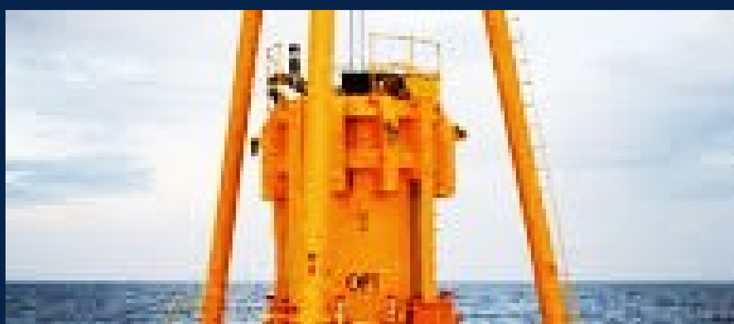
EXTREMADURA ENERGY AGENCY (AGENEX)

INPUT STUDY ON THE LARGE-SCALE INTRODUCTION OF RENEWABLES







MARCH 2019

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1 Executive Summary

This document is the first deliverable of the DeCarb Activity A3.1, which anticipates the organisation of an interregional workshop on the large-scale introduction of renewables in the energy mix. The purpose of this report is to serve as the primary source of knowledge for the capacity building and interregional learning processes of the interregional thematic workshop.

In particular, the input study will introduce the most relevant needs and challenges to be addressed for the reduction of Greenhouse Gas emissions. The latter will emerge by phasing out conventional energy sources and replacing them with renewable energy sources. The study also includes a techno-economic appraisal of renewable energies. Furthermore, several large-scale renewable projects in the EU are demonstrated in order to provide further information of best practices and examples to be followed, while an evaluation of the renewable energies development in the EU, is also included. The second part of the study focuses on the workshop topics & focal points on the most relevant issues to be discussed & addressed by participants during workshop proceedings. The study will finally specify the organisational details and provide guidelines on how to draft the workshop summary report, so as to facilitate the integration of its findings into the DeCarb action plans.

2 The DeCarb Project and Activities

2.1 The DeCarb Project

The low-carbon energy shift of EU economies will have a profound economic and social impact on regions extensively involved in coal value chains. DeCarb will support public authorities to initiate efforts, join forces and exchange experiences to: a) identify growth strategies to mitigate the impact of decarbonisation, b) make the most of EU funds & financing tools, and c) promote public dialogue on conflicting interests.

DeCarb brings together 9 partners from 9 countries, to exchange experiences & transfer knowledge on how to transition from the carbon-intensive era towards the clean energy future. It will support regions to secure sustainable development, economic & societal stability, and a major role in the 2030 energy mix.

2.2 The DeCarb Project's Operational Objectives

a) Increase the knowledge & capacities of public authorities on growth pathways beyond coal, and secure energy security & stability
b) Support the development of plans to create jobs to counteract the coal industry contraction, and analyse territorial impact to specify labour re-skilling and post mining land use needs
c) Promote public dialogue to resolve conflicts & build consensus on the clean energy transition, involving the energy sector, social partners, and the citizens
d) Raise awareness on the importance to plan ahead and implement measures for the new energy mix

2.3 The DeCarb Project's Partners

Table 1: DeCarb Partners

Country	Partner
	Stara Zagora Regional Economic Development Agency, Stara Zagora Province, Bulgaria
	Lodzkie Region, Poland
	ENEREA Eszak-Alfold Regional Energy Agency Nonprofit Ltd., Northern Great Plain, Hungary
	South-West Oltenia Regional Development Agency, South-West Oltenia Region, Romania
	Ministry for Economic Affairs and Energy, State of Brandenburg, Germany
	House of Energy, Denmark
	Regional Association of Local Governments of Western Macedonia, Western Macedonia, Greece
	Energy Agency of Savinjska, Saleska and Koroska Region, Savinjska, Saleska and Koroska Region, Slovenia
	Extremadura Energy Agency, Badajoz, Spain

3 Why renewables are important?

3.1 The Current Energy Mix and the Shift to Renewables.

Energy has a fundamental role in the modern industrial economy. Global energy demand constantly rises, however the conventional sources of energy are not endless. The rising growth of population has led to tremendously rising needs in energy consumption. Overexploitation of existing energy sources leads towards their depletion in the future and has furthermore produced significant implications to the environment. Global warming and climate change are gravely effected by the use of fossil fuels. Regarding the actual global energy mix, data show that approximately 85% of global energy consumption is found in oil, coal and gas. It is consequently well assumed that fossil fuels are also the major contributors to the world's total of greenhouse gas emissions. Nevertheless the international community is now, more than ever, highly concerned about environmental issues and the current trend is to progressively replace fossil fuels by renewable energy sources.

The EU has commenced implementing region-wide policies from the mid-nineties. A large debate and exhaustive negotiations among member states have led to considerably valuable Directives and actions that shaped the base resulting in 2009, in the RED (2009/28/EC), which set legally binding national targets contributing to an EU-wide target of 20% renewable energy in the total energy needs by 2020[1].

The breakthrough concerning renewable energy sources has been the COP21 and the Paris Agreement of 2015, where the future of Energy has been negotiated by representatives of 196 state parties on the basis of Nationally Determined Contribution (NDCs) basis.

COP21's goals focus on the reduction of production and consumption of fossil fuels regardless that in any case they will play a major role in the global energy mix. The most important measures related to energy concern the increase of renewables deployment (40% of submissions) as well as the improvement of other sources efficiency (1/3rd of submissions)[2] .

