the national energy strategy. It is the final phase of a green energy transformation that started years ago. The overall tendency is that the both institutions and companies are eager to adapt to a sustainable energy production and consumption putting into use both technical and behavioral solutions.

4.7.3 Germany –Lausitz-Spreewald region

Nearly half of the total staff employed in the R&D sector in Lausitz-Spreewald region works for entrepreneurs and private businesses.

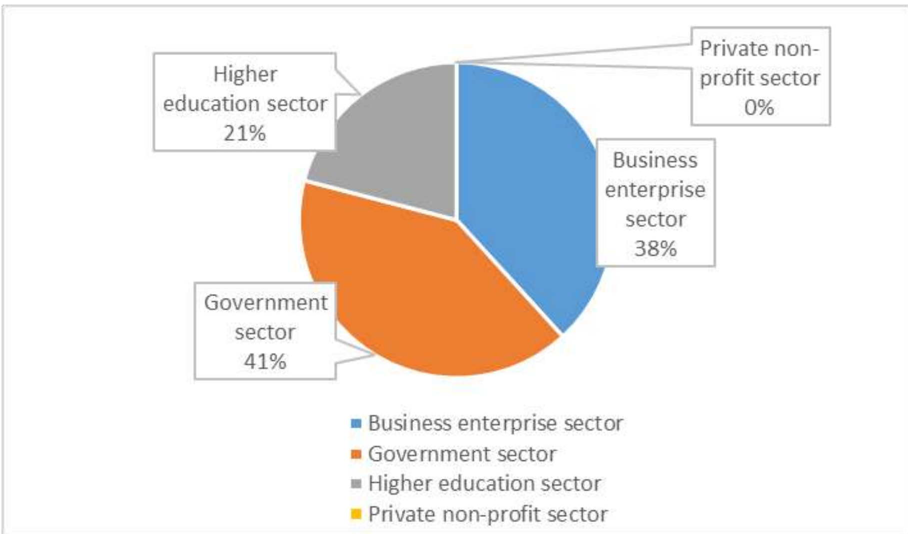


Figure 153 Breakdown of R&D personnel and researches among all R&D staff in Lausitz-Spreewald, [1.].

The work place figures have been converted to the key performance indicators (KPIs) which show the number of R&D employees per one thousand of the population in Lausitz-Spreewald. These are presented along with total number of jobs in the table below.

R&D personnel and researchers by sectors	**No of employees**	**No of employees per 1000 of population**
Business enterprise sector	280	0.5
Government sector	300	0.5
Higher education sector	150	0.3
Private non-profit sector	0	0.0

Table 104 Number of R&D personnel and researchers by sector among all the R&D staff in Lausitz-Spreewald, [1.].

The annual expenditures on the R&D activities in all four sectors listed earlier reached in 2015 circa 100 million EUR which is equivalent of 170 EUR per inhabitant in the Lausitz-Spreewald region. [1.]

Planned, Ongoing or completed research and innovation projects:

- The initiative 'Land-Innovation-Lausitz' for the bio-economic change of mining regions of the Brandenburg Technical University Cottbus-Senftenberg (BTU) and the Helmholtz Centre Potsdam German Research Centre for Geosciences can develop innovative and important concepts for the structural change in Brandenburg and help shape the regional change as an "innovation engine". The BTU was also successful with its project ´Digitale Reparaturwerkstatt Berlin-Brandenburg´.
- The 'Co-Innovation Platform Industrial Automation' of the Innovations region Lausitz GmbH, is another project from Lusatia for Lusatia. Industrial automation is a key challenge for companies.

- Examples for pilot innovation projects by the Economic Region Lusatia ”Wirtschaftsregion Lausitz (WRL)”.[24.]
- Heating with Calluna - Renewable energy from landscape management (use of biomass, pelleting, energetic use).
- Development and testing of a technology for the recycling of thick-walled composite fibers (recycling of wind turbines).
- Sector-coupled energy systems (use of alternative energy technologies - sea heat use and hydrogen technology - for sector-coupling, implementation of energy pools, integration into existing energy systems, heat supply to neighboring communities).
- Model for structural change by means of floating architecture (self-sufficiency regarding material and energetic supply and disposal).

The key innovation and research activities related to buildings, heating and cooling and industry undertaken in Lausitz-Spreewald include:

- Lausitz Energy Cluster (LCE): Energy Region based on the existing competences in the fields of energy technology and resource efficiency, the existing research capacities, the available infrastructure for electricity and gas as well as the supply of suitable space, Lusatia uses the trend of decarbonization in the energy sector to expand Renewable energies, the large-scale production of hydrogen, the energetic renovation of buildings and the energy-optimized urban and village renovation to build new, industry-compatible value chains. The power plant sites in, Jänschwalde and Spremberg are being transformed into new generation industrial parks focusing on the use of renewable energies and their transformation into long-term energy sources for the economy. [22.]
- Lausitz Cluster Mobility (LCM): regional model for climate-friendly, modern mobility In the region, various forms of climate-friendly mobility are to be researched, tested and applied. Storage technologies and production, the work on innovative drive technologies, the development and production of lightweight materials for road and rail, the production of high-tech materials as components for microelectronics or integrated transport concepts offer considerable potential.[22.]
- Lausitz Cluster Bioeconomy and Resource Efficiency (LCBR): Market leader in the careful use of fossil and limited resources and biogenic raw materials Building on existing resources, networks and companies (eg BASF), a wide range of application areas can be found in the production of new basic materials for the Pharmaceutical and chemical industry, regenerative medicine, agriculture and food production as well as internationally sought-after skills in dealing with mining landscape.[22.]
- Lausitz Campus artificial intelligence (LCKI): Lausitz becomes one of the European development sites for artificial intelligence which ce determines the dynamics of the digital revolution. The creation of a special meeting place between top researchers from computer science, engineering, mathematics and natural sciences as well as medicine and pharmacology with application-oriented research of the respective business units enables synergies and jumps from basic research into the practical life of the application. [22.]

There is a number of companies in the region related to the energy industry. The key one related to the businesses that specialize in and promote low carbon and renewable technologies, energy efficiency measures for buildings, district heating or energy storage are:

- UESA GmbH - The company designs, manufactures and assembles electrical equipment for industry and energy supply. The range of services includes power distribution systems, cable distributors, transformer stations, low-voltage and medium-voltage switchgear up to 24 kV, house connection boxes, automation and control systems and services in the solar sector.
- BASF Schwarzheide GmbH – key chemical supplier and manufacture in the fields as oilfield chemicals, refining, mining, water treatment, as well as wind and solar energy.
- Vestas Blades Deutschland GmbH - the world leader in wind turbine, in Lausitz state it houses a production, production facility and the workshop for the surface coating of the 55-meter-long rotor blades.
- Kjellberg Finsterwalde – the company offers products and technologies for the thermal cutting, joining and changing workpieces.
- Sweco GmbH – the company operates in the area of land management, regional development, waste management and geotechnics, water and wastewater management, landscape and ecology as well as energy technology.
- The Lausitz Energie Bergbau AG and the Lausitz Energie Kraftwerke AG (both together LEAG) are in charge of lignite mining in the two opencast mines Jänschwalde, Welzow Süd situated in the Lausitz-Spreewald region, and for the refinement of the raw material brown coal in the industrial park Schwarze Pumpe.
- ABB Automation GmbH - is a global leader in technology in the fields of electrification products, robotics and drives, industrial automation and power grids with customers in power supply, industry, transportation and infrastructure sector.

Planning process of the decarbonization in Lausitz-Spreewald has started years ago and successively is being implemented. The overall tendency is that the both institutions and companies are eager to adapt to a sustainable energy production and consumption putting into use both technical and behavioral solutions. The potential clashes can occur for the market participants that deliver services and products for the mines and coal-powered industries.

4.7.4 Greece – Western Macedonia region

No specific data are available in regional level for R&D personnel and researchers for the year 2016. In order to provide the current R&D profile of the regions, data from 2015 were used and presented in the following figure. It has to be mentioned that R&D involvement from other regions and moreover from the lignite industry itself is not registered in local level, forming a profile under further discussion.

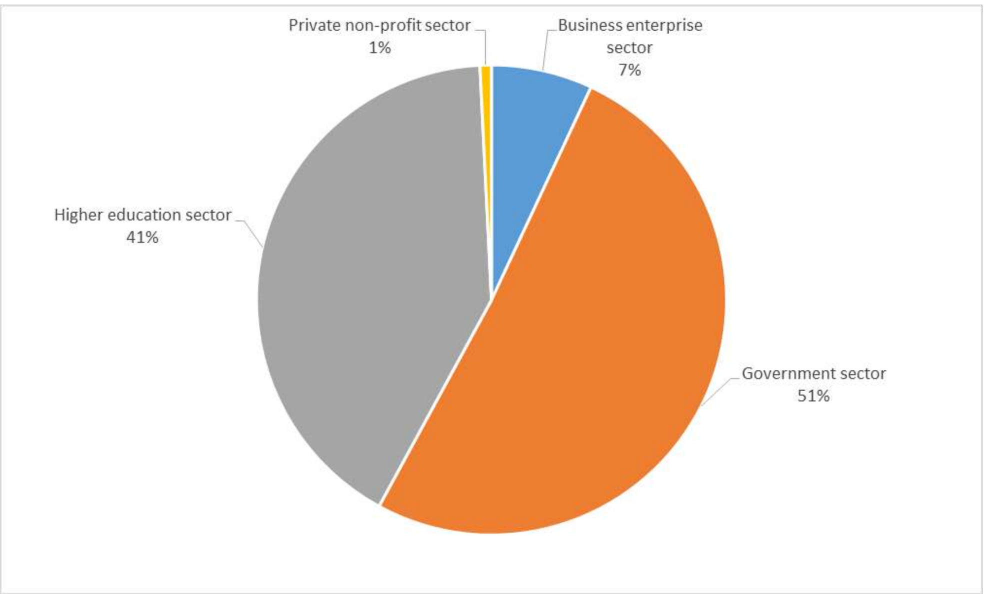


Figure 154 Profile of R&D personnel and researchers in Western Macedonia, [1.].

According to the Regional Innovation Scoreboard 2017 (RIS 2017) [36.], the region of Western Macedonia is characterized as "Moderate Innovator", with an innovation performance below EU average. It has to be noticed that based on the analysis carried out by RIS 2017 the region has its best performances in the following indicators [36.]:

- Most-cited scientific publications (normalized score of 0.855, 145 relative to Greece and 157 relative to the EU).
- Non-R&D innovation expenditures (normalized score of 0.415).
- SMEs innovating in-house (normalized score of 0.551).
- Innovative SMEs collaborating with others (normalized score of 0.576).
- Marketing/organizational innovations (normalized score of 0.456).
- Product/process innovations (normalized score of 0.534).

4.7.5 Hungary – Észak-Alföld region

There was no data provided.

4.7.6 Poland – Lodzkie region

The centers dealing strictly with supporting innovativeness of the regional economy in the Lodzkie Region include:

- Two technology parks (Lodz Regional Science and Technology Park, Bełchatów and Kleszczów Industrial and Technology Park).
- Two technology incubators (the Lodz Technology Incubator at the Lodz Regional Science and Technology Park, the Technology Incubator at the Bełchatów-Kleszczów Industrial and Technology Park).

R&D personnel and researchers by sectors	**No of employees**	**No of employees per 1000 of population**
Business enterprise sector	2,341	0.9
Government sector	N/A	N/A
Higher education sector	3,351	1.4
Private non-profit sector	N/A	N/A

Table 105 Number of R&D personnel and researchers by sector among all the R&D staff in Lodzkie, [1.].

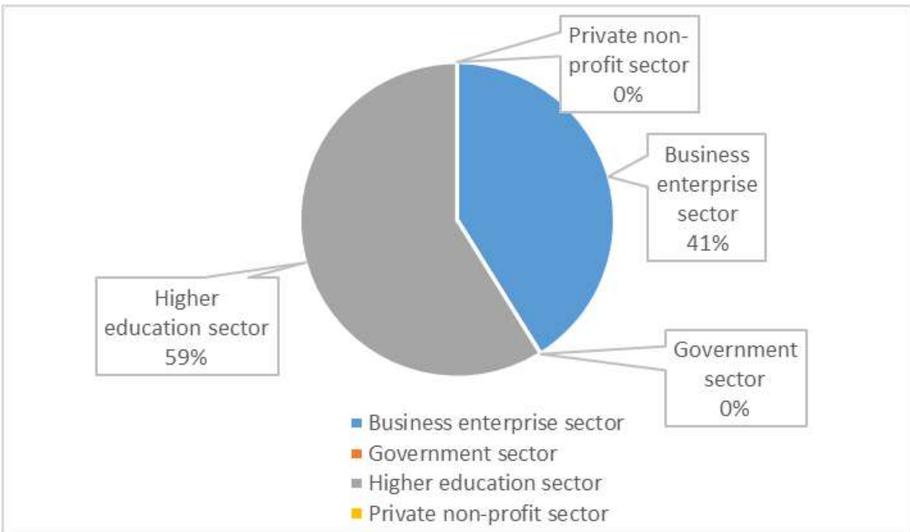


Figure 155 Breakdown of R&D personnel and researches among all R&D staff in Lodzkie, [1.].

The annual expenditures on the R&D activities in all four sectors listed earlier reached in 2016 circa 175 mEUR which is equivalent of 70 EUR per inhabitant in the Lodzkie region. [1.]

4.7.7 Romania – South-West Oltenia region

The South-West Oltenia Region is characterized by a low level of RDI activities, ranking seventh among development regions after spending on R & D activity. This is also visible in the chart below, which highlights the total research spending of each region. It is clear from the graph that the South-West Oltenia region has had a steady expenditure over the last 10 years, ranking the last places as a percentage of total research spending as a percentage of regional GDP.

No specific data are available in regional level for R&D personnel and researchers for the year 2016.

Fig. 5.40 Cheltuielile totale pentru cercetare – dezvoltare ca procent din PIB-ul regional pe regiuni de dezvoltare (%)

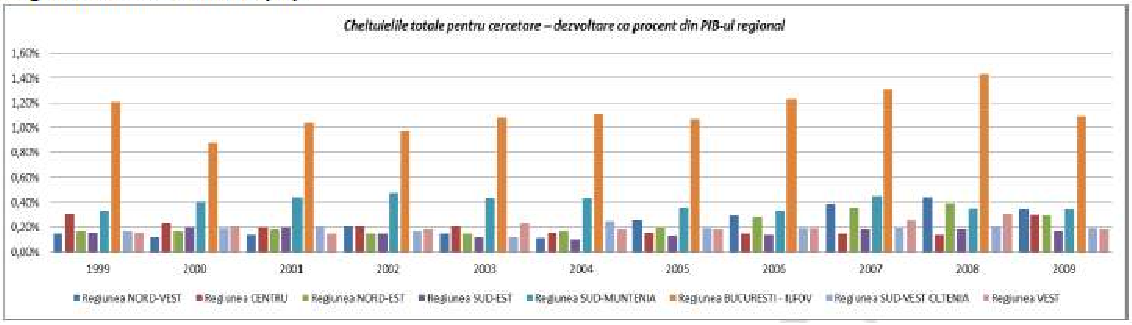


Figure 156 Breakdown of R&D personnel and researches among all R&D staff in South-West Oltenia, [57.].

The following CDIs are active in the region:

- Dolj County: Craiova National Institute for Research and Development in Electrical Engineering (ICMET), IPA - CIFAT Craiova, Craiova Plant Research and Development Station, Agricultural Research Station Şimnicu de Jos, Işalnita Vegetable Research and Development Station, Research Station - Development for Dabulni Sands Culture Culture, Craiova Experimental Didactic Station;Județul Vâlcea: Institutul de Criogenie și Separări Izotopice în cadrul căruia funcționează și Centrul Național de Cercetare pentru Hidrogen și Pile de Combustie, Stațiunea de Cercetare - Dezvoltare în Pomicultură, Stațiunea de Cercetare - Dezvoltare Viti-vînicolă Drăgășani;
- Gorj County: Tropical Research and Production Plant Tg. Jiu, the Strejesti Brewery Research Center.

In parallel with the R & D units, some firms carry out their own R & D activities, focusing on the development of new innovation products.

R&D personnel and researchers by sectors	**No of employees**	**No of employees per 1000 of population**
Business enterprise sector	11,963	6.3
Government sector	13,116	6.9
Higher education sector	18,965	10
Private non-profit sector	342	0.2

Table 106 Number of R&D personnel and researchers by sector among all the R&D staff in Romania.[1.]

4.7.8 Slovenia – Savinjska region

Nearly two-thirds of the total staff employed in the R&D sector in Slovenia works for entrepreneurs and private businesses; the private non-profit sector on the other hand employs only 0.4% of R&D personnel.