The International Energy Agency, to take the INDCs a step forward, has published several scenarios regarding the energy sector's future. The Bridge Scenario, the 450 Scenario and

[1] Renewable energy in Europe — 2018 Recent growth and knock-on effects, EEA Report No 20/2018p.12
[2] World Energy Outlook 2015 – COP21 Briefing, p. 3.

their “Combination”. According to this strategy, it is estimated, that the saving, by using variable renewables, will reach 37 Gt CO2 over the period to 2040[3]. Variable renewables, including wind and solar energy, will have an increase from 3% (actual share in global electricity) electricity to more than 20% by 2040. The great improvement in this field is explained by investment and installed capacity.

According to the IEA’s 450 scenario, the annual investment in renewables will reach $400 billion in 2025 (five years earlier from the Bridge Scenario), running up to $470 billion per year during 2026-2040 and variable renewables account for more than half of the total investment. As for installed capacity, the total renewables capacity will be more than tripled by 2040, reaching 6200GW, almost 60% of total capacity. Furthermore, it appears that they represent 450 GW right now, but according to this scenario, they will reach 3300 GW in 2040, representing more than 30% of the total global installed capacity[4].

As far as the EU is concerned, the indicative RED target was 13.8% for the years 2015-2016 and 16% for the years 2017-2018. The achieved RES share was 17% in 2016 while there has estimated to be 17.4% in 2017, surpassing the indicative target level set in the RED. Finally, it’s worth mentioning that according to member states’ NREAPs, the EU has surpassed the cumulative expected levels of 16.2 % and 17.2 %, respectively[5].

3.2 Positive Trends and the Importance of Renewables.

In order to reduce Greenhouse emissions and create a more environmentally sustainable planet, the use of Renewable Energy Sources (RES) is indispensable. This need derives from several reasons deciphered below.

Environment:

First of all, unlike conventional energy technologies renewable technologies tend to be cleaner sources, bearing the least possible environment effect[6]. They produce minimal global warming emissions throughout their whole circle of life (manufacturing, installation, operation, decommissioning)[7]. In addition, what makes the renewables of vital importance for the current and most definitely for the future energy mix is reliability and resilience. The

[3] WEO, 2015 Special Report, p. 105
[4] WEO, 2015 Special Report, p. 109
[5] Renewable energy in Europe — 2018 Recent growth and knock-on effects, EEA Report No 20/2018, p. 17
[6] https://www.renewableenergyworld.com/index/tech/why-renewable-energy.html
[7] Intergovernmental Panel on Climate Change (IPCC). 2011. IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation.

unintended consequences of climate change on energy are undoubtedly severe. Energy production and distribution is largely affected by weather phenomena while in some cases, extreme weather events have led to irreversible disasters[8]. This risk will be even more enhanced in the future because of the Global Warming and therefore the need for cleaner and more resilient technologies make renewables essential[9].

Furthermore renewable energy is endless and infinite. Unlike other sources which face decay and are threatened from stagnation, there will always be sun, wind, plant matter, earth's heat and water force to fuel our needs.

Public health:

Another crucial *pro* renewables aspect, is their importance for the amelioration of public health. Co2 and GHG emissions are responsible for air and water pollution. The latter affects gravely human life and it is significantly linked with medical problems affecting the respiratory and neurological systems, while constitute cause for heart attack, cancer, premature death among others. The latter is not negligible considering that "life cycle costs and public health effects of coal in the US, account for $74.6 billion every year"[10], according to latest Harvard studies.

Unemployment:

Europe among many unresolved domestic problems, still faces the implications of the financial crisis and the migration and refugees' crisis. Among others, a crucial problem within the European soil is unemployment, and especially youth unemployment. The implementation of renewable energies has extensions on this matter as well. Unlike conventional fossil fuel technologies which are largely mechanized and capital intensive, renewable energy is labor intensive. Human presence and involvement is vital throughout the whole procedure, from manufacturing to maintenance. The aforementioned does not imply that personnel in conventional energy projects will be fired and new employees will be recruited in the renewables' industry. The objective in this case is to achieve, for the energy sector's employees, a smooth transition from one industry to another. Of course the implementation of renewables imply the establishment of new jobs as well[11].

[8] Energy Resilience Brochure, pp. 2-5
[9] https://www.ucsusa.org/clean-energy/renewable-energy/public-benefits-of-renewable-power#.XFlB5lwzaUk
[10] https://www.ucsusa.org/clean-energy/renewable-energy/public-benefits-of-renewable-power#.XFlB5lwzaUk
[11] https://www.ucsusa.org/clean-energy/renewable-energy/public-benefits-of-renewable-power#.XFlB5lwzaUk

Economy:

As far as the markets are concerned, renewables could be important as they could considerably contribute to the stabilization of the energy prices. Although, investment is held *ex ante,* considering that no cost of raw material is needed, prices can be held relatively low and most importantly stable *ad infinitum*[12].

Last but not least, renewable energy technologies promote energy security in the region. The latter is achieved because using renewable energy sources the EU will reduce its dependence on energy imports[13]. The interconnection energy system that the EU attempts to create will diminish threats and risks.

Finally, it is noteworthy that the implementation of renewable energies in a region or country is neither easy and low-cost, nor always desired. To reach the energy capacity that fossil fuels currently provide, requires extremely large infrastructures and in some cases may not be the most profitable solution. Consequently, being beneficial or not, is not exactly the question posed by governments. Instead, it is the EU that eventually forces territories to increase the renewable energy share, reduce C02 as close to zero come, improve efficiency and support the energy interconnection scheme.

In order to further clarify the above mentioned statement, the next section will focus on the technical and economic appraisal of each renewable source. Solar power, wind power, geothermal power, hydroelectric and hydrokinetic power will be analyzed in order to provide information regarding their operation, capacity, costs, benefits and evaluate if there is potential for the implementation of large scale projects.

[12]https://www.ucsusa.org/clean-energy/renewable-energy/public-benefits-of-renewable-power#.XFlB5lwzaUk
[13] EU Directive, The Revised Renewable Energy Directive, December 2018

Indicative topics for discussion on current energy trends and the importace of renewable energies:

- An overview of the policy framework relevant to the topics addressed by DeCarb in partnership countries: Weaknesses, delays and areas of improvement.
- The impact of fossil fuels in climate change and global warming.
- The positive and negative aspects of renewable energy sources.
- Tools to evaluate the feasibility of renewables' implementation.
- Discussion on the viability of the EU targets on renewable energy.

4 Techno-economic appraisal of Renewable Energy Sources

4.1 Solar power

Solar energy stands for the process of using directly the sunlight and achieve capturing the sun's energy. Continuously, technological progress has allowed to convert sun's energy into heat used for illumination, hot water, electricity, and as far as business and industry are concerned, cooling systems[14].

4.1.1 Technical Appraisal

Solar power's infrastructures are categorized in Photovoltaic (PV) panels and Concentrating solar power facilities (CSP). Both practices include a sunlight capturing procedure, which converts sunlight into resourceful electricity.

PV projects use the photovoltaic panels to produce electricity, while their capacity may consist of hundreds of megawatts, involving consequently millions of installed solar panels. Furthermore, the capacity and efficiency of the outputs can be intensified and optimized by using mechanisms, tracking and following the sun, hence capturing supplementary sunlight. There are three principal types of solar cells.

Firstly, single-crystal cells, made in cylinders and sliced into thing wafers. Secondly, polycrystalline cells, made of molten silicon cast into ingots and the sliced into squares. Finally, thin film cells which involve spraying or depositing materials onto glass or metal surfaces in thin films preparing the module at one time not requiring the assembling of individual cells[15].

Concentrated solar power (CSP), unlike the PV technology, exploits the sun's heat and produces heated liquid and steam, which can be used for a turbine's generation. Considering that sunlight is profuse, both practices can possibly produce and supply a tremendously large amount of electricity, which is simultaneously environmentally and economically attractive.

PV cells consist two layers of semiconductor material, composed of silicon crystals. Following a procedure called doping, impurities are added to silicon crystal, making them good electricity conductors. This is the first step in order to create an electric current. Continuously, the bottom layer of the cell is usually doped with boron, bonding with the silicon to facilitate

[14]https://us.sunpower.com/blog/2018/02/23/learn-about-seven-types-renewable-energy/

[15] Fraunhofer Institute for Solar Energy Systems, Photovoltaics report, 2018

a positive charge (P), while the top layer is doped with phosphorous, bonding with the silicon to facilitate negative charge (N). The in-between to semiconductors surface, is called P-N Junction. Electron movement at this surface produces an electric field, allowing electrons to flow only from (P) to (N).

With sunlight penetrates the cell, its energy knocks electrons loose in both layers, but because of the opposite charges electrons are prevented to flow form (N) to (P). This is however operated by an external circuit, in which electrons flow proving a supply of electricity. Considering that PV systems include individual square cells, they are grouped together as modules or panels and used as separate units or larger arrays, in order to generate more power.

4.1.2 Economic Appraisal

Solar devices have 100% utility value by installation. Implementing this energy source will enhance both the utility for the user in terms of monetary and financial benefits and the economy, as it provides it with environmentally friendly energy[16].

Although solar power continues to account for a small share of overall energy supply, the residential and commercial sectors are slowly embracing renewable energy. As prices continue to decline, it is expected that solar energy systems become predominant. Anticipated price per kilowatt-hour in EU, in 2050 is 2 cents, which is 2-3 cents less than 2015 prices. Feed-in-Tariff schemes have been implemented to increase appeal and provide financial resources to proprietors, by the government[17].

The EU has added an estimated 6 GW of solar PV capacity in 2017, for a year-end total of nearly 108 GW[18]. Markets are in transition but there is visible progress. Costs' decrease and innovative technological developments generate the demand for rooftop and ground-mounted applications[19], while the demand is significantly increased in the region. Denmark holds the 90% of the solar thermal capacity for district heating in Europe accounting for 76% (932MWth) of the global total by the end of 2017[20].

[16] Journal of Clean Energy Technologies, Vol. 1, No. 1, January 2013, pp.18-19

[17] Trevir Nath, The Economics Of Solar Power, Oct 14 2018 https://www.investopedia.com/articles/investing/061115/economics-solar-power.asp

[18] Renewable Energy Policy Network for the 21st Century, 2018.

[19] Tim Buckley and Simon NIcholas, Global Electricity Utilities in Transition (Cleveland, OH: 2017), http://ieefa.org/wp-content/

[20] Renewable Energy Policy Network for the 21st Century, 2018.

To conclude, solar power is pollution free, electricity and LPG are costly, and it is easy to operate and subsidy[21]. What is actually needed, is to raise public awareness and familiarize more stakeholders with the benefits of the solar energy.