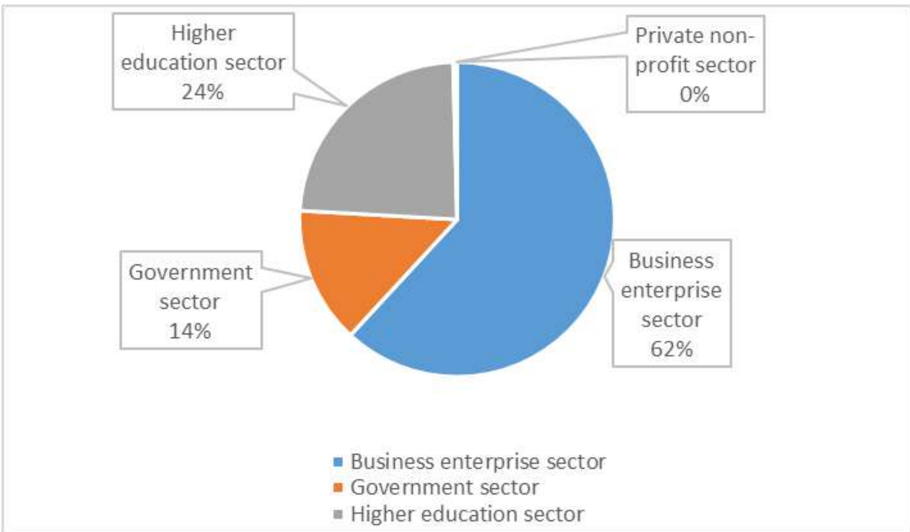


Figure 157 Breakdown of R&D personnel and researches among all R&D staff in Slovenia, [42.].

As downsizing the national figures of R&D personnel by sectors to the regional level would deviate too much from the actual number of the total R&D personnel in Savinjska region (1,662), the table below present conversion of the work place figures to the key performance indicators (KPIs) in Slovenia. The numbers of R&D employees per one thousand of the population are presented along with total R&D number of jobs in Slovenia.

R&D personnel and researchers by sectors	**No of employees**	**No of employees per 1000 of population**
Business enterprise sector	13,602	6.6
Government sector	3,090	1.5
Higher education sector	5,212	2.5
Private non-profit sector	89	0.0

Table 107 Number of R&D personnel and researchers by sector among all the R&D staff in Slovenia, [42.].

The annual expenditures on the R&D activities in all four sectors listed earlier reached in 2017 around 800 million EUR, which is equivalent of 388 EUR per inhabitant in the Slovenia. In Savinjska region, annual R&D expenditure was nearly 70,150,000 EUR, which is around 275 EUR per inhabitant of the region.

In order to promote and support the process of innovation (from conception to implementation) in the country, the Chamber of Commerce and Industry of Slovenia (CCIS) developed the Innovative Slovenia Program. The aim of the program is to offer a variety of activities that are aiming to foster the spirit of innovation in Slovenia, and thereby contribute to success in foreign markets.

Every year, each of 13 regional chambers of commerce invite local innovators and their projects to the competition for the the CCIS Innovation Award. The national competition for the country's best innovation is a two-step process, where innovations from all regions in Slovenia are assessed according to a set of criteria applied on regional and thence national level. All competition entries must meet 3 main criteria pertaining to originality, viability and contribution to the clean environment as well as 6 sub-criteria.

The business environment of Slovenia has been considerably improved, particularly within the last decade since the financial crisis of 2008. According to the World Bank ("Doing business indicators"), it improved its global ranking from the 55th place in 2008 to 37th in 2018. The strongest features of the national business environment are a well-diversified and robust export sector, highly educated and skilled workforce and as well as a high quality of life. It also holds a competitive advantage in trading across borders, transparent resolvent of insolvency cases, ease of paying taxes and presently a stable banking sector (overcapitalized by the Slovenian government).

The administrative environment for doing business has generally been improved and is sufficiently effective to service the economy. The major issue for businesses is the Slovenian ineffective and slow judicial system, which has a substantial backlog of unresolved court proceedings, even though according to the OECD, Slovenia allocated 0.5% of its national GDP to the judicial systems (second only to Israel).

Starting a company is relatively easy and affordable, both for nationals and citizens of EU member states. Interested parties can receive in depth guidance on national "one-stop-shop" portal such as EUGO and e-VEM. For a business to operate in Slovenia permanently, the owner is required to register the company as a business entity. Economic activity may be performed by an individual or business in a variety of legal and organizational forms. A citizen of the EU, EEA or the Swiss Confederation, has the same rights and obligations in the country as a Slovenian business entity. However, as a non-resident of the Republic of Slovenia, prior to commencing operations, an EU citizen must obtain a Slovenian tax number, and in specific cases, a personal identification number. The financial cost of opening a business depend on the type of legal form of a company (sole trader or a limited liability company) but is in general very low. Moreover, several activities such as the registration of a simple one-person LLC, general proposal for the registration of founding the LLC or a change of activity in the Slovenian Business Register can be done free of charge at Republic of Slovenia at VEM offices in multiple locations. There are several companies that handle the procedure on behalf of the company to be, whereby total cost of starting up a company amount to a few hundred EUR.

The banking sector, although overcapitalized to mitigate the negative spill over effects of the global financial crisis does not easily provide financing to the economy, in particular to micro, small and medium sized enterprises. For companies with the sole trader legal form, it`s particularly difficult. Start-up companies are not eligible for loans from conventional sources, as the high risk of failure can`t meet the requirements of the lending institutions. Funding sources are however widely available through an extensive network of business support organizations or directly through companies.

Green jobs, material productivity and energy efficiency in relation to the pragmatic use of natural resources and optimized water management are regarded as one of the key opportunities defined within Slovenia's Smart Specialization Strategy.

Active labor policies played a key role in supporting the business environment in Slovenia, particularly after the onset of the financial crisis, although issues of relatively high unemployment and poor enforcement of labor laws was characteristic of the national situation even within the period of economic expansion before 2008. Non-flexible formation and inability to adapt to rapidly changing macroeconomic state of affairs were recognized as essential negative impacts on the overall low competitiveness of the national economy. The main goal of the several reforms carried out since 2009 were to increase flexibility and security of the national labor market by insuring better workers' rights protection, lowering labor costs, simplification of layoff procedures for employers, stricter and more efficient supervision as well as enhanced judicial protection.

4.7.9 Spain – Extremadura region

Over a half of the total staff employed in the R&D sector in Extremadura region works for entrepreneurs and private businesses.

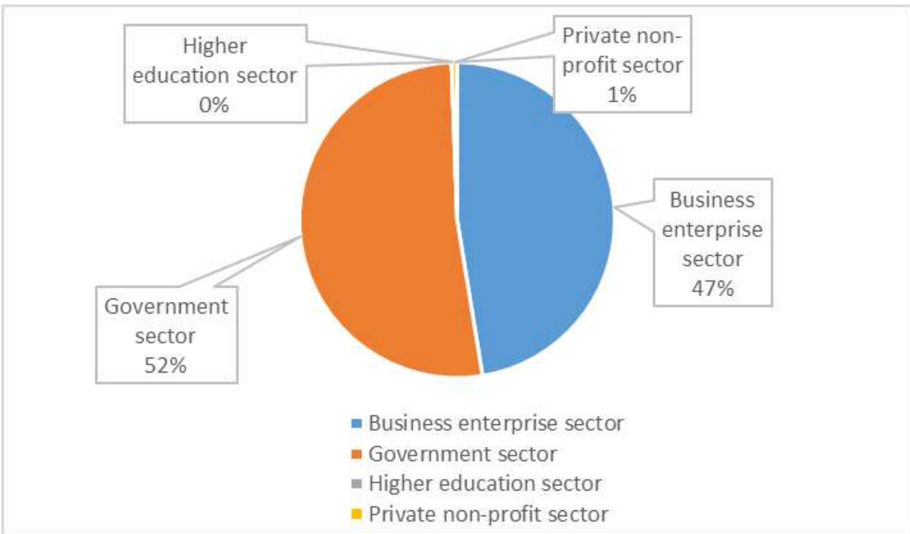


Figure 158 Breakdown of R&D personnel and researches among all R&D staff in Extremadura, [1.].

R&D personnel and researchers by sectors	**No of employees**	**No of employees per 1000 of population**
Business enterprise sector	425	0.4
Government sector	466	0.4
Higher education sector	0	0.0
Private non-profit sector	5	0.0

Table 108 Number of R&D personnel and researchers by sector among all the R&D staff in Extremadura, [1.].

The annual expenditures on the R&D activities in all four sectors listed earlier reached in 2016 circa 106 mEUR which is equivalent of 100 EUR per inhabitant in the Extremadura region. [1.]

4.8 Political and organizational restructuring support instruments

4.8.1 Bulgaria – Yugoiztochen region

This section shows what is the position and attitude of the country leader towards coal intensive industry as presented on the following figure.

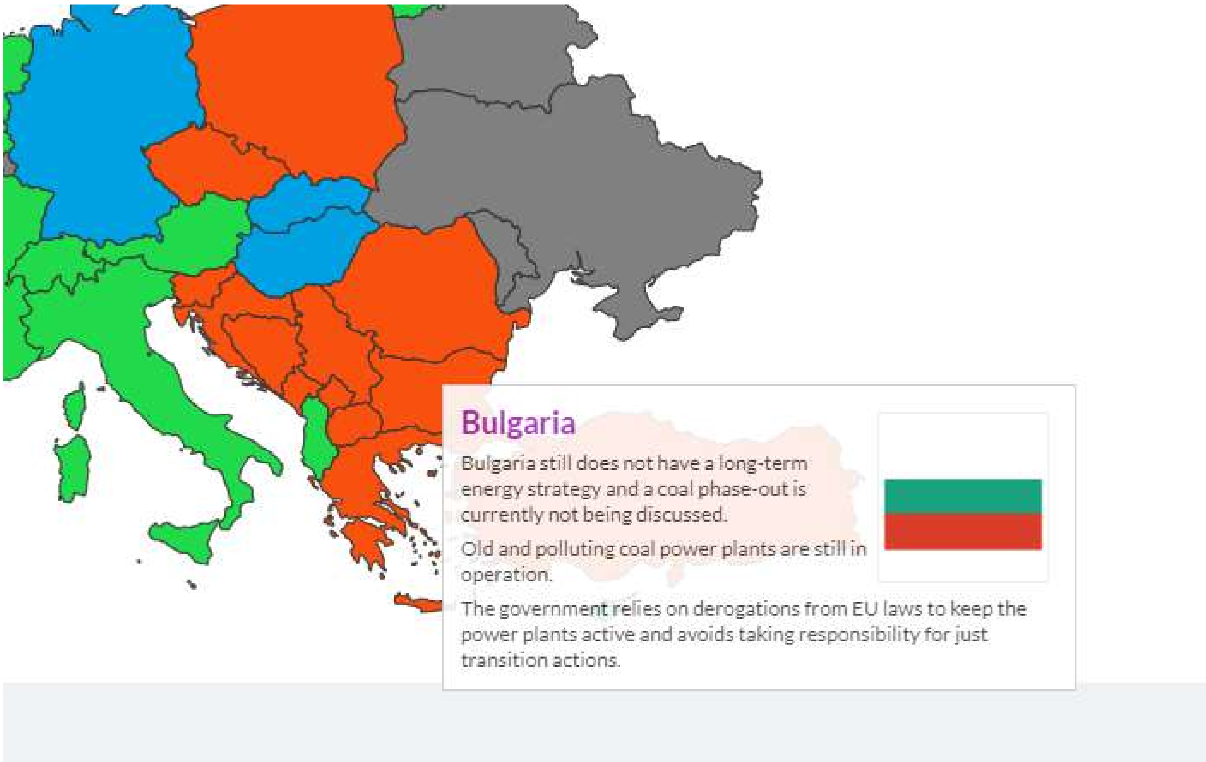


Figure 159 Overview of country leader position towards coal intensive industry (Bulgaria is highlighted with the comment box).

4.8.2 Denmark – Nordjylland region

The success of the coal intensive industry conversion to low-carbon and energy efficient technologies is dependent on the attitude of the politicians and organizations. Denmark is one among very few European countries that is leading on phasing out coal. By 2025 the government expects to decommission all remaining coal-fired power plants.

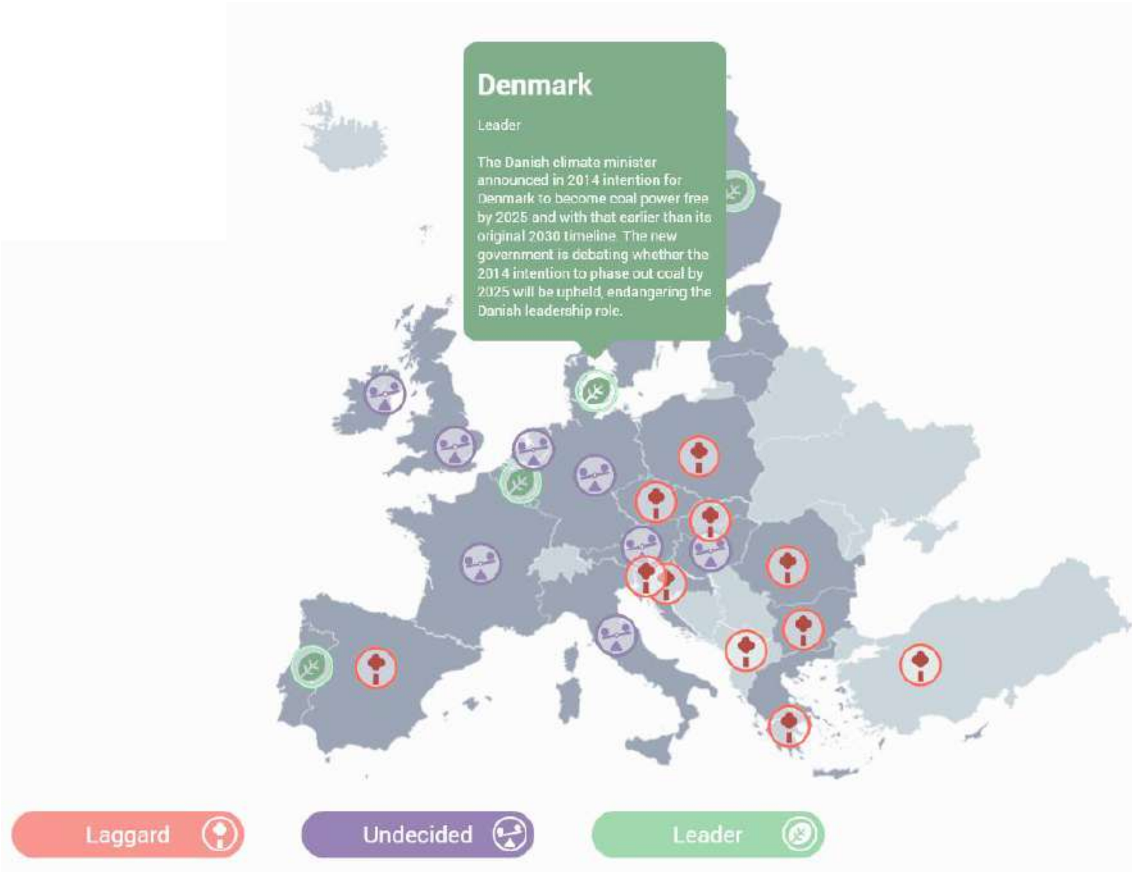


Figure 160 Overview of country leader position towards coal intensive industry (Denmark is highlighted with the green comment box).

Among the current local and national programs and schemes related to coal conversion and implementation of carbon emission mitigating measures are:

- National: The Danish governmental energy strategy until 2050 presents a wide spectrum of new energy policy initiatives in order to considerably reduce fossil fuel dependence. Up to 2020, the strategy will reduce the use of fossil fuels in the energy sector by 33% compared with 2009. In addition, the strategy will increase the share of renewable energy to 33% by 2020 and it will reduce primary energy consumption by 6% by 2020 compared with 2006 due to a strong focus on energy efficiency improvements.[13.]
- Regional: An energy strategy for the municipality of Aalborg is in the making. The strategy includes an action plan to convert the local powerplant from coal to sustainable energy by 2027. Aalborg Municipality is the only municipality in the Nordjylland Region to use coal in its energy production.

Politicians and policy makers that take the lead in the coal transition express a very high degree of willingness towards the green energy transition. For instance, all political parties in Denmark agreed to the newly signed national energy strategy, which states that Denmark should be fossil free in 2050.