4.2 Wind power

While solar power captures sunlight and heat in order to create a supply of energy, wind power exploits the wind. More specifically, turbines harness the air current and continuously convert them into power. The power produced is emissions-free, hence friendly to the environment and endless. Especially because of these two reasons, wind power is one of the fastest growing renewable technologies having great potentials for the future.

4.2.1 Technical Appraisal

Air harnessing is definitely one of the most sustainable ways to produce electricity. Furthermore, no toxic emissions and no heat-trapping emissions are produced, therefore wind power puts no pressure on global warming. Its abundancy and cost-competitiveness makes wind power the most important alternative to fossil fuels[22]. Wind power technologies are extremely competitive as natural gas plants, while being far cheaper than new coal and nuclear plants. In comparison with fossil fuels several benefits can be demonstrated.

First of all, wind power produces no air or water pollution and, as mentioned earlier, no global warming emissions and waste products, while more water is saved. Moreover, wind energy is a job creating energy source leading as such to numerous economic benefits. In addition, the new technologies implemented in wind power, allow a stabilization even reduction of energy prices. Furthermore, one major cause of energy security is energy dependence. In this framework, wind power can cut dependence on imported fossil fuels and therefore can create a more energy secured environment. Finally, wind power is a sustainable energy source which respects the environment and biodiversity, and implements practices that conserve natural resources in order to be available in the future[23].

To specify roughly stated environmental benefits of wind power, it is important to underline that there is no air pollution production, unlike conventional electricity generation which releases a series of toxic substances. Furthermore, turbine manufacturing and construction is

[21] Journal of Clean Energy Technologies, Vol. 1, No. 1, January 2013, p.20
[22] https://www.ucsusa.org/clean-energy/renewable-energy#.XFveRHduKUm
[23]https://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/renewables-tapping-into-wind.html#.XFveZXduKUk

carbon free. Every megawatt-hour generated with wind power avoids one ton of CO_2 emissions[24]. In addition, wind power uses virtually no water, while the conventional energy sources are responsible for a considerable amount of water withdrawals. In the same framework, after meticulous research and technological advancement, wind power has eventually no harmful impact towards wildlife[25].

4.2.2 Economic Appraisal

Wind power is already an electricity supplier, accounting for approximately 20%, for several regions in Europe. Denmark is leading with 20% wind power involvement in its energy mix, while two states in Germany, of 4million inhabitants combined, get 40% of the electricity from wind[26]. More promising developments will occur in the future, concerning both storage and reliability.

Wind power meets a generally wide acceptance. In 2017 more than 52GW has been added globally and its cumulative capacity has increased 11% to around 539GW[27]. It is worth mentioning the increasing competition around wind power's deployment, deriving especially from its maturity, its cost-competitiveness and its potential environmental positive outcomes[28]. Because of the substantial drop of wind power's prices both offshore and onshore, this source has turned to be the least-cost option for producing power capacity in large and rising number of markets[29].

The EU is the second larger regional market in added capacity of wind power, accounting for over 30%[30]. The EU has installed approximately 15.6 GW of gross capacity, up to 25% over 2016 additions, bringing its total capacity to 168.7 GW (153 GW onshore and 15.8 GW offshore). By 2017, 16 EU member states were reaching more the 1 GW each while 9 had

[24] UCS, p. 2
[25] ibid, p. 6
[26] Earth Policy Institute, 2010
[27] Renewable Energy Policy Network for the 21st Century, 2018. P. 109
[28] Renewable Energy Policy Network for the 21st Century, 2018. P. 110
[29] https://www.bloomberg.com/news/articles/2016-04-06/wind-and-solarare-crushing-fossil-fuels ; "Wind power leading the charge to drive out fossils", GWEC, 15 June 2017, http://gwec.net/wind-power-leading-the-charge-to-drive-out-fossils/.
[30] Renewable Energy Policy Network for the 21st Century, 2018. P. 111

more than 5GW, representing a 12% increase and meeting about 11.6% of the total electricity demand[31][32].

In Europe, the average capacity of recently installed turbines offshore was 5.9 MW in 2017, 23% higher comparatively to 2016, and double compared to 10 years earlier[33]. Wind power's maturation of the supply chain, cost reduction in the industry logistics, as well as shipping and significant competition, have led some of the biggest oil and gas companies (Shell, Statoil, Total and Eni), as well as servicing to oil and gas industry companies, towards wind power[34].

Regarding the economic benefits of wind power, it is apparent that initial investment costs are higher than conventional energy projects. This occurs because of the need to manufacture and install the earlier mentioned infrastructures. Nevertheless, whatever the initial cost is, what really matters, is that this energy source is fuel-free. Furthermore, technological progress has led to an 80% drop of wind power costs over the last decades. Finally, the wind power offers stability in the prices establishing an undoubtable long-term advantage unlike the volatility in prices of oil and gas.[35].

The wind power is according to data, a job creator industry. A 100 MW wind project on average creates 40 to 160 construction jobs approximately, or as it is estimated one or two jobs for each turbine. Moreover, the maintenance of such a project would require the involvement of 10 to 25 employees at a permanent basis[36]. Of course with the development of the projects, jobs growth will be considerable. Wind power projects reduce dependence and therefore money is circulated within the local economy, providing direct employment chances in all the stages related to the project.

To conclude, as every energy source, wind power may face several challenges, however these challenges are not unsurpassable. In broad terms, considering that there are already

[31] "Europe powered by wind: Germany added 42% of EU's 2017 wind capacity", EU Bulletin, 15 February 2018, http://www.eubulletin.com/8183europe-powered-by-wind-germany-added-42-of-eus-2017wind-capacity.html; David Weston, "Race to beat auctions sees European capacity grow 20%", Windpower Monthly, 13 February 2018, https://www.windpowermonthly.com/article/1456946/race-beat-auctions-sees-european-capacity-grow-20.
[32] WindEurope, op. cit. note 11, pp. 7, 9, 15; 12% in 2012 from WindEurope, op. cit. note 6.
[33] WindEurope, Offshore Wind in Europe, op. cit. note 37, pp. 7, 15. Increase in 2017 based on average size of 4.8 MW in 2016, from idem.
[34] United States from Erin Ailworth, "Energy suppliers find fresh lift from offshore wind", Wall Street Journal, 5 August 2017, https://www.wsj.com/articles/energy-suppliers-find-fresh-lift-from-offshore-wind-1501930801.
[35] Union of Concerned Scientists (UCS). 2011. RENEWABLES: ENERGY YOU CAN COUNT ON, TAPPING INTO WIND POWER, p. 2).
[36] NREL 2005

numerous utilities involving wind power, it is apparent that it will significantly contribute to the electric supply, providing a sustainable and reliable energy source in the future.

4.3 Geothermal energy

Geothermal energy is roughly generated by the heat found below earth's crust. More specifically in the underground layer, large amounts of heat are produced, ordinarily from the decay of naturally radioactive materials, such as uranium and potassium. Research presents, that within 10,000 meters of earth's surface, the amount of energy is 50,000 times larger than oil and gas global resources[37].

4.3.1 Technical Appraisal

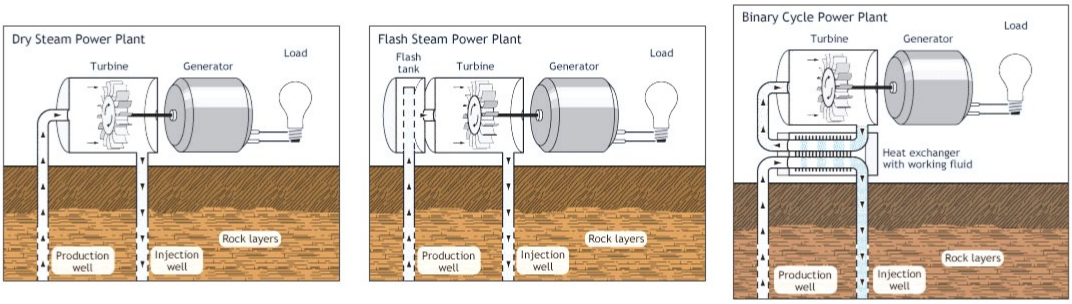
Geothermal energy is captured by either creating geothermal springs for power plants, or by using direct extracting procedures. Regarding the first category, technologically advanced hydrothermal systems send cool water into earth's crust and when heated, it rises back to the surface. When on surface, capturing the steam and use it to generate power is not complex. Geothermal plant also drill their own holes into rocks for even more efficient steam capturing[38].

Three basic designs have been implemented for the exploitation of geothermal power. Firstly, the dry steam, where steam goes directly through the turbine and then through a condenser it is condensed into water. Secondly, hot water is depressurized into steam able to generate the turbine. Finally, in the so called binary cycle system, water is delivered through a heat exchanger where heating a second liquid (mostly isobutene) which, given its lower than water boiling levels, is more easily transformed into steam[39].

[37] Geothermal Energy Association (GEA). 2013. Geothermal: International Market Overview Report.

[38] Office of Energy Efficiency and Renewable Energy (EERE). 2008a. An evaluation of enhanced geothermal systems technology. Washington, DC: U.S. Department of Energy.

[39] https://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-geothermal-energy-works.html#bf-toc-1



Source: U.S. Department of Energy

Regarding geothermal power's direct use, springs are used directly for heating. More specifically geothermal hot water can be used directly for buildings' heating, drying and de-icing purposes, but also to improve oil recovery and assist in industrial processes, such as pasteurizing milk and spas and water warming at fish farms.

4.3.2 Economic Appraisal

As every other renewable source of energy, geothermal power has also several advantageous benefits. First of all, it is worth mentioning that this source can be developed anywhere. It is a highly flexible and provides a diversification in the energy mix, while keeping volatility and rising electricity prices relatively low. Furthermore, geothermal energy resources can lead to economic growth opportunities. Countries could benefit significantly from taxes, royalties, technology exports and jobs[40].

However, geothermal technology's advancement relies to private sector's involvement as many countries are able to individually finance these projects. An overview of the costs demonstrates that 10% goes to project planning, 50-75% to drilling costs and the remaining, to engineering and risk insurance technologies respectively[41].

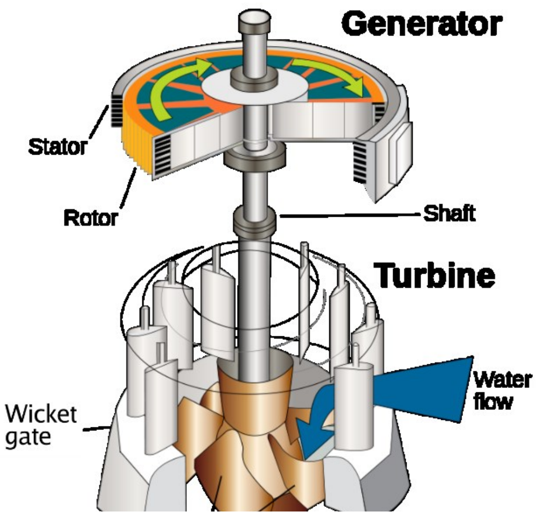
National governments could benefit from investment support (ex. capital grants) and operating support (ex. Price subsidies, green certifications). In the EU, the most common scheme is the feed-in-system[42].