4.8.3 Germany –Lausitz-Spreewald region

The German government is committed to the national, European and Paris climate protection targets for the period up to 2050. The 2016 climate protection plan of the German government describes the gradual path towards a largely greenhouse gas-neutral economy and society in Germany by the middle of the century. The German government is pursuing the triangle of supply security, environmental compatibility and economic viability. The implementation of the climate protection plan will accelerate structural change in many regions and economic sectors, especially in the energy generation sector. The associated changes must not be at the expense of the coal-producing regions on one side, but must rather open up opportunities for sustainable economic dynamism with high-quality employment. The Federal Government's aim is to preserve the regions as energy regions of the future and to avoid structural breaks and restrictions on international competitiveness.

Launched in June 2018, a multi-stakeholder government coal commission was challenged with proposing a new date and measures for ceasing the coal power industry. In February 2019, the commission presented its final report which foresees a phase-out of coal in Germany by 2038 with the option for revision in 2035. This also states a short-term closures of 12,5 GW by 2022 and review points in 2023, 2026, 2029 and 2032.

Current local and national programs and schemes related to coal conversion and implementation of carbon emission mitigating measures include:

- National:
    - National Climate protection plan
    - National Sustainability Strategy of Germany
- Regional:
    - Energy Strategy 2030 (Energiestrategie 2030), Ministry for Economic Affairs and Energy Brandenburg
    - Sustainability Strategy of Brandenburg and its updating (concrete goals and indicators)
    - Energy Strategy Concept for the Lausitz-Spreewald region

Regional Investment Concept Lusatia by the Economic Region Lusatia, Wirtschaftsregion Lausitz (WRL) Politicians and policy makers that take the lead in the coal transition express a very high degree of willingness towards the structural change.

4.8.4 Greece – Western Macedonia region

Western Macedonia is participating as a pilot region in the Coal Regions in Transition Platform. Its participation in addition to the work carried out through the last years on the identification of new pathways for the regional development is an essential opportunity to boost activities and policies in order to identify the future lignite industry role, to create new business opportunities and to confront current and expected unemployment in the Region.

4.8.5 Hungary – Észak-Alföld region

There was no data provided.

4.8.6 Poland – Lodzkie region

- Poland's energy policy until 2030

Government document which presents the state strategy aimed at responding to the most important challenges facing the Polish energy sector, both in the short term and in the perspective of 2030.

Poland's energy policy until 2030, Annex to Resolution No. 202/2009, Council of Ministers, dated 10 November 2009.

- Clean Air program

The Act and executive regulations create a system of legal regulations, the most important elements of which are:

- a statutory ban on the sale of solid fuels not adapted for combustion in households, i.e. sludge and flotoconcentrates,
- a statutory ban on importing unsorted coal into Poland, the so-called "unsorted" coal, introduction of a consumer awareness-building tool, not yet existing in the Polish legal system, i.e. certificates of quality of solid fuels, which customers will receive from coal sellers upon request, thus receiving information on the calorific value of purchased fuels,
- construction of an institutional system for quality control of solid fuels by the National Treasury Administration, the Office of Competition and Consumer Protection and the Trade Inspection, which have been equipped with appropriate control powers and are provided with budget funds for the implementation of these tasks until 2027 in the total amount of over PLN 78 million.

- Development Strategy for Łódź Province 2020.

The Strategy is the most important document of the voivodeship self-government defining the vision of development, objectives and main ways of achieving them in the context of the existing conditions. The document plays a guiding role for the self-government authorities of the voivodeship, as well as for poviat and commune self-governments, scientific and business circles, non-governmental organizations and other institutions, and for all the inhabitants of the region. It also plays an important coordinating role for other programming and planning documents, in particular for the Regional Operational Program for the Łódź Province for 2014-2020.

The strategy assumes that the regional development policy will be implemented on two levels: horizontal and territorial-functional. In total, these spheres are focused, inter alia, on measures aimed at limiting air pollution through strategic measures, i.e. implementation of low-emission and energy-saving technologies, development of "green industries" and services for the use of RES and implementation and development of low-emission coal technologies.

- Regional Operational Program for the Lodzkie Region for the years 2014-2020

The scope of the Regional Operational Program for the Lodzkie Region for the years 2014-2020 is a response to the development challenges that have been identified in the main strategic documents and includes those areas of intervention whose implementation will bring the greatest effects.

The program under Priority Axis IV Low-Emission Economy will contribute to the achievement of the Partnership Agreement "Increasing the competitiveness of the economy". The key challenges of the voivodeship in the field of low-carbon economy are: effective use of the potential of the possessed resources and conditions for the development of low-carbon energy and an increase in the use of renewable energy sources.

Projects implemented under OP IV will directly contribute to the reduction of the emissions of the economy, improvement of air quality, improvement of the state of the environment in cities and rural areas, which will affect sustainable development: supporting an economy which uses resources more efficiently, is more environmentally friendly and more competitive, which is the essence of the Europe 2020 Strategy. The intervention planned in OP IV will aim at reducing air pollution by reducing emissions of pollutants.

In accordance with the provisions of the Detailed Description of Priority Axes of the Regional Operational Program for the Lodzkie Region for the years 2014-2020, the scope of intervention under Priority Axis IV Low-Emission Economy includes:

- Measure IV.1 Renewable energy sources
- Measure IV.2 Thermomodernization of buildings
- Measure IV.3 Air protection
- Measure IV.4 Reduction of pollutant emissions

As a result of the undertakings undertaken in the area of energy production from renewable sources, the energy security of the Lodzkie Region will be improved, and in particular the energy supply will be improved in areas with poorly developed energy infrastructure. The increase in the share of renewable energy sources in the fuel and energy balance of the Lodzkie Region will contribute to the improvement of the efficiency of the use and saving of resources of energy raw materials and the improvement of the state of the environment by reducing the emission of pollutants to the atmosphere, soil and water and reducing the amount of waste generated.

Investments in deep energy modernization of public utility buildings and multi-family residential buildings will allow to reduce energy demand, which will to a large extent translate into lower consumption of conventional fuels and, consequently, will reduce emissions of air pollutants responsible for the so-called low emission phenomenon and greenhouse gas emissions.

As a result of the implementation of passive construction projects, modernization of heat sources and projects related to district heating networks, heat losses will be reduced, which will lead to a reduction in operating costs. Investments in public lighting with the use of energy-saving and ecological equipment will contribute to energy savings in the Lodzkie Region.

Projects under Priority Axis IV will help build a more competitive low-carbon economy in Lodz Province, which makes efficient, sustainable use of resources and reduces pollutant emissions.

- RESOLUTION NO. XLIV/548/17SEJMIK OF THE LODZKIE VOIVODSHIP OF 24 October 2017

on introducing restrictions on the operation of installations in which fuels are burnt within the territory of the Lodzkie Voivodeship.

4.8.7 Romania – South-West Oltenia region

The business environment also has an important contribution to this area with the Romanian central government, namely: the Ministry of Economy, Commerce and Business Environment, the Romanian Academy, the Ministry of National Education and Scientific Research and the National Authority for Scientific Research and Innovation - ANCSI It is necessary for A.N.C.S.I to invest in research programs in the mineral resources sector.

In the framework of the General Programmatic Research, the programs initiated must be the basis for substantiating and supporting national policies and strategies for the development of the mining sector, identifying new trends, critical directions in the field of consumption, extraction, exploitation of mining resources and social aspects.

The geological research program should lead to the establishment of the national data base on mineral resources, clarify the prospects of identifying new deposits, lead to the completion of geological works in the areas with prospects for shaping redeemable reserves.

Sectoral research should lead to the diversification and refinement of technological options for the production and exploitation of the mining product, to promote the recovery of useful minerals from all available sources (including isolated deposits, anthropogenic deposits, waste or wastewater), to detail the technical framework both at the scale macro, for large and micro-scale operators for SMEs.România si-a îndeplinit angajamentul european cu privire la țintele naționale pentru eficiența energetică, energia regenerabilă și emisiile de GES pentru anul 2020. The strategic effort in the coming years will mainly consist of imparting an evolution of the energy sector in line with the priority strategic objectives, including participation in the long and complex transformation process for mitigating climate change.

In this context, the results of the quantitative modeling of the Romanian energy sector for the period 2016-2030 substantiate the negotiation mandate of Romania for setting the national indicative targets for 2030 on GHG, RES and energy efficiency emissions in a fair manner.

4.8.8 Slovenia – Savinjska region

The issue of phasing out coal in Slovenia, as is the case for the majority of coal intensive regions located in East European countries, is controversial in the sense that feasible alternatives that could realistically substitute the energy source without having a profound impact on the economy and moreover an economically viable energy supply to households and industry are yet to be defined. To date, there is no overarching framework defining restructuring support instruments for coal-fired energy producers neither on the regional or national level. Each operation is specific in terms of its role and importance to the domestic economy and national energy system.

Both within the context of the Savinjska region and the country as a whole, the Šoštanj thermal power plant (Termoelektrarna Šoštanj) is the largest source of electricity production and therefore the biggest factor to consider in terms of wider impacts caused by a future phase out of coal. The newest addition to the power plant was the construction of a modern BAT 600 MW unit with the intent to replace existing old, outdated and inefficient units. At present there are on-going discussions between relevant stakeholders on various levels, which includes HSE (Holding Slovenske Elektrarne d.d. – owner of TEŠ and Velenje lignite mine), the Ministry of Infrastructure, Ministry of Environment and Spatial affairs, local decision makers and other relevant partners, on the topic of how and when to implement the transition. With respect to the supply of lignite, discussions are currently being focused on the preparation of the legislation mandating the terms of a gradual closure of the Velenje lignite mine, which is the only mine still opened for exploitation since the closure of the brown coal mines at Zagorje, Senovo and Kanižarica under joint ownership of Rudnik Trbovlje-Hrastnik d.o.o.. Recently, the representatives of the Šoštanj municipality have declared that they expect the Ministry of

Infrastructure to prepare the framework for a comprehensive shut-down program by the end of September 2019. The concession of Premogovnik Velenje for extracting lignite, awarded by the state for a predefined period will expire in January 2022, none the less it`s almost certain that a prolongation of the concession will be issued. However, the national Environmental Agency (Agencija Republike Slovenije za Okolje – ARSO) recently issued a formal decision permitting the import of black coal (or generally coal with substantially higher heating value compared to domestic soft coal) to be used in co-firing with local produced lignite at Šoštanj thermal power plant. The decision indicates that about 1200 tonnes of coal would (could) be transported to Šoštanj daily. Unit 6 which started operating in the spring 2015 was designed to be operational until 2054. HSE is also investigating possible alternative energy sources that would allow the retention of the energy production on the existing location and has publicly declared that various possibilities are on the table. An idea passed on by one of the highest-ranking officials was the possibility to use municipal waste as a partial energy source, but it is only clear at present that significant investment would be required in order to repurpose the plant in order to allow such capability.

Most recent experience with concluding operations in coal-powered energy is the closure of the Trbovlje thermal power plant (Termoelektrarna Trbovlje-TET) and consequently the brown coal mines joined within the company Rudnik Trbovlje-Hrastnik d.o.o. - RTH. Also, a subsidiary of HSE, the company underwent liquidation procedures beginning in 2014 after enduring long-term loses due to poor economic performance overall. The framework for shutting down the plant was however set already in July 2000 with the passing of the law on the gradual closure of the Trbovlje-Hrastnik mines and development restructuring of the region (Zakon o postopnem zapiranju Rudnika Trbovlje-Hrastnik in razvojnem prestrukturiranju regije - ZPZRTH), which anticipated the commercial exploitation of the resource until 2007, closure operations to commence until 2012 as well as the scope of financial resources required to fund said operations. The law underwent several amendments, which also saw the extension of the deadline for exploitation until 2009/2012 (ZPZRTH-A, ZPZRTH-B) and the extension of the deadline for final closure by the end of 2018. For each of the mandated procedures the legislation provided the basis for supporting the operations closure with direct state funding.

The process could be in a sense considered a best practice due to two main aspects of how it was carried out. Firstly, this includes the fact, that the company dealt with collective redundancies through either pension schemes for the workers with sufficient years of service or reemployment mechanisms within other subsidiaries of HSE. Secondly, it was realized by the key actors involved, that seeing through a complete liquidation of the energy location at Trbovlje would not be in the best interest of the holding company, the region and country as a whole, therefore it was halted. In 2018, the company began operations under a new name (HSE Energetska družba Trbovlje d.o.o.), which in addition to the primary location on the Sava river also includes dislocated units of Lakonca (previous energy carried depot, presently converted into a larger area intended for industrial use) and Prapretno (closed landfill for ash and slag). The core business of the new company with respect to the short-term business plan of HSE is to provide storage facilities for petroleum products and system reserves of the national electric power transmission system. The 125 MW coal fired power unit is permanently halted and will be dismantled in the following years, however, future changes in the energy market as well as new technologies could bring the energy location back in operation. Currently, the stakeholders involved are considering various options including biomass co-generation, heat storage and even an incineration plant of municipal waste.

Another relevant actor in the context of coal-fired energy and a good example of feasible transition scenarios is the Thermo power and heating plant Ljubljana (Termoelektrarna-toplarna Ljubljana – TE-TOL). The power and heating plant was constructed in the beginning of the 1960s, primarily as 2 boilers with nominal heat power of 128 MW, which was designed to be supplied by domestic lignite from Velenje and brown coal from Zasavje (Trbolje-Hrastnik). The second investment phase in the middle of 1970s ,introduced capacity for power production and in 1985 the 3rd unit (block) of the power and heat plant was constructed. Ever since 2000, the company was focused on reaching energy production targets while minimizing negative environmental impacts.

An integrated approach for achieving environmental and energy goals becomes a key principle of TE-TOL and thus the need for sustainable adaptation and technological development was defined as a strategic priority for the company. The company focused on actions with which existing coal technology would be gradually replaced with new environmentally less burdensome technologies that can over the long-term implement the mission and vision of the company towards increasing the share of electricity from cogeneration and renewable energy sources, increasing energy and environmental efficiency, and reducing dependence on just one energy source. In 2008, the first strategic project, namely the introduction of a renewable energy source - the co-incineration of wood chips with coal in boilers of unit 3 was successfully implemented. The produced energy from wood chips at the annual level represents about 10 percent of the total production or 20 percent of the production from block 3. By using wood chips (roughly 100.000 thousand tons per year), the consumption of coal has been significantly reduced.

The next and at the same time the biggest development project in progress is the installation of a gas-steam unit that will replace 2 coal blocks, by which TE-TOL will double the production of electricity, increase its energy efficiency and reduce environmental impacts, especially nitrogen oxides and carbon dioxide per unit of useful energy. An important contribution will also be felt at the national level, as the production of electricity from cogeneration will increase, as well as installed power for electricity generation in the electricity system. This year (2019) TE-TOL signed a contract with Mytilineos Holdings S.A. for the supply of equipment for the construction of a gas-steam unit that will substitute 2 existing coal-powered units by 2022, with which most of the future coal supply will be avoided. A reduction of 70% is implied by the project. Only coal-fired unit 3, that was repurposed in 2008 for the combustion of wood chips will remain in operation in order to secure dispersed supply of primary energy carriers. The investment strategy does not however address the very low level of energy independence on the national level, as most of the gas is imported. Slovenia has substantial domestically available hydro-energy sources and lignite but is completely dependent on the import of liquid and gaseous fossil fuels as well as Uranium. The overall energy dependency of the country was 48.7% in 2015 (increased 4.2% from 2014), making it a Member state with medium dependency considering that the average for the European Union member states (EU-28) was 54.0% in 2015.

In conclusion, it is clear that each individual energy location has to be addressed separately with its own set of legislation and tailored for purpose regional development funding. The transition toward clean energy must be pragmatic and sustainable, instead of relying on narrow ad-hoc fixes that do not take into account the comprehensive effects of such actions. For example, in absolute terms, Slovenia has done more to decarbonize its energy system by constructing the modern unit 6 at TEŠ (due to much higher efficiency and lower emissions of GHG and pollutants), than it was achieved through all the subsidies into photovoltaic solar and wind power plants, even though the investment is one of high controversy and political backlash. The total phase out of coal in the short to medium-term however is not yet deemed realistic.

The long-term strategic outlook for the country is however well defined and structured so as to support the sustainable energy transition on the national level across various fields of energy supply and use:

- National Energy Program of the Republic of Slovenia for the period up to 2030 (Nacionalni energetski program Republike Slovenije za obdobje do leta 2030: »aktivno ravnanje z energijo).
- Operational program for limiting greenhouse gas emissions until 2020 (Operativni program ukrepov zmanjšanja emisij toplogrednih plinov do leta 2020 - OP TGP).
- Resolution on the Energy concept of Slovenia (Predlog Resolucije o energetskem konceptu Slovenije – EKS).
- Action plan for renewable energy sources (Akcijski načrt za obnovljive vire energije za obdobje 2010-2020 - AN OVE.