[40] GEOELEC, Factsheets on Geothermal Electricity
[41] GEOELEC, Factsheets on Geothermal Electricity
[42] GEOELEC, Factsheets on Geothermal Electricity

In 2017, the total valuable energy from geothermal resources was approximately 613 PJi. Concerning direct use's estimates, there is a lack in data. The new geothermal power generating capacity is estimated 0.7 GWii in 2017, bringing the global total to an estimated 12.8 GW[43]. In Europe, it is appraised that the current technological advancement will offer great potential for district heating and power production because the region's building stock can be heated at relatively low temperatures[44]. 62 geothermal plants are in operation, 48 in EU member states, 35 of them sited in Italy. The number of under-development projects is constantly increasing. The latter will progressively bring an estimated additional capacity of 1 GWe, for a total of nearly 4 GWe by 2019[45].

Regarding energy efficiency, geothermal power operates more than 70% of the time, especially because of the independency on climate conditions. According to the National Renewable Energy Action Plans of the EU member-states, the capacity will grow further in the upcoming period. In 2020 the forecasted production is about to be 11TWh. The economic potential which is linked to the rising growth of Turkish and Icelandic markets, is even more optimistic reaching in 2020, 21.2TWh for the EU-28[46].

4.4 Hydroelectric power



Source: U.S. Army Corps of Engineers

Hydroelectric power derives from the process of exploiting moving water to produce electricity. To achieve the latter, requires that water should move with appropriate speed and volume in order to whirl a propeller device, which continuously rotates a generator to produce electricity[47]. In order to make the system more efficient and increase the volume of water, developments have led in the implementation of

[43] Renewable Energy Policy Network for the 21st Century, 2018. p. 79
[44] European Technology and Innovation Platform on Deep Geothermal, "Vision for deep geothermal: looking towards 2050", press release (Pisa, Italy: 27 March 2018), http://www.etip-dg.eu/front/wp-content/uploads/A-Vision-for-Deep-Geothermal_pressRelease.pdf.
[45] GEOELEC, Factsheets on Geothermal Electricity
[46] GEOELEC, Factsheets on Geothermal Electricity
[47] https://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-hydroelectric-energy.html#references

impoundments or dams. Water is dropping down though a gap, passing through a pipe called penstock, triggering the turbine to spin. That activates magnets to rotate and generate electricity[48].

4.4.1 Technical Appraisal

As far as the operation of hydroelectric power is concerned, there is a variety of types of turbines implemented in the hydro facilities, while their use is highly dependent on the amount of hydraulic head at the facility. The most common turbine designs are the Kaplan, Francis and Pelton. Some designs tend to use both kinetic force and water pressure in order to achieve greater results.

Source: http://www.mecamidi.com

The Kaplan turbine resembles to a normal boat propeller, using a 3 to 6 blades runner and is able to provide up to 400 MW of power. Changing the pitch of the blades can improve the operation of the turbine. The Francis turbine has a runner with 9 or more fixed blades and is able to provide up to 800 MW, directing water to move in an axial stream[49]. The Pelton turbine is similar to a water wheel. A set of particularly designed buckets are mounted on the outside of a circular disk, used in high hydraulic site and is able to provide up to 20 MW[50].

Two more processes are available in order to generate hydropower energy, avoiding the use of a dam. The first process is known as run-of-the-river. The volume and speed is not increased by a dam but instead this project spins the blades in order to capture water moving in the river. These projects can decide to produce power when it is most necessary. However,

[48] https://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-hydroelectric-energy.html#references
[49] U.S. Department of Energy (DOE). Types of Hydropower Turbines. http://www1.eere.energy.gov/water/hydro_turbine_types.html
[50] https://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-hydroelectric-energy.html#references

considering that these projects do not have the ability to control the amount and time, when electricity is produced.

The second process is called pumped storage. In this process, water is pumped from a lower reservoir to a higher one during calm times and when electricity is cheap, and uses electricity that is produced from other energy sources. The necessity to have storage resources could potentially raise attention concerning new pumped storage projects' building[51].

Unlike earlier mentioned renewable energy sources, hydropower is not considered as totally environmental friendly. It may not emit global warming gasses or air pollution materials, however hydropower projects can have environmental and societal repercussions. The later are highly dependent on the location and operation of the project.

Dams in flooded areas can emit methane with the decomposing of organic matter, while hydropower projects can reduce river flows, altering the temperatures and degrading the environment and wildlife.

4.4.2 Economic Appraisal

In Europe, there are three pumped storage plants operating. Their principal component is that they combine pumping capability with the conventional natural flow hydropower production. Hydropower industry is constantly developing and new sustainable development advancements are in priority along with modernization and digitalization of the existing projects[52]. According to the World Bank, hydrokinetic energy has a significant potential to provide impressive development welfares if implemented in a financially and environmentally sustainable manner[53]. Modernisation of the existing hydropower plants remedies current operational concerns while contributes to the life extension of the projects, to the increase of maintenance internals, to the costs' reduction and to advancement of reliability. Furthermore, modernization is significantly important in order to increase efficiency, power output, flexibility, to provide grid support and finally to create a resilient to climate change energy system[54].

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[51] The Role of Pumped Storage Hydro Resources in Electricity Markets and System Operation. National Renewable Energy Laboratory. May 2013. http://www.nrel.gov/docs/fy13osti/58655.pdf
[52] Renewable Energy Policy Network for the 21st Century, 2018. p. 86
[53] Renewable Energy Policy Network for the 21st Century, 2018. p. 86
[54] IHA, *Activity and Strategy Report 2017-18* (London: February 2018), p. 32, https://www.hydropower.org/publications/iha-activity-and-strategy-report-2017-2018.

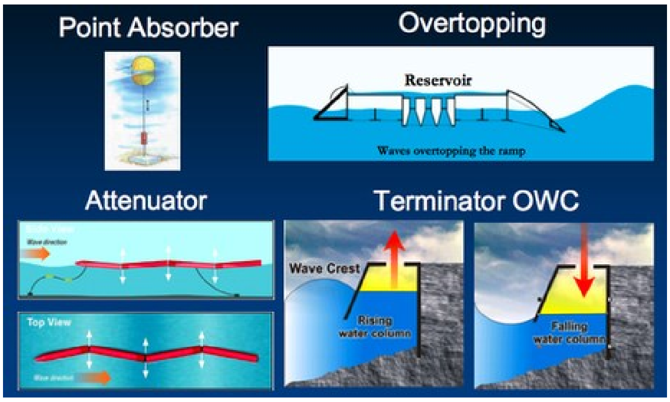
Digitalization of hydropower projects, on the other hand, can be implemented on existing infrastructures. Digitalisation involves the implementation of very progressive simulation, and advanced monitoring and control technologies. The latter allows a more effective observation and responsiveness to every aspect concerning the project's operating conditions. Ultimately, the operation will be more efficient, the plants more reliable and the integration with the operation of other facilities, more flexible[55].

4.5 Hydrokinetic power

Hydrokinetic power roughly uses the movement of water in order to create electricity. In fact, implementing the new technologies, hydrokinetic power goes further to the exploitation of the abundance of oceans and rivers without the existence of dams[56].

4.5.1 Technical Appraisal

The hydrokinetic technologies generate power by harnessing the kinetic energy of a body of water. The estimates regarding the amounts of energy to be produced by using ocean power are tremendously high, while there is significant progress concerning the reduction of global warming emissions and materials such as mercury and matter[57].



Source: https://wave-energies.weebly.com/

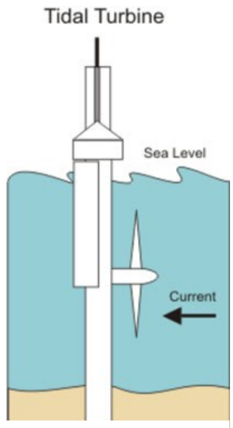
To proceed to a more technical aspect of hydrokinetic energy, it has to be clarified that the technologies developed to produce energy from waves and currents, are called hydrokinetic energy conversion and are visible in two categories. The first category consists of the wave

[55] Michael Harris, "Smarter hydro", *Hydro Review*, vol. 37, no. 1 (2018), http://www.hydroworld.com/articles/hr/print/volume-37/issue-1/cover-story/smarter-hydro.html
[56] https://www.ucsusa.org/clean-energy/renewable-energy/how-hydrokinetic-energy-works#.XFxTJnduKUk

[57] https://www.ucsusa.org/clean-energy/renewable-energy/how-hydrokinetic-energy-works#.XGPMYnduKUk

energy converters (WECs), and the second, the rotating devices respectively. Both are under development that explains the general practice of pilot devices.

The WECs, involve the motion of two or more bodies, the displacer (acted by the waves) and the reactor (moving in response), and can be further subcategorized. The WECSs subcategories are: the oscillating water column, the point absorber, the attenuator and the overtopping device[58].



Source: https://www.eia.gov/

Unlike the WECs, the rotating devices involve the rotor use, capturing the kinetic energy of a flow while it passes through. The current generates the rotor's move and consequently rotational energy is converted into electricity by a generator. Rotating devices capture the kinetic energy of a flow of water, such as a tidal stream, ocean current or river, as it passes across a rotor. The rotor turns with the current, creating rotational energy that is converted into electricity by a generator.

As it is already mentioned, the generation of hydrokinetic energy is not linked with harmful to the environment emissions. Nonetheless, hydrokinetic power, as a source of energy, is not yet fully explored regarding unintended negative consequences towards wildlife, biodiversity and the environment in general. What is also interesting, considering that on-shore installations in other types of energy is easier to examine, the sea cannot be entirely understood. Therefore, choosing a location wisely is essential, and needs fastidious research focusing in three main aspects; environment, economics and competing uses.

4.5.2 Economic Appraisal

Ocean energy markets, even after decades of research are still in embryonic level[59]. The 529 MW operating capacity accounted in 2017, is represented by two tidal barrage hydrokinetic projects[60]. Scotland seems to be predominant. The 2017's net additions capacity was more than 4 MW, for a year end of 17 MW of tidal stream and 8 of wave energy[61]. Hydrokinetic

[58] https://www.ucsusa.org/clean-energy/renewable-energy/how-hydrokinetic-energy-works#.XFxTJnduKUk
[59] REN21 p. 88 .1
[60] REN21 p. 88 .2
[61] REN21 p. 88 .3

power's deployment in Europe has apparently been slower than anticipated, especially considering the global developments. In ocean power technologies, government support is predominant, while international cooperation will progressively push the new technologies towards commercialization[62].