4.8.9 Spain – Extremadura region

Extremadura is a lead region in the use (or not use) of coal and in the percentage of renewables in the energy mix. This is due to the high commitment from the regional government to a transition for a low-carbon economy. In the latest years they encouraged investments in RES and promoted the deployment of new solar plants in the region. After years of economic crisis, this is coming back, in this case willing to change the energy system promoting self-consumption and allowing citizens to take part in the energy market.

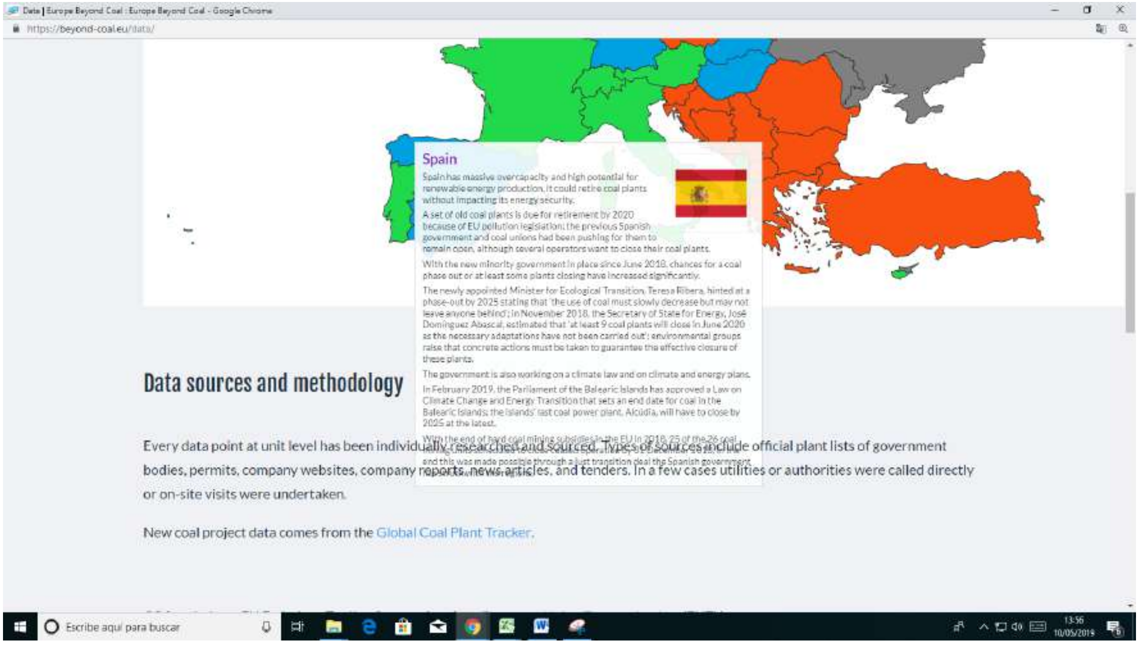


Figure 161 Overview of country leader position towards coal intensive industry (Spain is highlighted with the comment box).

4.9 Financial support for energy conversion investments

4.9.1 Bulgaria – Yugoiztochen region

In Bulgaria there are currently several available funds:

- Operational Program Regions for Growth 2014-2020.
- National Energy Efficiency Program for Multifamily Buildings.
- Energy Efficiency and Renewable Energy Fund.
- The Home Energy Efficiency Loan Program (Second Framework Extension).
- Financial Mechanism of the European Economic Area 2014-2021.
- Rural Development Program 2014-2020.
- Kozloduy Fund.

4.9.2 Denmark – Nordjylland region

There are a few key subsidy programs in Demark that support low-carbon and efficient energy production. This includes:

- ELENA -European Local Energy Assistance – provides funds for municipalities for investments in sustainable energy. This includes the areas as energy efficiency measures in private and public housing, integration of renewable energy sources in buildings as well as modernization and expansion of district heating and cooling.
- NER300 – is the world's largest subsidy program for demonstration projects on carbon capture and storage. This is addressed to both, individual organizations and large consortia to invest into environmentally safe CO_2 capture commercial projects in the energy production and industrial use.
- Interreg Europe – offers financial support for the municipalities in activities as research and innovation, SME competitiveness, low-carbon economy and environment and resource efficiency.
- Horizon2020 – is the biggest EU Research and Innovation program ever with nearly €80 billion of funding available over 7 years (2014 to 2020)-The scheme put emphasis on excellent science, industrial leadership and tackling societal challenges. Among others it supports the development in the energy sector including areas as rational energy use, reliability of supply and renewable energy sources.

The regional funds and incentives for investments into renewables and low-carbon energy plants include:

- National Operational Program for the European Regional Development Fund, 2014–2020 DENMARK - Innovative and Sustainable Enterprise Growth looks into the energy consumption of Danish SMEs and helps them minimize future energy costs by aiding the application of more energy efficient technology.
- The Financial agreement from 2009 400 million. Danish Krones was allocated to support private energy conversion. From 2013 small individual oil-based heating plants for buildings were prohibited and the Government would pay 25 % of the cost when converting to geothermal or solar heat or connecting the buildings to the Danish district heating grid.

4.9.3 Germany –Lausitz-Spreewald region

The key subsidy programs in Germany that support low-carbon and efficient energy production are:

- EEG (supporting Renewable energy law).
- Structural strengthening law for the coal regions in Germany, € 3.5 billion for Brandenburg until 2038 (a number of projects with green energy and energy efficiency background will be promoted).
- Federal Program 'WIR - Change through Innovation in the Region' is aimed at regions in eastern Germany. The German government promotes in the coming years with up to 15 million euro for each project, sets up regional alliances in East Germany, 3 projects in Brandenburg's part of Lusatia (see 4.7.1).

The regional funds and incentives for investments into renewables and low-carbon energy plants are as follows:

- EFRE/RENplus, about 100 Mill. € for NUT2 2 area (80 % EU, 20 % Federal State-funding) With the RENplus 2014 - 2020 funding program, the Brandenburg Ministry for Economics Affairs and Energy (MWE) supports projects that reduce energy-related CO_2 emissions as part of implementing the energy strategy.
- EFRE/Technoly transfer MWE supports knowledge and technology transfer and cluster management measures also in energy technology.
- EFRE/Profit, MWE supports the implementation of research and development projects also in energy sector.

4.9.4 Greece – Western Macedonia region

The main goal for regional transition is to design and implement projects that bring investments and jobs to the region, offsetting losses from declining lignite industry, exploiting the know-how and skills acquired over the past decade but also ensuring an environmentally and economically sustainable future. The current financial schemes supporting the transition deals with the above[36.]:

- Regional Development Fund of Western Macedonia

Established in 2016 by the Western Macedonian Regional Council, the Fund reached its operational status in 2018. It is co-funded by the Public Power Corporation, through compensatory supporting actions, and the Hellenic Fund for Entrepreneurship and Development. Aims to support local SMEs in Regional level in the form of small low interest loans. Strong emphasis is being given on projects with substantial added value to the local economy. The Fund will invest 10 M€ in a minimum of 200 innovative business plans.

- National Just Transition Fund

Established by the Greek Government for the lignite areas, financing sustainable development actions providing a budget of 60 M€ (20 M€ per year) during the period of 2018-2020. The funding priorities are related to the Region's Smart Competitiveness Strategy, as well as past development plans and proposals, promoting the development of clean energy, energy saving, circular economy, primary sector, exploitation of industrial heritage and integrated intervention programs. The main aim of the program is job creation and entrepreneurship support.

4.9.5 Hungary – Észak-Alföld region

There was no data provided.

4.9.6 Poland – Lodzkie region

- Clean Air Program - National Program

The objective of the scheme is to improve energy efficiency and reduce emissions of dust and other pollutants into the atmosphere from existing detached houses or to avoid emissions of air pollutants from newly constructed detached houses.

- The Provincial Fund for Environmental Protection and Water Management in Lodz supports projects in the field of water protection and water management, air protection, land protection, nature protection, environmental education and monitoring, prevention and elimination of extraordinary environmental threats by providing assistance:
  - loans,
  - bridge loans,
  - non-repayable grants,
  - the transfer of funds to the State budget units,
  - subsidies to interest rates on credits and loans taken from commercial banks,
  - partial repayment of the principal of a bank loan.

- Regional Operational Program for the Lodzkie Region for 2014-202

Priority Axis IV Low emission economy, Priority Axis V Environmental Protection.

Priority axis IV Low-carbon economy combines the scope of intervention of CT 4 Supporting the transition to a low-carbon economy in all sectors (PI 4a, 4c, 4e) and CT 6 Preserving and protecting the natural environment and supporting resource efficiency (PI 6e). Measures under this axis are financed by the ERDF.

Priority axis V Environment combines the scope of CT 5 Promotion of climate change adaptation, risk prevention and management (PI 5.b.) and CT 6 Preservation and protection of the environment and support for resource efficiency (PI 6.a, 6.b, 6.d). Measures under this axis are financed by the ERDF.

4.9.7 Romania – South-West Oltenia region

There are several key subsidy programs in Romania that support low-carbon energy and efficient production. This includes:

- Regional Operational Program 2014-2020 - Priority Axis 3: Supporting the transition to a low-carbon economy.
- Large Infrastructure Operational Program 2014-2020 - Priority Axis 6: Promoting Clean Energy and Energy Efficiency to Support a Low Carbon Economy.
- Interreg Europe – offers financial support for the municipalities in activities as research and innovation, SME competitiveness, low-carbon economy and environment and resource efficiency.
- Climate Change and Green Growth, Low Carbon Economy Program, aiming at operationalizing the National Climate Change Strategy and Developing the Climate Component of the 2014-2020 Operational Programs.
- "Photovoltaic Systems" - Program for the installation of photovoltaic panels systems for the production of electricity in order to cover the consumption needs and surplus delivery in the national network.
- "Green House" - Program for the installation of renewable energy heating systems, including the replacement or completion of classical heating systems.

4.9.8 Slovenia – Savinjska region

There are a few operational instruments for supporting measures in the area of sustainable energy development for decarbonizing energy production, transmission and use. Generally, the conventional method of financing public infrastructure is through budgetary sources combined with user payments, but it`s worth noting that the economic crisis of 2008 has fundamentally changed the view on public infrastructure investment. There is a problem in all member states regarding investment in public infrastructure, with some countries overcoming them more successful than others. Slovenia is not immune to global developments and is one of the countries where a highly conservative attitude regarding the use of alternative sources of funding promoted by the EU in the field of public infrastructure investments can be perceived, especially on the state level. Most of the public infrastructure investments in Slovenia are financed directly through public funds, i.e. from state and municipal budgets. In terms of alternative methods of financing, it is possible to identify in particular: 1.) private capital that can be integrated into projects within the scope of the mechanism based on the institute of public-private partnership, 2.) EU funds: Cohesion Fund, European Regional Development Fund (ERDF), European Social Fund and 3.) EIB funds, whereby the EIB also actively supports projects of public-private partnerships.

Public-private partnerships involving private capital have gained recognition within the past years, particularly within the context of the national call for co-financing energy renovation of buildings through energy supply (ESC) and energy performance contracting (EPC) mechanisms, whereby various models (BOT, BTO, BOO, etc.) have been applied. The number and total investment value of projects carried out through public-private partnerships have been increasing, primarily due to outstanding public budget deficits and a widening gap between the needs for investing in economic infrastructure and the available resources that the public authorities are able to allocate.

From the side of the European Union (EU), financial support projects and programs in various areas are made available: regional and urban development; employment and social inclusion; agriculture and rural development; maritime affairs and fisheries; research and innovation; humanitarian aid. The management of most of the EU budget funds that enable the implementation of the Europe 2020 strategy is carried out in partnership with national and regional authorities (i.e., the system of shared management), in particular the management of the assets of the five structural and investment funds, the common provisions of which are defined by the common strategic framework:

- European Regional Development Fund (ERDF): regional and urban development.
- European Social Fund (ESF): social inclusion and good governance.
- Cohesion Fund (KS): economic convergence of less developed regions.
- European Agricultural Fund for Rural Development (EAFRD).
- European Maritime and Fisheries Fund (EMFF).

Other budgetary resources are managed directly by the European Commission (EC), in the form of grants (support to individual projects related to EU policies) and in the form of public procurement schemes (for the needs of the EU institutions).

Another essential source of co-financing for larger infrastructure projects is provided from the side of the European Investment Bank – EIB, which has been involved in financing infrastructure in the country since 1977. Slovenia has one of the highest EIB lending levels per capita among countries that joined the EU in 2003 and has applied the funds for various types of infrastructure projects (either directly or through SID bank), from transport (rail and motorways) to investment into the national electricity grid. An important source of funding project development assistance (PDA) projects is the European Local Energy Assistance (ELENA) fund.

Among other sources of financing, the most appropriate are the debt instruments provided by the Slovenian Environmental Public Fund (Slovenski okoljski javni sklad – Eko sklad) and the Slovenia export and development bank (Slovenska izvozna in razvojna banka, d.d - SID banka).

The Slovenian Environmental Public Fund was established under the 1993 Environmental Protection Act. The fund was assigned with new tasks in the field of supporting investment in energy efficiency of the final consumers of energy with the renewed Energy Act (EZ-1), transposing the EED and EPBD Directives and the National Energy Efficiency Action Plan Action. As such, it is (currently) oriented to fulfil targets of the National Energy Efficiency Action Plan Action for the period 2017-2020 (AN-URE 2020), the Long-Term Strategy for Mobilizing Investments in the energy renovation of buildings (DSEPS 2015) and the program for investment of the climate fund, the National Renewable Energy Action Plan 2010-2020 (AN-OVE 2020) and the Operational Program for the reduction of GHG emission (OP-TGP). The main purpose of the public fund is to facilitate investment in energy efficiency, renewable energy sources and other areas of sustainable development by providing also grants (non-repayable subsidies) and low-cost loans to both individuals and legal entities including municipalities, providers of public utility services and enterprises. It is the only specialized institution within the country that provides direct financial support for environmental projects. The Eco Fund provides lending from dedicated assets and from 2008 through irreversible financial incentives. The key advantages of lending compared to commercial banks are lower interest rates and longer repayment periods. Some estimates of effective interest rates on Eco Fund loans indicate that the cost of investments is 15% lower than the cost of investments made through commercial banks. Eco Fund Incentives positively influence tax revenues, reduce the size of the grey economy, open up green jobs, contribute to the sustainable development of the construction industry, and also to the development of the use of strategic resources, such as, wood. The fund offers various kinds of incentives in the fields of energy efficiency, renewable energy, sustainable mobility as well as in the field of fresh water conservation and even waste management with various kinds of measures, which consist of but are not limited to the following:

- Installation of solar heating systems,
- Installation of wood biomass heating plants for central heating,
- Installation of heat pumps for central heating,
- Installation of solar heating systems (collectors – solar thermal),
- Installation of micro solar power plants,
- Installation of small solar, wind and water power plants,
- Installation of micro CHP units (micro cogeneration of heat and electricity)
- Connecting older one or two-floor building to district heating systems,
- Installation of energy-efficient wooden windows,

- Thermal insulation of façades (thermal envelopes)
- Thermal insulation of the roof and/or ceilings
- Installation of ventilation by returning the heat of waste air (recuperation),
- Installation of gas condensing boilers for central heating,
- Construction or purchase of nearly zero-energy new one or two-floor buildings,
- Complete renovation of older buildings,
- Purchasing a dwelling in a new or renovated almost zero-energy three and multi-dwelling buildings,
- Optimization of heating systems,
- Deep energy renovation,
- Non-refundable financial incentives to legal persons for electric vehicles,
- etc.

In addition, for legal persons (for e.g. enterprises) the fund also provides incentives (soft-measures) for co-financing of awareness-raising, education and promotion projects of non-governmental organizations (NGOs) as well as events and other communication/educational activities.

Financing of infrastructure and energy projects can also be partly carried out through the application of sources from the SID Bank. SID Bank provides municipalities with mechanisms for long-term financing of investments in local public infrastructure and local measures of efficient use of energy and housing for vulnerable groups of the population. Municipalities in the provision of financial resources for the implementation of their projects largely use non-refundable development assistance from European funds and similar forms of assistance. As a rule, they need additional financing to close the financial structure of individual projects, which they acquire in the form of revolving funds on the financial market. In order to provide additional and special needs for custom-made instruments, SID Bank has developed a development-incentive program for long-term financing to promote investments in local public infrastructure, local energy efficiency measures, local housing care measures for vulnerable population groups.

The program is implemented in cooperation with the European Investment Bank (EIB) and the Council of Europe Development Bank (CEB), whereby financing is either carried out by means of co-financing by interested commercial banks or in the form of direct financing. The way they differ is that in the case of co-financing in the offer one of the commercial banks also participates. Insofar as none of the commercial banks accede to the financing, SID Bank assesses the possibilities of direct financing.

Within the context of the Savinjska region, a lot of focus has been dedicated for obtaining co-financing for coordination and support projects dealing with capacity development, education/training and reskilling and stakeholder engagement within the scope of the Horizon 2020 framework program for coal intensive regions, albeit these attempt have been thus far unsuccessful.

4.9.9 Spain – Extremadura region

In the last few years, in Extremadura there were many support schemes for large-scale renewable energy plants, especially solar; but after the development of the solar technology and the huge decrease in prices (speaking about PV technology), this support disappeared because projects were profitable enough.

After an era of feed-in tariffs and incentives from the regional and national government, the current situation is that there are no subsidies for these large-scale renewable energy plants.

There are nevertheless, subsidies available for private owners and small municipalities from the Regional Government of Extremadura for energy efficiency in buildings and renewable energies for self-consumption. Calls are launched once a year with a limited budget.

In a similar way to the example given for Denmark, there are various different lines at EU level to support energy investments:

- GreenerEx, is an ELENA that we experienced in Extremadura and that ended in December 2018. It allowed investments in the region for approximately 42M€.
- AGENEX is currently involved in 6 Horizon2020 projects, 8 Interreg Europe Projects, as well as Interreg POCTEP (cross-border Spain and Portugal) and Interreg SUDOE (Spain, Portugal and France). All of them provide financial support towards a low carbon economy. And the Regional Government is involved in several other projects from the same programs.

The region is also leading CSP-ERANET Co-fund by the EC to promote and finance R&D projects in the concentrated solar power (CSP) technology.

5 SWOT analysis

The following SWOT study summarizes the key strengths, weaknesses, opportunities and threats of the clean energy transition. It is based on the conclusions made when describing the present situation within the **nine** areas distinguished in the section earlier. The four categories of the SWOT are defined as:

- The strengths are the resources or capacities the regions can use to effectively achieve their objectives. These reflect the internal conditions directly resulted from the present situation in the energy sector including energy resources, regulations and social behaviors.
- The weaknesses are the limitations, defects and disadvantages in the regions that will hinder achieving their goals. Similarly, to strengths, these are directly linked to the present situation, environmentally and organizationally related.
- The opportunities are favorable factors or overlooked trends in the regions that would facilitate the decarbonization process and enhance the position of efficient energy consumption management and low-carbon energy technologies. These are triggered by the external factors which stem from society, markets and policies.
- The threats are any unfavorable situations and reactions to the process of phasing out coal that are potentially damaging to its strategy. This includes the barriers, constraints or any external circumstances that may cause problems, difficulties and delays.

5.1.1 Bulgaria – Yugoiztochen region

STRENGTHS	***WEAKNESSES***	***OPPORTUNITIES***	***THREATS***
- Compliance of the National economic development plan with the EU policy. - Higher public awareness on the energy sector challenges and environmental challenges. - Existence of large deposits of lignite. - RES projects such as Hydro power plants are encouraged to be implemented. - Increased share of energy from wind generators, which is 100% ecological. - Well-developed pollution monitoring system. - A large number of completed ecological projects (Complex "Maritsa Iztok" - sulfur purifying installations, etc.)	- Scarce local energy potential, e.g. lack of large deposits of natural gas. - Uranium ore mines are closed and the yield is terminated. - Low efficiency of the built-up wind generators. Thermal and Solar potential hasn't been explored enough. - Costs for the construction of facilities generating energy from RES are still significant. - A large part of the energy facilities are operated for over 20 years require constant rehabilitation. - Energy market not completely liberated and functioning. - Insufficient internal financial resources for realization of projects for renewables. - Not enough R&D in the energy sector. - Not enough potential in education to encourage R&D and new approaches	- The energy sector is stated to be stable. - The largest share of energy production in Bulgaria is currently from coal-fired plants. Globally, coal is the fuel with the largest stocks. - It is possible to build high-efficiency, low-capacity facilities, using new technologies, which are environmentally friendly. The share of energy can be increased using combined plans. - Coal-fired plants rehabilitation significantly prolongs the service life of the plants. - Good potential to use biomass, thermal and solar energy for thermal energy. - Introducing new financial instruments to remote using of RES. - Investments in R&D and education to create experts and scientists to work and introduce new technologies for decarbonization. - Work closely with National,	- Legislative uncertainty in the legal framework and long-term - policies. - Lack of synergy between different laws. - Increase of greenhouse gas quota requirements. - Lack of political will for coal free transition. - Lack of investments and business initiatives in the sector. - High social-economic impact and social resistance.

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
		Regional and Local Authorities to introduce new policies and strengthen the political will to change.	

5.1.2 Denmark – Nordjylland region

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
- The amount of coal used for electricity and heat production and industrial processes is relatively low (20-30%) compared to the total production making the last steps in the transition easier. - The local energy sources from especially wind and solar can cover the total consumption of electricity and heat. Beside that there are huge resources of excess heat from industries and geothermal heat. - More than 60% of heat demand is supplied by district heating. Thus, the infrastructure is suitable for high use of RES and transition to other fuels than coal. - Less than 250 directly workplaces and a little more than 1000 indirectly work places are connected to the coal value chain compared to a total of 265,000 work places in the region. - Unemployment rate is very low (3.3%) and the employment in	- Some of the technologies (especially large-scale heat pumps, large scale storages and geothermal heat) are still in the development phase. - The coal fired plant Nordjyllandsværket is one of the most efficient in the world and still able to run at least 8 years more. - Change to biomass is not the final solution, so technologies without burning fuels are preferable. - Cement production (the industrial use of coal) is private business and thus coal is low taxed and a cheap solution. Also, other fuels might not be able to provide with the necessary temperatures for the production process. - CCS from cement production is not economical feasible. - Use of excess heat from industries is complicated caused by a complicated tax system. - Nordjylland (and Denmark) does not have a direct coal industry.	- The industrial structure in Region North Denmark is very well for production of needed technologies for production of electricity and heat using renewable sources since all nearly parts of the technologies are already produced in the region or under development. - Researchers at Aalborg University will be able to support development of the needed technologies in the industry. - Transition of Nordjyllandsværket can be a demonstration case how to replace coal fired electricity and heat with a new smart, hybrid energy system with electricity from wind and solar and heat from industrial production (excess heat), thermal storages, solar thermal, heat pumps using different heat sources and maybe geothermal heat. - CO_2 from flue gas from cement production can be utilized as carbon source in methanol production. This technology will	- Cheap CCS technologies might be more economical attractive than transition to RES. - Boundary conditions for district heating can be changed making individual systems more attractive and thus reduce the total flexibility in the energy system. - EU might reduce ambitions for prevention of climate changes. - The CO_2 quota system might not work, resulting in low prices. - The Danish government might give up their policy for zero emission in 2050. - The only coal-based power plant in Nordjylland is owned by the municipality, so if the local policymakers do not implement the right regulations, the power plant will continue to run on coal. This scenario is very unlikely though, as the city council unanimously voted to convert the power plant to renewable energy. The municipality bought the powerplant from private owners

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
the energy sector is app. 15,000 in more than 300 companies, most SMEs. This gives good opportunities to employ people from the coal supply chain. - The educational capacity is far larger than the possible amount of unemployed people from the coal supply chain. - In the private sector change from many employees in ship building, cement and chemical industry to creation of new jobs within production of wind power equipment, biogas, solar thermal, large scale heat pumps, control systems has taken place in the last 20 years. Many innovative SMEs makes the private sector able to adapt changes in boundary conditions. - Most of the municipalities have plans for transition to RES in the heating and electricity sector 100% backed up by politicians. For Aalborg a decision has been taken to close Nordjyllandsværket in 2028. - Beside that clusters for sustainable production and for	Indirectly, workplaces in the mining industry in the countries that Denmark import coal from can be affected, along with workplaces in the transport sector. - Alternative energy sources can cover Nordjyllands needs, but the biggest challenge is storage of the renewable energy.	make it possible to replace a large part of the fossil fuel for aeroplanes. - Organic waste can be transformed to oil in the HTL process (hydrothermal liquefaction) developed at Aalborg University. - Quota prices for CO_2 is now app. 20 €/ton but might rise to maybe 100 €/ton. - High quota prices for CO_2 can make CO_2 storage through production of methanol economical feasible. - Change of boundary conditions, for instance demand of a certain % of non-fossil fuels for air transport, can do the same. - Nordjylland has sufficient skills, but are beginning to lack the number of workers. - The problem-based learning method of Aalborg University calls for real-life cases to be solved. This has generated a lot of innovative ideas and prototypes within the field of renewable energy. - Nordjylland and Denmark as a	in order to have full control over the power plant and make sure the conversion will take place.

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
transition to RES (House of Energy) support the transition. - National and European funds can support the transition from coal to RES but in the heating and electricity sector the main driver is high taxes on coal and no or low taxes on RES. - Denmark already has the highest proportion of wind power in the world and there is potential for more wind capacity. - Nordjylland already has a very developed district heating system, with only hard-to-reach locations not connected. These locations are transitioning from fossil-based individual heating to renewable technology. - Nordjylland has a high number of companies in the field of renewable energy, both large companies as Siemens Wind Power and a large number of SMEs. With Aalborg University situated in the region, Nordjylland has a large knowledge pool in the field of renewable energy as well. - The Danish governmental energy		whole has a strong business for renewable energy production and storage. -	

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
strategy until 2050 presents a plan to completely rid Denmark of fossil fuels. Aalborg Municipality is the only municipality in the Nordjylland Region to use coal in its energy production. An energy strategy for the municipality of Aalborg is in the making including an action plan to convert the local powerplant from coal to sustainable energy by 2027.			

5.1.3 Germany –Lausitz-Spreewald region

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
- The local energy sources from especially wind and solar can cover the total consumption of electricity and heat by 2030. Beside that there are huge resources of excess heat from industries and geothermal heat. - Potential of geothermal energy to generate heat for domestic hot water and central heating purpose. - The liabilities after the final phase-out of coal mining in Germany will be funded by a very well financed program by German Government. - Unemployment rate is very low (6%) and the industrial and engineering sector is very well developed in the region with large companies. This gives good opportunities to employ people from the coal supply chain. - The Brandenburg region has developed multiple strategies for transition of Lauisitz-Spreewald to RES in the heating and electricity sector which is very good backed up by politicians.	- Only just above 10% of heat demand is supplied by district heating. This needs to be developed to enable an efficient use of RES energy and transition to other fuels than coal. - Nearly 4,500 directly workplaces are connected to the coal value chain compared to a total of 265,000 work places in the Lausitz region which can be impacted by ceasing the coal mines and power plant. - Coal-based heat and electricity is still the cheapest source of energy. - Some of the technologies (especially large-scale heat pumps, large scale storages and geothermal heat) are still in the development phase. - Change to biomass is not the final solution which at the moment constitutes the major proportion of heat supply among RES (60% of total RES heat production), so technologies without burning fuels are preferable.	- Lausitz-Spreewald state can take advantage of decarbonization trends in the energy sector and develop new industrial value chains through the expansion of renewable energies, the large-scale production of hydrogen, the refurbishment of energy buildings and the energy-optimized urban and rural transformation. - The power plant sites in, Jänschwalde and Spremberg can be transformed into new generation industrial parks focusing on the use of renewable energies and their transformation into long-term energy sources for the economy. - The closed-down mining sites can undergo rehabilitation and reclamation to be restored to their pre-mine uses (e.g. re-cultivation, forestry, agriculture). Based on existing examples from other parts of Lausitz-Spreewald state, the post-mining areas can be transformed to the artificial lakes, leisure parks.	- The new proposal of the government coal commission aiming at phasing-put coal intensive industries entirely by 2038 may face delays in order to maintain the energy security. - Cheap CCS technologies might be more economical attractive than transition to RES. - Boundary conditions for district heating can be changed making individual systems more attractive and thus reduce the total flexibility in the energy system. - EU might reduce ambitions for prevention of climate changes. - Security of electricity supply in the face of simultaneous scrapping of base electricity load from nuclear and coal power plants. - Risk of jeopardizing European competitiveness in the cheap electricity supply and backup supply which is exported to countries relying mostly on unpredictable RES. - High scale expensive investment

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
The recent strategy aims to phase-out all coal activities by 2038. - There is a number of research activities in the Lauisitz-Spreewald aiming and innovative, efficient and low-carbon energy solutions and - Carbon Capture and Storage (CCS) is not an alternative for ceasing coal-intensive industries since only a pilot installation has been developed and with the objections from society, the government is unlikely to approve the commercial installations. - High research and networking activity among private companies targeting efficient energy technologies, carbon cycles, power grid expansion, energy distribution and storage. - Project proposal developed regarding the innovative and efficient use of lignite, application-oriented Hydrogen Research Center, Greentech in building technology and pilot project on the use of CO_2 as a	- Use of excess heat from industries is complicated caused by a complicated tax system. - Alternative energy sources can cover needs, but the biggest challenge is development of district heating and energy storage of the renewable energy. - Networking gap between university research and industry. - Not enough people in R & D sector.	- The post-mining sites can also become redeveloped and converted into a solar energy park, The potential for PV-sites will be analyzed in 2019/2020. - The installation of wind energy projects in former coal mining areas also has a positive impact on local economy. New local employment opportunities are created during construction and operation phases. (One of an example is Windpark Klettwitz in Germany repowered in 2015 reaching 93 MW nominal power. During the construction process more than 120 people were involved). - Abatement of CO_2 emissions will improve a quality of life and reduce health sector expenses.	into alternative energy production, electrical and thermal storage and DH infrastructure affecting electricity prices and affordability of customers. - Demographic change. -

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
valuable substance. This was achieved in the dialogue of regional stakeholders from business, science and politics.			

5.1.4 Greece – Western Macedonia region

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
- Important geographical position regarding the country's borders to Western Balkan countries. - Characterization of the Region as Energy Centre of Greece. - Significant and skilled human resources on energy sector and fur/leather production. - Valuable tourist resources, natural ecosystems and a rich cultural heritage. - Primary sector produces quality products (e.g. wines, fruits, dairy products) with the potential to improve their added value. - Operation of University and Research Institutions.	- Natural and anthropogenic environment burden on the Kozani - Ptolemaida - Amynteo - Florina axis. - Local economy's high dependence on the lignite industry activities and fur industry, against other economic activities. - Low development of innovation and R&D by local SMEs - Country's highest unemployment rate, especially in ages of 18-25. - Limited spatial development and concentration of business activities, mainly along the energy axis. - Lack of foreign investments.	- Empowerment of policies towards to new economic activities (green economy, use of RES, social economy, agriculture of high productivity etc.) - Possibilities of reuse of out of operation lignite industry installations, integrating them into the new economic and social reality. - Development of economic relations with the Balkan countries and penetration in the Balkan market. - Increase of demand for quality tourism services based on natural environment, local production and culture.	- The continuation of the environmental degradation of the area and in compliance with European and national commitments regarding the reduction of carbon dioxide pollutants. - Conservation of the negative economic climate, which guides to lack of liquidity and low investment rates. - Conservation of high unemployment rates could guide to brain drain. - Delay of adopting innovations and new technologies by SMEs could guide to loss of markets in Greece and abroad.

5.1.5 Hungary – Észak-Alföld region

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
-	-	-	-

5.1.6 Poland – Lodzkie region

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
- Lodzkie region is one of the best developing voivodships in the country in the field of renewable energy sources RES. The region has a large potential of biomass, geothermal waters and wind. There are more than 170 wind power plants in Lodz. Natural geothermal resources of the region are used in heating and recreation. The intensified development of the energy sector in the region, observed in recent years, has contributed to the creation of links and cooperation between institutions and enterprises. - The development of RES is facilitated by climatic conditions and geothermal water deposits. The central and eastern part of the voivodeship is particularly sunny - the districts the city of Lodz and the eastern Lodz, Brzeziński, Rawski and Tomaszów as well as Opoczyński districts, which is conducive to the development of photovoltaics.	- The local energy sources from especially wind and solar cannot cover the total consumption of electricity and heat. - The share of renewable energy in total electricity production in 2016 was only 3.9%. and it was the lowest in the country. This is due to the very high share of energy production from conventional sources (Bełchatów Power Plant). - Hydroelectric power generation has a small significance in the Lodzkie Region, mainly due to the nature and small drops of the rivers. All the hydropower plants in operation are so-called small power plants with an installed capacity of less than 5 MW. These are 2 power plants on the Jeziorsko and Sulejów reservoirs and about 40 smaller ones, which together generate about 10 MW of energy. - The share of energy from renewable sources in the total amount of energy produced in the region is only 2 %.	- National and European funds can support the transition from coal to RES. - According to the results of the assessment carried out by the European Commission on the basis of the Regional Innovation Scoreboard from 2017, Lodzkie Region is a moderate innovator at the medium level with progressive dynamics of innovation growth. - Apart from the already built geothermal energy acquisition center in Uniejów, further expert opinions are being carried out in order to demonstrate in which towns and cities similar investments may be made. The research is conducted in Skierniewice and Radomsko, while the wells have already been drilled in Kleszczów and Poddębice. - The centers dealing strictly with supporting innovativeness of the regional economy in the Lodzkie Region include: 1.Two technology parks (Lodz	- EU might reduce ambitions for prevention of climate changes. - SMEs do not fully use the financial support of ROP WL in the implementation of innovations.

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
- In 2016, 86 municipalities had solar and photovoltaic installations located in public utility buildings, which were used exclusively for heating and electricity generation for own needs. Large-scale photovoltaic installations are also developing more and more intensively. - The northern part of the voivodeship comprising the following districts: Kutnowski, Łęczycki, Łowicki and the northern parts of the districts: Poddębicki, Zgierski, Brzeziński and Skierniewicki are characterised by favourable conditions for the production of energy from wind power plants. In 2016, there were approx. 475 wind power plants operating in the voivodeship with the total capacity of approx. 600 MW. - The voivodeship also has large reserves of geothermal waters, of which the most prospective for heating purposes are the waters of Lower Cretaceous and Lower Jurassic, districts of Poddębice, as well as in the	- It is estimated that up to 20 thousand people may lose their jobs due to the liquidation of the Bełchatów mine. - Insufficient ecological awareness of the society is a general problem on the scale of both the voivodeship and the whole country. This is a kind of obstacle to the introduction of various environmental programs, e.g. related to the replacement of coal-fired furnaces with gas-fired furnaces for individual customers. In this particular case, the barrier is often the economic factor, which is associated with the reluctance to pay more for heating, even if it translates into greater comfort. Factors such as increased energy efficiency or reduced air pollutant emissions are often not taken into account.	Regional Science and Technology Park, Bełchatów and Kleszczów Industrial and Technology Park). 2.Two technology incubators (the Lodz Technology Incubator at the Lodz Regional Science and Technology Park, the Technology Incubator at the Bełchatów-Kleszczów Industrial and Technology Park). - At the end of 2015, there were 73643 companies operating in the sectors with a large potential to create green jobs in Lodzkie Region. They constituted 30% of all economic entities registered in the voivodship. - The implementation of measures from the ROP LEADER can contribute to : 1) Share of electricity production from renewable sources in total electricity production (2.6% in 2013 to 4.7% in 2023). 2) Sales of heat for municipal and household purposes (16 443 292 GJ in 2013 to 13 802 618 GJ in 2023). 3) Average annual concentration of PM10 in agglomerations and cities of the voivodship (42.06 μ/m³ in 2012	

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
north of the voivodeship. - The educational and research potential is a strong point of the Lodzkie Voivodeship. Lodz is an educational centre with dynamically operating universities: The University of Lodz, Technical University of Lodz. - Poland has legislation to promote the transition from coal-based energy to clean energy, such as : Clean Air, Energy Policy of Poland until 2030. - Clean Air is a comprehensive program that aims to reduce or avoid emissions of dust and other pollutants into the atmosphere from single-family homes. The program focuses on the replacement of old furnaces and boilers with solid fuel and the thermal upgrading of detached houses to efficiently manage energy. - The Provincial Fund for Environmental Protection and Water Management in Lodz supports projects in the field of		to 27.6 μ/m³ in 2023)	

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
water protection and water management, air protection, land protection, nature protection, environmental education and monitoring, prevention and elimination of extraordinary environmental threats. - Projects implemented under the Regional Operational Program for the Lodzkie Region for 2014-2020 directly contribute to the reduction of emissions of the economy, improvement of air quality, improvement of the state of the environment in cities and rural areas, which will affect sustainable development: support for - a more resource-efficient, more environmentally friendly and more competitive economy, which is the essence of the Europe 2020 Strategy.			

5.1.7 Romania – South-West Oltenia region

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
- the largest energy producer in Romania with reused energy resources; - close to Motru - Jiu Valley mining areas, there are two of the largest thermal power plants in Romania: Rovinari and Turceni; - the region is rich in mineral resources; - the region has important mineral resources mainly coal and oil (Gorj County, Valcea County); - the major electricity producers are on the territory of the region; - the economy of Gorj County has as promoter the mining and coal-mining industries. These two industries occupy the largest part of the population occupied in industry and mostly contribute to the achievement of the county's GDP; - the existence of a concessional exploitable reserve of over 100 million tons, concentrated in a single deposit with a degree of insurance of about 60 years; - existing infrastructure, both as	- the Oltenia Region includes several mono-industrial areas located mainly in Gorj County, such as Motru and Rovinari mining basins; - environmental problems affecting water, air, soil and subsoil; - insufficient investments for soil rehabilitation in mining areas have led to the existence of extensive degraded surfaces; - poor development of the industry with high added value (Re-industrialization Strategy); - insufficient green spaces in the cities of the region; - the industry is still based on large industrial units with obsolete and energy-intensive technology; - low sector contribution to region GDP; - dependence on the declining mining industry, with its social consequences, is evidenced by the existence on the territory of Gorj County of 3 disadvantaged areas, created in the main coal	- developing the service sector will provide opportunities for new jobs; - EU allocates substantial funds through operational programs; - availability of workforce for re-training and skills development; - maintaining a mining infrastructure appropriate to domestic demand so as to ensure continuity of production over a long period of time and security of supply of energy resources; - the possibility of implementing modern methane capture technologies from coal and methane emissions from the exploited fields; - degassing coal.	- increasing the unemployment rate following the privatization of large enterprises and industrial restructuring; - the problems accumulated in the coal mining industry are still hard to solve; - the continuous decrease of the amount of energy produced by the combustion of coal (the high price of this type of energy, the contraction of the country's necessity due to the change of the technological profile, towards the technologies with low energy consumption, the increase of the share of the production of energy from renewable sources and from nuclear sources) will create important problems in the economic and social structure of the county; - increased production costs, generated by compliance with environmental protection and health and safety conditions; - high social vulnerability due to the mono-industrial character of

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
surface facilities and as main opening mines, long-term use for the actual extraction and for transport to the beneficiaries by rail; - territorial concentration of mining in a relatively small area; - the existence of qualified personnel in mining, tradition and professional expertise; - contributing to national energy security in crisis situations compared to other resources; - relatively reduced distance from beneficiaries; - have environmental permits and exploitation licenses.	exploitation areas, where the restructuring process generated the most important social problems: the Motru- Rovinari, Albeni area and Schela area; - difficult geological - mining conditions (depth, tectonic, stratigraphy, variability); - high exploitation hazards due to the high methane content of the reservoir, with predisposition to self-ignition and explosions; - low calorific value compared to international supply; - degree of mechanization of reduced exploitation, physically and morally used equipment; - difficulties in the selective exploitation of coal; - reduced possibilities of significantly improving the quality of production with the current technology of exploitation; - reduced competition in coal extraction; - high production cost.		the area; - the dependence of coal production on the operation of a limited number of production capacities 25 energy; - affecting environmental and climate change requirements.

5.1.8 Slovenia – Savinjska region

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
- Savinjska region is one of the largest energy pools in Slovenia. - The region has a very good geographical and very strategic position quite centrally in Slovenia with important road and railway connections to other cities inside and outside the country. - Savinjska region has a very developed district heating system with the second longest district system in the country (Velenje, together with Šoštanj, 176.5 kilometres of a warm-water system) - One of only two large cooling distribution system in the country is in the Savinjska region (Velenje). - Country's only municipal waste incinerator, where the heat is produced from biodegradable waste is situated in Savinjska region (Municipality of Celje) - Establishment of five subregions in order to improve development efficiency of the region as whole. - Unemployment rate is at lowest	- Limitations to the exploitation of some types of renewable energy sources such as landscape conditions, difficulties with obtaining all necessary legal permissions or lack of funds. - Local economy's high dependence on the lignite industry activities. - Velenje lignite mine with its 140-year tradition plays an important role in the coal industry of the region, therefore phasing out coal in Slovenia and Savinjska region can affect direct as well as indirect workplaces in the mining industry. - Unemployment rate was above the country's average in the past years. - Brain drain of high-skilled workers due to low wages and a lack of modern organization and management practices in Slovenian workplaces - R&D expenditure per inhabitant is far below EU-28 average. - Country's innovation funding and outcomes in the business sector	- Savinjska region with the biggest thermal power plant in the country can keep its generating capacities and remain one of the largest energy pools in Slovenia by long-term reliable, safe, competitive and environmentally friendly generation of electric and heat energy by using various primary sources. - Increasing effort on the exploitation of renewable energy sources (primarily wood biomass and solar energy). - Development of new innovative energy services. - Investment in facilities that would allow the possibility of using municipal waste as a partial energy source in other cities beside Celje. - Possibility to reuse of out of operation coal mining industry installations after the lignite mine closure. - Redesigning post-mining landscapes in the future. - Transformation of the Velenje lake area (3 artificial lakes	- The issue of phasing out coal in Slovenia is controversial in the sense that feasible alternatives that could realistically substitute the energy source without having a profound impact on the economy and moreover an economically viable energy supply to households and industry. - The risks of higher energy import dependence due to phasing out coal. - Loss of workplaces directly or indirectly linked to the coal value chains that would primarily have consequences on local level. - Degradation of land due to coal mining and a lack of efforts for a restoration planning in the Municipality of Velenje. - Ageing of the population, which could worsen the demographic trend and put additional strains on the public budget. - The continuation of the brain drain whereby highly educated and skilled population would be replaced poorly educated,

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
level in the past ten years (9.1% in 2018) - The workforce in Slovenia and in Savinjska region that is generally highly skilled and educated. Education in the country is of very high quality compared against international metrics and greatly accessible to practically all citizens, even at tertiary level. - Well-developed centralized secondary education network with a very wide range of technical specific programs, preparing students for specific occupations before for entering to the labour market or enrolling for tertiary education. - Operation on one of dislocated units of Faculty of Energy Technology (University of Maribor) in Velenje. - Attractive tourist location with rich cultural heritage and dynamic green landscape (lakes, rivers, mountains, hills, valleys). - Diverse tourist offer with a great number of natural thermal spas and health resorts, biking trails, hiking spots, tourist farms any	are concentrated in a small number of large firms, with SMEs and the services sector lagging far behind. - Lack of overarching framework defining restructuring support instruments for coal-fired energy producers neither on the regional or national level.	created as a side effect of lignite excavation) presents a great opportunity for the further renovation of Velenje beach that could lead to additional tourist offer and increase a tourism demand in the city and the region. - Ambition of Municipality of Velenje to become a hydrogen valley (development of a replicable, balanced and integrated hydrogen economy by facilitating investment into market-ready hydrogen technologies). - The construction of Third Development Axis that will establish a traffic connection from the north to the southeastern part of Slovenia (from Austrian to the Croatian border) and highly improve connection of Savinjska region with other regions. Its construction will put Velenje on a very strategical location between the Koroška region and the main national motorway connecting east to west.	unskilled workforce.

STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
many other.		- Providing attractive employment opportunities in order to reduce the brain drain of graduates and highly-skilled workforce (Slovenia and Savinjska region) - Boosting the investments that would increase the share of renewable energy sources in the final energy consumption (Slovenia and Savinjska region).	

5.1.9 Spain – Extremadura region

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
- Very good potential of solar, biomass and hydro energy. Good natural resources and low consumption due to few inhabitants in the region (rural). - Several companies specialized in renewable technologies at regional and national level. Strong energy cluster and SMEs in the sector. - Good percentage of renewable energies in the energy mix. - No coal production in the region.	- High rate of unemployment in the region. - Difficulties to implement district heating, due to lack of awareness/tradition and few hours of heating needed. - Low potential and know-how in geothermal energy.	- Good skills for the construction of new plants. - Local “know-how” and high potential for implementation and development of renewable technologies. - Possibilities of EU funded projects. - Studies are analyzing the possibility of increasing the RES production to close the nuclear power plant that exists in Extremadura.	- There are no threats in the region related to the coal-based energy production, as there is no such production in Extremadura.

6 List of tables

Table 1 Coal-intensive regions investigated in the SWOT study. 15
Table 2 Annual coal consumption with the breakdown of coal source for Yugoiztochen region according to general source [3.] (GWh/annum), 2016. 20
Table 3 Total and coal-based production of heat and electricity in Yugoiztochen region according to general source [3.][2.], (GWh/annum), 2016. 21
Table 4 Coal consumption and coal-based energy production per 1000 of population in Yugoiztochen region according to general source [3.], 2016....................................... 21
Table 5 Annual coal consumption with the breakdown of coal source for Nordjylland region according to general source [3.] and specific information [4.], (GWh/annum), 2016. 23
Table 6 Total and coal-based production of heat and electricity in Nordjylland region according to general source [3.] and specific information [4.], (GWh/annum), 2016... 24
Table 7 Coal consumption and coal-based energy production per 1000 of population in Nordjylland region according to general source [3.] and specific information [4.], 2016. 24
Table 8 Annual coal consumption with the breakdown of coal source for Lausitz-Spreewald region according to specific source[23.], (GWh/annum), 2016. 27
Table 9 Total and coal-based production of heat and electricity in Lausitz-Spreewald region according to general source [3.][2.] and electricity demand based on local data[23.], (GWh/annum), 2016. 27
Table 10 Coal consumption and coal-based energy production per 1000 of population in Lausitz-Spreewald region according to general source [3.] and local data[23.], 2016. 28
Table 11 Annual coal consumption with the breakdown of coal source for Western Macedonia region according to general source [3.] and specific information [29.], (GWh/annum), 2016.. 31
Table 12 Total and coal-based production of heat and electricity in Western Macedonia region according to general source [3.] and specific information[30.], (GWh/annum), 2016. 32
Table 13 Coal consumption and coal-based energy production per 1000 of population in Western Macedonia region according to general source [3.] and specific information [30.], 2016.. 32
Table 14 Annual coal consumption with the breakdown of coal source for Észak-Alföld region according to general source [3.] (GWh/annum), 2016. 34
Table 15 Total and coal-based production of heat and electricity in Észak-Alföld region according to general source [3.][2.], (GWh/annum), 2016. 35
Table 16 Coal consumption and coal-based energy production per 1000 of population in Észak-Alföld region according to general source [3.], 2016. 35
Table 17 Annual coal consumption with the breakdown of coal source for Lodzkie region according to general source [3.] (GWh/annum), 2016. 37

Table 18 Total and coal-based production of heat and electricity in Lodzkie region according to general source [3.][2.], 2016. 38
Table 19 Coal consumption and coal-based energy production per 1000 of population in Lodzkie region according to general source [3.], 2016. 38
Table 20 Annual coal consumption with the breakdown of coal source for South-West Oltenia region according to specific source [39.][3.], (GWh/annum), 2017. 41
Table 21 Total and coal-based production of heat and electricity in South-West Oltenia region according to specific source [39.], (GWh/annum), 2017. 41
Table 22 Coal consumption and coal-based energy production per 1000 of population in South-West Oltenia region according to specific source [39.][3.], 2017. 42
Table 23 Annual coal consumption with the breakdown of coal source for Slovenia and Savinjska region according to general source [3.] and specific information (GWh/annum), 2016. 46
Table 24 Total and coal-based production of heat and electricity in Slovenia and Savinjska region according to general source [3.] and specific information [42.], (GWh/annum), 2016. 47
Table 25 Coal consumption and coal-based energy production per 1000 of population in Savinjska region according to general source [3.] and specific information [42.], 2016. 47
Table 26 Annual coal consumption with the breakdown of coal source Extremadura region according to general source [3.] (GWh/annum), 2016. 49
Table 27 Total and coal-based production of heat and electricity in Extremadura region according to general source [3.][2.], (GWh/annum), 2016. 50
Table 28 Coal consumption and coal-based energy production per 1000 of population in Extremadura region according to general source [3.], 2016. 50
Table 29 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Yugoiztochen region (GWh) according to general source [3.] (GWh/annum), 2016. 51
Table 30 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the Yugoiztochen region (GWh) according to general source [3.] (GWh/annum), 2016. 52
Table 31 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Nordjylland region (GWh) according to general source [3.] and specific information [4.] (GWh/annum), 2016. 55
Table 32 Electricity production using RES and its proportion per 1000 of population compared to total electricity demand in the Nordjylland region according to general source [3.] and specific information [4.] (GWh/annum), 2016. 57
Table 33 Wind power potential in Nordjylland region. [2.], (m/s). 59
Table 34 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Lausitz-Spreewald region (GWh) according to specific information [16.], (GWh/annum), 2015/2016. 61
Table 35 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the Lausitz-Spreewald region (GWh) according specific information [16.], (GWh/annum), 2015/2016. 62
Table 36 Wind power potential in Lausitz-Spreewald region [2.], (m/s). 65

Table 37 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Western Macedonia region (GWh) according to general source [31.][3.], (GWh/annum), 2016. 67
Table 38 Electricity production using RES and its proportion per 1000 of population compared to total electricity demand in the Western Macedonia region according to general source [3.] and specific information [26.],[33.] (GWh/annum), 2016. 68
Table 39 Wind power potential in Western Macedonia region, [2.], (m/s). 70
Table 40 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Észak-Alföld region (GWh) according to general source [3.] (GWh/annum), 2016. 71
Table 41 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the Észak-Alföld region (GWh) according to general source [3.] (GWh/annum), 2016. 72
Table 42 Wind power potential in Észak-Alföld region. [2.], (m/s). 74
Table 43 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Lodzkie region (GWh) according to general source [3.] (GWh/annum), 2016. 76
Table 44 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the Lodzkie region (GWh) according to general source [3.] (GWh/annum), 2016. 77
Table 45. Wind potential at 50 meters for Lodzkie Region 2016. 79
Table 46 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the South-West Oltenia region (GWh) according to general source [3.] (GWh/annum), 2016. 82
Table 47 Proportion of RES electricity production per 1000 of population according to specific information, [55.], (GWh/annum). 86
Table 48 Heat production using RES and its proportion per 1000 of population compared to total heat demand in the Savinjska region (GWh) according to general source [41.], (GWh/annum), 2018. 88
Table 49 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the Slovenia according to specific source, [44.], GWh/annum), 2018. 90
Table 50 Wind power potential in Savinjska region, [2.]. 96
Table 51 Electricity production using RES and its proportion per 1000 of population compared to total heat demand in the Extremadura region (GWh) according to general source [3.] (GWh/annum), 2016. 99
Table 52 Wind power potential in Extremadura region. [2.], (m/s). 101
Table 53 DH heat supply volumes and their proportion per 1000 of population in Yugoiztochen region on general source, [6.], (GWh/annum), 2016. 102
Table 54 DH heat supply volumes and their proportion per 1000 of population in Nordjylland region based on general source, 2013 [6.] and specific information, [4.] (GWh/annum), 2016. 104
Table 55 DH heat supply volumes and their proportion per 1000 of population in Lausitz-Spreewald region based on specific information, [14.], (GWh/annum), 2016.106

Table 56 DH heat supply volumes and their proportion per 1000 of population in Western Macedonia region based on general source, [6.], (GWh/annum), 2013 and specific information, [26.],[28.], (GWh/annum),2016. ... 109
Table 57 DH heat supply volumes and their proportion per 1000 of population in Észak-Alföld region based on general source, [6.], (GWh/annum), 2016. ... 110
Table 58 DH heat supply volumes and their proportion per 1000 of population in Lodzkie region based on general source, [6.], (GWh/annum), 2016. ... 111
Table 59 Information regarding DH heat system in Romania based on general source, [6.], 2016. ... 113
Table 60 DH heat supply volumes and their proportion per 1000 of population in Slovenia and Savinjska region based on general [4.] and specific information, [44.], (GWh/annum). ... 115
Table 61 Heat supply potential via DH based on different minimum heat demand and supply requirements in Extremadura region, [2.], (%). ... 118
Table 62 Number of direct work positions related to coal industry and its share per 1000 of population in Yugoiztochen region [8.]. ... 119
Table 63 Number of indirect work positions related to coal industry and its share per 1000 of population in Yugoiztochen region [8.]. ... 120
Table 64 Number of direct work positions related to coal industry and its share per 1000 of population in Nordjylland region [8.]. ... 122
Table 65 Number of indirect work positions related to coal industry and its share per 1000 of population in Nordjylland region [8.]. ... 123
Table 66 Number of direct work positions related to coal industry and its share per 1000 of population in Lausitz-Spreewald region [8.]. ... 126
Table 67 Number of direct work positions related to coal industry and its share per 1000 of population in Western Macedonia region [8.]. ... 130
Table 68 Number of indirect work positions related to coal industry and its share per 1000 of population in Western Macedonia region. [8.] ... 130
Table 69 Number of direct work positions related to coal industry and its share per 1000 of population in Észak-Alföld region [8.]. ... 133
Table 70 Number of indirect work positions related to coal industry and its share per 1000 of population in Yugoiztochen region [8.]. ... 133
Table 71. Number of direct work positions related to coal industry and its share per 1000 of population in Poland, [8.]. ... 135
Table 72. Indirect workplaces related to coal activities in Poland, [8.]. ... 135
Table 73 Number of direct work positions related to coal industry and its share per 1000 of population in South-West Oltenia region [8.]. ... 136
Table 74 Number of indirect work positions related to coal industry and its share per 1000 of population in South-West Oltenia region [8.]. ... 137
Table 75 Structure of population occupied by sectors of activity in South-West Oltenia region. ... 138
Table 76 Average number of employees by sectors of activity in South-West Oltenia region [8.]. ... 138
Table 77 Number of direct work positions related to coal industry and its share per 1000 of population in Savinjska region, [52.], [53.]. ... 141

Table 78 Number of indirect work positions related to coal industry and its share per 1000 of population in Vzhodna Slovenija region, [8.]. 142
Table 79 Employment overview by sector compared with the total number of employees in v region based on the general data, [1.], and the local information, 2017. 145
Table 80 Employment overview by sector compared with the total number of employees in Nordjylland region based on the general data, [1.], 2017 and the local information, [9.], 2016. 147
Table 81 Employment overview by sector compared with the total number of employees in Lausitz-Spreewald region based on the general data, [1.], 2017. 148
Table 82 Employment overview by sector compared with the total number of employees in Western Macedonia region based on the general data, [1.], 2017 150
Table 83 Employment overview by sector compared with the total number of employees in Lodzkie region based on the general data, [1.], 2017. 152
Table 84 Employment overview by sector compared with the total number of employees in South-West Oltenia region based on the general data, [1.], 2017........ 154
Table 85 Employment overview by sector compared with the total number of employees in Slovenia and Savinjska region based on the local information, [42.], 2016. [42.].. 156
Table 86 Employment overview by sector compared with the total number of employees in Extremadura region based on the general data, [1.], 2017.................. 157
Table 87 Number of students enrolled in tertiary education by level in Yugoiztochen based on the general data, [1.], 2017. 158
Table 88 Number of employees working actively in the R&D activities among all the staff in Yugoiztochen. 159
Table 89 Number of students enrolled in tertiary education by level in Nordjylland based on the general data, 2017 [1.] and the local information, [10.], 2017............. 160
Table 90 Number of employees working actively in the R&D activities among all the staff in Nordjylland. 161
Table 91 Number of students enrolled in tertiary education by level in Lausitz-Spreewald based on the general data, [1.], 2017. 163
Table 92 Number of employees working actively in the R&D activities among all the staff in Lausitz-Spreewald.. 164
Table 93 Number of students enrolled in tertiary education by level in Western Macedonia based on the general data, 2017 [1.] 165
Table 94 Number of students enrolled in tertiary education by level in Lodzkie based on the general data, [1.], 2017.. 168
Table 95 Number of employees working actively in the R&D activities among all the staff in Lodzkie.. 168
Table 96 Number of students enrolled in tertiary education by level in South-West Oltenia based on the general data, [1.], 2017... 173
Table 97 Number of students enrolled in tertiary education by level in Savinjska region based on the local information,[42.], 2017... 174
Table 98: Students' enrolment to specific programs offered by University of Ljubljana and University of Maribor,[54.] , 2019... 176

Table 99 Number of employees working actively in the R&D activities among all the staff in Savinjska region, [42.], 2017. 176
Table 100 Number of students enrolled in tertiary education by level in Extremadura based on the general data, [1.], 2017. 177
Table 101 Number of employees working actively in the R&D activities among all the staff in Extremadura. 177
Table 102 Number of R&D personnel and researchers by sector among all the R&D staff in Yugoiztochen, [1.]. 178
Table 103 Number of R&D personnel and researchers by sector among all the R&D staff in Nordjylland, [1.]. 179
Table 104 Number of R&D personnel and researchers by sector among all the R&D staff in Lausitz-Spreewald, [1.]. 181
Table 105 Number of R&D personnel and researchers by sector among all the R&D staff in Lodzkie, [1.]. 186
Table 106 Number of R&D personnel and researchers by sector among all the R&D staff in Romania.[1.] 187
Table 107 Number of R&D personnel and researchers by sector among all the R&D staff in Slovenia, [42.]. 188
Table 108 Number of R&D personnel and researchers by sector among all the R&D staff in Extremadura, [1.]. 191

7 List of figures

Figure 1 Comparison of coal-fueled energy production (left vertical axis) and total coal consumption (right vertical axis) among the regions, (GWh/1000 of population).......... 5
Figure 2 Comparison of heat production using renewable energy among the regions, (GWh/1000 of population). 6
Figure 3 Comparison of electricity production using renewable energy among the regions, (GWh/1000 of population). 7
Figure 4 Comparison of work positions in the coal industry among the regions, (GWh/1000 of population). 7
Figure 5 Location of the Yugoiztochen region on the map.[25.].................................. 18
Figure 6 Primary Energy Production and Gross Domestic Energy Consumption, 1000 Toe based on general data. 19
Figure 7 Primary Energy Production Structure (2015) based on general data. 19
Figure 8 Structure of final energy consumption (2015). 20
Figure 9 Annual energy demand in Yugoiztochen region indicated by general source [2.], [3.] (GWh/annum), 2016.. 20
Figure 10 Proportion of energy generated using coal fuel in Yugoiztochen region according to general source [3.][2.], (%), 2016. 21
Figure 11 Location of the Nordjylland region on the map.[25.]................................... 22
Figure 12 Annual energy demand in Nordjylland region indicated by general source [2.], [3.] and specific information [4.] (GWh/annum), 2016. 22
Figure 13 Proportion of energy generated using coal fuel in Nordjylland region according to general source [2.], [3.] and specific information [4.] (%), 2016. 23
Figure 14 Location of the coal-intensive state, Lausitz-Spreewald in Brandenburg region (NUTS2), [15.]. 25
Figure 15 Annual heat and cooling demand in Lausitz-Spreewald region indicated by general source [2.] and electricity demand based on local data [14.] (GWh/annum), 2016. 26
Figure 16 Proportion of heat generated using coal fuel in Lausitz-Spreewald region according to general source [3.][2.] and electricity demand based on local data[23.], (%), 2016. 27
Figure 17 Location of the coal-intensive state, Western Macedonia region (NUTS2), [15.]... 29
Figure 18 Proportion of energy generated using coal fuel in Western Macedonia region according to general source [2.], [3.] and specific information [30.][4.] (%), 2016. 31
Figure 19 Location of the Észak-Alföld region on the map.[25.].................................. 33
Figure 20 Annual heat and cooling demand in Észak-Alföld region indicated by general source (GWh/annum), 2016. 34
Figure 21 Proportion of energy generated using coal fuel in Észak-Alföld region according to general source [3.][2.], (%), 2016. 34
Figure 22 Location of the Lodzkie region on the map.[25.] 36
Figure 23 Annual energy demand in Lodzkie region indicated by general source [2.], [3.] (GWh/annum), 2016.. 37

Figure 24 Proportion of energy generated using coal fuel in Lodzkie region according to general source [3.][2.], (%), 2016. 38
Figure 25 Location of the South-West Oltenia region on the map.[25.] 39
Figure 26 Primary energy resources local data[38.], (%), 2017. 40
Figure 27 Annual energy demand in South-West Oltenia region indicated by general source [2.], [3.] (GWh/annum), 2016. 40
Figure 28 Proportion of energy generated using coal fuel in South-West Oltenia region according to specific source [39.][3.], (%), 2017. 41
Figure 29 Location of the Savinjska region on the map.[25.] 44
Figure 30 Annual energy demand in Slovenia and Savinjska region indicated by general source [2.], [3.] (GWh/annum), 2016. 45
Figure 31 Proportion of energy generated using coal fuel in Slovenia and Savinjska region according to general source [2.], [3.] and specific information [43.] (%), 2016. 46
Figure 32 Location of the Extremadura region on the map.[25.] 48
Figure 33 Annual energy demand in Extremadura region indicated by general source [2.], [3.] (GWh/annum), 2016. 49
Figure 34 Proportion of energy generated using coal fuel in Extremadura region according to general source [3.][2.], (%), 2016. 50
Figure 35 Heat production using renewable energy sources in Yugoiztochen region according to general source [3.], (%), 2016, ... 51
Figure 36 Electricity production using renewable energy sources the Yugoiztochen region (GWh) according to general source [3.] (GWh/annum), 2016. 52
Figure 37 Heat production potential from renewable energy sources in proportion to the total heat demand in Yugoiztochen region according to general source [2.] (%), 2016. 53
Figure 38 Heat production using renewable energy sources in Nordjylland region according to general source [3.] (top chart) and specific information [4.] (bottom chart), (%), 2016. 54
Figure 39 Electricity production using renewable energy sources in Nordjylland region according to general source [3.] (top chart) and specific information [4.] (bottom chart) 2016, (%). 56
Figure 40 Heat production potential from renewable energy sources in proportion to the total heat demand in Nordjylland region according to general source [2.] and specific information [4.] (%), 2016. 57
Figure 41 Geothermal energy potential in Nordjylland region. [11.] 58
Figure 42 Excess heat potential in Nordjylland region. [12.] 58
Figure 43 Heat production using renewable energy sources in Lausitz-Spreewald region according to specific information 250[16.], (%), 2015/2016. 60
Figure 44 Electricity production using renewable energy sources the Lausitz-Spreewald region (GWh) according to specific information [16.], (GWh/annum), 2015/2016. 61
Figure 45 Heat production potential from renewable energy sources in proportion to the total heat demand in Lausitz-Spreewald region according to general source [2.] (%), 2016. 63
Figure 46 Geothermal energy potential in Lausitz-Spreewald region [11.]. 64
Figure 47 Excess heat potential in Lausitz-Spreewald region [12.]. 64

Figure 48 Heat production using renewable energy sources in Western Macedonia region according to general source [31.][3.], (%), 2016. 66
Figure 49 Electricity production using renewable energy sources in Western Macedonia region according to general source [3.] (top chart) and specific information [26.],[33.] (bottom chart) (%), 2016. 67
Figure 50 Heat production potential from renewable energy sources in proportion to the total heat demand in Western Macedonia region according to general source [2.] and specific information [4.] (%), 2016. 69
Figure 51 Excess heat potential in Western Macedonia region, [12.]. 70
Figure 52 Wind potential in Western Macedonia region, [5.], (W/m^2). 70
Figure 53 Heat production using renewable energy sources in Észak-Alföld region according to general source [3.], (%), 2016, ... 71
Figure 54 Electricity production using renewable energy sources the Észak-Alföld region (GWh) according to general source [3.] (GWh/annum), 2016. 72
Figure 55 Heat production potential from renewable energy sources in proportion to the total heat demand in Észak-Alföld region according to general source [2.] (%), 2016. 73
Figure 56 Excess heat potential in Észak-Alföld region. [12.] 73
Figure 57 Heat production using renewable energy sources in Lodzkie region according to general source [3.], (%), 2016, ... 75
Figure 58 Electricity production using renewable energy sources the Lodzkie region (GWh) according to general source [3.] (GWh/annum), 2016. 76
Figure 59 Heat production potential from renewable energy sources in proportion to the total heat demand in Lodzkie region according to general source [2.] (%), 2016. .. 77
Figure 60. Geothermal energy potential in Lodzkie region 78
Figure 61. Wind potential in Lodzkie Region (W/m2) 78
Figure 62 Romania's potential for green energy production and the percentage distribution of estimated renewable energies, (%), 2017, ... 80
Figure 63 Romania's potential for green energy production and the percentage distribution of estimated renewable energies, (%), 2017, ... 81
Figure 64 Electricity production using renewable energy sources in the South-West Oltenia region (GWh) according to general source [3.] (GWh/annum), 2016. 81
Figure 65 Proportions of potential RES in Romania according to local source, [55.], (MJ/m^2). 82
Figure 66 Solar energy potential map in the South-West Oltenia region according to local source, [55.], (kWh/m^2/annum) 83
Figure 67 Wind energy speed at 50m in Romania according to local source, [55.], (m/s). 84
Figure 68 Solar radiation map in Romania according to local source, [55.], (MJ/m^2). .. 85
Figure 69 Biomass potential map in Romania according to local source, [55.], (MJ/m^2). 86
Figure 70 Heat production using renewable energy sources in Slovenia according to specific information, [41.], (%), 2018. 87
Figure 71 Shares of primary electricity sources, [44.], in the period 2013–2017. 88

Figure 72 Electricity production using renewable energy sources in Slovenia according to specific information, [44.], (%), 2018. 89
Figure 73 Heat production potential from renewable energy sources in proportion to the total heat demand in Savinjska region according to general source [2.] (%), 2016. 91
Figure 74 Global annual irradiation on horizontal surface in Slovenia, [45.]. 91
Figure 75 Forest cover in Slovenia, [46.], [%]. 92
Figure 76 Estimated free wood potential for the SaŠa region [47.], 2010. 92
Figure 77 Estimated free WB potential for the SaŠa region, [47.], 2010. 93
Figure 78 Geothermal energy potential in Savinjska region, [11.]. 93
Figure 79 Temperature distribution at 1000 m, [46.]. 94
Figure 80 Excess heat potential in Savinjska region, [12.]. 95
Figure 81 Excess heat potential in Savinjska region, [49.]. 95
Figure 82 Mean annual wind speed at 50 meters, [50.]. 96
Figure 83 Electricity production using renewable energy sources the Extremadura region (GWh) according to general source [3.] (GWh/annum), 2016. 98
Figure 84 Heat production potential from renewable energy sources in proportion to the total heat demand in Extremadura region according to general source [2.] (%), 2016. 99
Figure 85 Geothermal energy potential in Extremadura region [11.]. 100
Figure 86 Excess heat potential in Extremadura region [12.]. 100
Figure 87 Waste energy potential in Extremadura region[12.]. 101
Figure 88. Wind potential in Extremadura region, [5.], (W/m^2). 101
Figure 89 District heating supply to final customer in proportion to the total heat demand in Yugoiztochen region based on general source, [6.], (%), 2013. 102
Figure 90 District heating supply to final customer in proportion to the total heat demand in Nordjylland region based on general source, 2013 [6.] and specific information, [4.] (%), 2016. 103
Figure 91 District heating plants by annual output in Nordjylland region based on the local data [7.], (GWh). 104
Figure 92 Heat supply potential via DH based on different minimum heat demand and supply requirements in Nordjylland region, [2.], (%). 105
Figure 93 District heating supply to final customer in proportion to the total heat demand in Lausitz-Spreewald region based on local data, [14.], (%), 2016. 106
Figure 94 Heat supply potential via DH based on different minimum heat demand and supply requirements in Lausitz-Spreewald region, [2.], (%). 107
Figure 95 District heating supply to final customer in proportion to the total heat demand in Western Macedonia region based on general source, [6.], (%), 2013 and specific information, [26.],[28.], (%),2016. 108
Figure 96 Heat supply potential via DH based on different minimum heat demand and supply requirements in Western Macedonia region, [2.], (%). 109
Figure 97 District heating supply to final customer in proportion to the total heat demand in Észak-Alföld region based on general source, [6.], (%), 2013. 110
Figure 98 District heating supply to final customer in proportion to the total heat demand in Lodzkie region based on general source, [6.], (%), 2013. 111

Figure 99. Heat supply potential via DH based on different minimum heat demand and supply requirements in Lodzkie Region, [2.], (%). 112
Figure 100 District heating supply to final customer in particular counties in South-West Oltenia region based on local source,[56.], (%), 2011/2012. 114
Figure 101 District heating supply to final customer in proportion to the total heat demand in Savinjska region based on general [4.] and specific information, [44.][44.], (%). 115
Figure 102 Heat distribution systems in Slovenia in 2017 based on the local data, [44.], (GWh) 116
Figure 103 Heat supply potential via DH based on different minimum heat demand and supply requirements in Savinjska region, [2.], (%). 117
Figure 104 Overview of number of workplaces related to the coal mining by country (Yugoiztochen region is highlighted in circle) [8.]. 119
Figure 105 Overview of number of workplaces related to the coal-fired power plants by country (Yugoiztochen region is highlighted in circle) [8.]. 120
Figure 106 Overview of number of workplaces related to the coal mining by country (Denmark is highlighted in circle) [8.]. 121
Figure 107 Overview of number of workplaces related to the coal-fired power plants by country (Denmark is highlighted in circle) [8.]. 122
Figure 108 Overview of number of workplaces related to the coal mining by country (Brandenburg region is highlighted in circle, with the Coal areas located in the Lausitz-Spreewald state) [8.]. 124
Figure 109 Mining areas [17.]. 125
Figure 110 Overview of number of workplaces related to the coal-fired power plants by country (Brandenburg region is highlighted in circle, with the Coal areas located in the Lausitz-Spreewald state) [8.]. 126
Figure 111 Mining areas and significance in Greece, [35.]. 128
Figure 112 Overview of number of workplaces related to the coal mining by country (Western Macedonia region is highlighted in circle) [8.]. 128
Figure 113 Overview of number of lignite mines and power plants in Western Macedona, [35.]. 129
Figure 114: Evolution of lignite capacity in Western Macedonia, [35.]. 130
Figure 115 Overview of number of workplaces related to the coal-fired power plants by country (Western Macedonia region is highlighted in circle) [8.]. 131
Figure 116 Overview of number of workplaces related to the coal mining by country (Észak-Alföld region is highlighted in circle) [8.]. 132
Figure 117 Overview of number of workplaces related to the coal-fired power plants by country (Észak-Alföld region is highlighted in circle) [8.]. 133
Figure 118 Overview of number of workplaces related to the coal mining by country (Lodzkie region is highlighted in circle) [8.]. 134
Figure 119 Overview of number of workplaces related to the coal-fired power plants by country (Lodzkie egion is highlighted in circle) [8.]. 135
Figure 120 Overview of number of workplaces related to the coal mining by country in South-West Oltenia region is highlighted in circle) [8.]. 136

Figure 121 Overview of number of workplaces related to the coal-fired power plants by country (South-West Oltenia region is highlighted in circle) [8.]. 137
Figure 122 Overview of employment within coal-fired power plants in the South-West Oltenia region, [8.]. 138
Figure 123 Location of operation coal mines in EU (Slovenia is highlighted in red circle), [8.]. 139
Figure 124 Overview of companies within the company Holding Slovenske elektrarne (Savinjska regija is highlighted in circle), [51.].[8.] 141
Figure 125 Overview of number of workplaces related to the coal mining by country (Extremadura region is highlighted in circle) [8.]. 143
Figure 126 Overview of number of workplaces related to the coal-fired power plants by country (Extremadura region is highlighted in circle) [8.]. 144
Figure 127 General employment pattern in Yugoiztochen region based on the general data, [1.], 2017. 145
Figure 128 General employment pattern in Nordjylland region based on the general data (top graph), 2017 [1.] and the local information (bottom graph), 2016. [9.] 146
Figure 129 General employment pattern in Lausitz-Spreewald region based on the general data, [1.], 2017. 148
Figure 130 General employment pattern in Western Macedonia region based on the general data, [1.], (%), 2017. 150
Figure 131 General employment pattern in Lodzkie region based on the general data, [1.], 2017. 152
Figure 132 General employment pattern in South-West Oltenia region based on the local data, [56.][1.], 2012. 153
Figure 133 General employment pattern in South-West Oltenia region based on the general data, [1.], 2017. 153
Figure 134 General employment pattern in Savinjska region based on the specific data, [42.], 2017. 155
Figure 135 General employment pattern in Extremadura region based on the general data, [1.], 2017. 157
Figure 136 Proportion of employees working actively in the R&D activities among all the staff in Yugoiztochen, [1.], 2015. 158
Figure 137 Proportion of students enrolled in technical science faculty in Nordjylland, [10.], 2017. 160
Figure 138 Proportion of people enrolled in technical programs at the vocational education in Nordjylland, [10.], 2017. 161
Figure 139 Proportion of employees working actively in the R&D activities among all the staff in Nordjylland, 2016. 161
Figure 140 Proportion of employees working actively in the R&D activities among all the staff in Lausitz-Spreewald, [1.], 2015. 163
Figure 141 Proportion of students enrolled in technical science faculty in Western Macedonia, 2017. [10.] 165
Figure 142 Proportion of employees working actively in the R&D activities among all the staff in Lodzkie, [1.], 2015. 168

Figure 143 Teaching staff by type of educational institution in South-West Oltenia region based on the local data, 2012/2013 and 2017/2018. 170
Figure 144 Graduation level of students in a tertiary education in South-West Oltenia region based on the local data, 2016/2017. 171
Figure 145 Students and graduates of the engineering and energy related faculties in South-West Oltenia region based on the local data, 2017. 171
Figure 146 School population in the particular counties in South-West Oltenia region based on the local data,[56.], 2011. 172
Figure 147 Proportion of students enrolled in tertiary education by level in Slovenia and Savinjska region, [42.], 2017. [42.] 174
Figure 148 Proportion of first-year enrollment to universities in Slovenia,[54.], 2019. 175
Figure 149 Proportion of employees working actively in the R&D activities among all the staff in Savinjska region, [42.], 2017. [42.] 176
Figure 150 Proportion of employees working actively in the R&D activities among all the staff in Extremadura, [1.], 2015. 177
Figure 151 Breakdown of R&D personnel and researches among all R&D staff in Yugoiztochen, [1.]. 178
Figure 152 Breakdown of R&D personnel and researches among all R&D staff in Nordjylland, [1.]. 179
Figure 153 Breakdown of R&D personnel and researches among all R&D staff in Lausitz-Spreewald, [1.]. 181
Figure 154 Profile of R&D personnel and researchers in Western Macedonia, [1.]. ... 184
Figure 155 Breakdown of R&D personnel and researches among all R&D staff in Lodzkie, [1.]. 186
Figure 156 Breakdown of R&D personnel and researches among all R&D staff in South-West Oltenia, [57.]. 187
Figure 157 Breakdown of R&D personnel and researches among all R&D staff in Slovenia, [42.]. 188
Figure 158 Breakdown of R&D personnel and researches among all R&D staff in Extremadura, [1.]. 191
Figure 159 Overview of country leader position towards coal intensive industry (Bulgaria is highlighted with the comment box). 192
Figure 160 Overview of country leader position towards coal intensive industry (Denmark is highlighted with the green comment box). 193
Figure 161 Overview of country leader position towards coal intensive industry (Spain is highlighted with the comment box). 205

8 References

[1.] Eurostat: https://ec.europa.eu/eurostat/data/database

[2.] HotMaps: http://www.hotmaps.hevs.ch/map

[3.] EU 28 countries energy consumption data by fuel, EU Commission, DG ENER, Unit A4, August, 2018: https://data.europa.eu/euodp/data/dataset/information-on-energy-markets-in-eu-countries-with-national-energy-profiles/resource/6f7fde05-5cdb-4c9d-a4c3-a2b078f31f2b

[4.] Energy balance Region Nordjylland 2016

[5.] Global wind atlas: https://globalwindatlas.info/

[6.] Euroheat, 2013: http://www.euroheat.org/wp-content/uploads/2016/03/2015-Country-by-country-Statistics-Overview.pdf

[7.] Grøn Energi, Danske Fjernvarme: https://northsearegion.eu/media/1531/the-danish-energy-system-case-dh.pdf

[8.] EU coal regions: opportunities and challenges ahead, 2018: https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/eu-coal-regions-opportunities-and-challenges-ahead

[9.] Danmarks Statistik, GF6: Generel firmastatistik efter region, branche (DB07, 10-grp) og enhed: http://www.statistikbanken.dk/GF6

[10.] Danmarks Statistik, UDDAKT10: Uddannelsesaktivitet efter status, køn, alder, bopælsområde, uddannelse og tid: www.statistikbanken.dk/UDDAKT10

[11.] Magyar Bányászati és Földtani Szolgálat (Mining and Geological Survey of Hungary) https://map.mbfsz.gov.hu/geo_DH/

[12.] Heat Road Map Europe: https://heatroadmap.eu/peta4/

[13.] The Danish governmental energy strategy until 2050: http://www.stm.dk/multimedia/Energistrategi_2050.pdf

[14.] Energiedatenbank Brandenburg, Energie steckbrief daten komplett summer planungsregion für Lausitz spreewald, 2016.

[15.] Die Bedeutung der Regionalen Planungsgemeinschaften für die Entwicklung des ländlichen Raumes https://www.landtag.brandenburg.de/media_fast/5701/RAG%20Lausitz.pdf, 2017.

[16.] Wirtschaftsförderung Brandenburg Energie, Ausbaustand der erneuerbaren energien (bereich wärmeerzeugung und stromerzeugung), 2015/2016.

[17.] CoalSwarm, Global Coal Plant Tracker, https://endcoal.org/tracker/ .

[18.] Agentur für Erneuerbare Energien (AEE), Beschäftigung durch den Ausbau Erneuerbarer energien 2015 in den Bundesländern, 2015.

[19.] Ministerium fur Wirtschaft und Energie, Datenblatt zur wirtschaftlichen Entwicklung im brandenburger Teil der Lausitz: Industrie (Bergbau und Verarbeitendes Gewerbe), 2017.

[20.] FRONT PHOTO: Schwarze Pumpe power station LEAG Lausitz Energie Kraftwerke AG - Kraftwerk Schwarze Pumpe.

[21.] Europe Beyond Coal – 6) Coal phaseout plans, https://beyond-coal.eu/data/ .

[22.] Bundesministerium für Wirtschaft und Energie (BMWi), Kommission „Wachstum, Strukturwandel und Beschäftigung“, 2019.

[23.] Statistik Berlin Brandenburg, Statistischer Bericht, Energie- und CO_2-Bilanz im Land Brandenburg, 2016

[24.] Regional Investment Concept Lusatia, Regionales Investitionskonzept Lausitz, RIK.

[25.] Map open source tool: https://mapchart.net/ .

[26.] RES H/C SPREAD project, http://www.res-hc-spread.eu/en_GB/countries/greece/

[27.] Western Macedonia's experiences from applying for EU cohesion funds for energy efficiency / sustainable heating & cooling, D. Giannakopoulos, A. Sidiropoulos, A. Dimitriou, European Week of Regions and Cities, 10/10/2018, Brussels

[28.] Communication with Western Macedonia DH companies

[29.] LCP database, European Environmental Agency

[30.] Published data of power plants hourly production by IPTO SA (http://www.admie.gr/) processed by CERTH/CPERI.

[31.] EUROSTAT, share of renewable energy in gross final energy consumption by the heating and cooling sector in Greece (Code: sdg_07_40)

[32.] Operator of Electricity Market – ΛΑΓΗΕ http://www.lagie.gr/

[33.] Greek RES Operator SA (http://www.dapeep.gr/)

[34.] Study entitled "Western Macedonia Region Strategy for Exploiting Biomass Focusing on District Heating”, SPECIFIC MANAGEMENT OFFICE OF THE OPERATIONAL PROGRAM OF THE REGION OF WEST MACEDONIA, 2015

[35.] Western Macedonia Coal Platform Working Group documentation

[36.] Regional Innovation Scoreboard 2017 (RIS 2017) https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/region-dytiki-makedonia

[37.] RES H/C SPREAD project: http://www.res-hc-spread.eu/en_GB/ .

[38.] Statistical Yearbook of Romania, 2017.

[39.] Resursele de energie primera, Romania, 2017.

[40.] Mapchart: https://mapchart.net/europe-nuts3.html

[41.] Energetska bilanca Republike Slovenije za leto 2017, 2018, https://www.energetika-portal.si/fileadmin/dokumenti/publikacije/energetska_bilanca/ebrs_2017.pdf

[42.] Statistical Office of the Republic of Slovenia, https://www.stat.si/StatWeb/

[43.] Šoštanj Thermal Power Plant, http://www.te-sostanj.si/si/

[44.] Report on th Energy Sector in Slovenia for 2017, June 2018, Agencija za energijo

[45.] PV portal Slovenski portal za fotovoltaiko, 2007, http://pv.fe.uni-lj.si/Welcome.aspx

[46.] Zavod za gozdove Slovenije, http://www.zgs.si/index.html

[47.] Regional analysis of RES potential and material flow Savinjska-Šalek region, 2010, Energy Agency of Savinjska, Šaleška and Koroška Region

[48.] Geološki zavod Slovenije, 2019, http://prenit.geo-zs.si/geozs/index.php/dejavnosti/geotermija

[49.] Atlas trajnostne energije, 2019, http://borzen.maps.arcgis.com/apps/webappviewer/index.html?id=9a8d05acccff4a908f66de6958c9a3bc

[50.] ARSO METEO, 2018, Environmental agency of the republic of Slovenia, http://meteo.arso.gov.si/met/sl/

[51.] Holding Slovenske elektrarne, 2019, https://www.hse.si/en/

[52.] Letno poročilo 2017, 2018, Premogovnik Velenje

[53.] Letno poročilo za leto 2017, 2018, Termoelektrarna Šoštanj

[54.] Analiza prijave in vpisa študijsko leto 2018/2019, 2019, Univerza v Ljubljani, Visokošolska prijavno-informacijska služba

[55.] Romania, ANM, ICPE, ICEMENERG.

[56.] Romania: Anuarul Statistic al României, 2012; Recensământul Populației și Locuintelor, 2011-date prelucrate

[57.] Romania, INS, 2012.