To conclude, it is necessary to invest more in research and development in order to optimize ocean power and simultaneously testify its potential impacts on the environment. Reducing global warming emissions and producing sustainable energy, respecting the environment, is principal. What is certain about ocean power, is that harnessing waves and currents will not have poisonous to the environment consequences such as certain fossil fuels.

In the following section, several large-scale renewable projects are cited and presented. The rationale of the presentation of these projects originates from the facts that the selected projects firstly constitute best practices in the field of renewable energies' implementation. In addition the projects are fully recognized by the EU and also are settled in EU soil. Finally, the projects are highly connected with the previous section on renewable energy sources and can provide with inspiration and incentives for the implementation of large-scale renewable projects in the future.

Indicative topics for discussion on technical and economic aspects of available renewable energy sources:

- An overview of each renewable energy source and evaluation of strengths and weaknesses for each partnering country.
- Technological advancements in the field of renewable energy and future prospects.
- The EU energy market: focus on renewable energy.

[62] REN21 pp. 89 .11, .12, .14

5 Renewable energy developments in the DeCarb partnership regions/countries

It is observed that all partners of the DeCarb INTERREG Europe project attempt to create a low-carbon economy, achieve energy security, ensure environmental sustainability and climate protection, and establish a stable energy supply in the regional market. Furthermore, there is focus on promoting research and innovation on low-carbon technologies, which is required in order to reduce CO2 and meet with the 2030 sustainable development goals. In this framework, it is important to decipher the partner's role in the renewable energy supply and evaluate how this role converge with the above mentioned objectives.

Finally, as already stated, there needs to be considered, that is the EU forcing member states to adopt energy policies and implement renewable energy practices, in order to accomplish its goals. Reducing C02 as close to zero, improving efficiency and supporting the energy interconnection scheme is primordial for the EU but not feasible all its members.

5.1 Stara Zagora Regional Economic Development Agency, Stara Zagora Province, Bulgaria

To enhance the use of renewable energies instead of fossil fuels, over 4 billion Euros have been invested and the installed capacity exceeded 2.2 GWh, while even from 2013-2014, 13% of Bulgaria's electricity was generated from renewable energy sources. However, to achieve that, Bulgaria employed preferential prices that had noble results, but eventually matched with the rise in costs of solar panels and wind turbines. As a result, subsidized prices were too high to cover the high production costs. Energy costs do not only depend on renewable energy, nevertheless, it is renewable energy that is eventually found unappreciated by public opinion. Regardless that, Bulgaria, being small in consumption needs, has great potential to exploit biomass, to totally transform its energy mix and eradicate by 2040 all conventional energy sources[63].

The Stara Zagora Regional Economic Development Agency is a non-profit organization[64] based in Stara Zagora province in Bulgaria which is considered to be an economic center. As far as renewable energies are concerned, Bulgaria, as indicated by Eurostat, has beaten the EU targets for electricity production and consumption from renewable sources set in the Europe

[63] https://www.balcanicaucaso.org/eng/Areas/Bulgaria/Green-energy-in-Bulgaria-an-uneasy-success-158848

[64] https://www.szeda.eu/en/

2020 strategy. In 2016, Bulgaria's electricity consumption from renewables reached 18, 8 while the goal was 16%. Furthermore, in the last 12 years electricity consumption from renewables doubled, with a 8% of electricity generated by solid waste and biofuels, a 0, 2% for electricity produced by geothermal sources, a 0,8% by photovoltaics and a 0,7% by wind power[65].

5.2 Lodzkie Region, Poland

Poland has set the goal of 15% for renewable energy sources in the total national energy consumption. The need of implementation of the climate-energy package and the awareness concerning environmental and societal positive outcomes of energy security, has generated the growing development in the whole EU, and in Poland in particular. The renewable energies' growth in Poland reached its peak in 2012 with a 13, 7%. As far as the production of electricity is concerned, from 3847, 3 GWh that were accounted in 2005, reached the capacity of 17.066,6 GWh in 2013. This undoubted growth in electricity production via renewable energy was followed by a growth in the national electricity production[66]. Furthermore, it is observed, that wind energy in Poland has the highest developmental potential as between 2005-2014, the average rate of the wind power development in terms of capacity reached 53%[67].

Nonetheless, regardless the considerable growth, there are several barriers that Poland faces and can be categorized in four groups: economic barriers, environmental barriers, social barriers and legal barriers[68].

Lodz is located next to Mazowieckie, being the most important region in central Poland, in terms of energy production[69]. Lodz's production exceeds 15% of the country's total energy generation. More than 88% of the energy produced in the region of Lodz originates from thermal coal-fired power plants while the electricity generation from the region exceeds 50% and has increased even more in the past few years. The percentage of hydropower plants'

[65] https://www.bnr.bg/en/post/100932162/bulgaria-among-eu-countries-with-highest-consumption-of-electricity-from-renewables

[66] https://www.scientific-publications.net/get/1000015/1432901347324167.pdf, p. 53

[67] https://www.scientific-publications.net/get/1000015/1432901347324167.pdf, p. 61

[68] https://www.scientific-publications.net/get/1000015/1432901347324167.pdf, p. 52

[69] https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/lodzkie

share in the electricity generation in the region is less than 1%. Nonetheless, Lodz has generally been characterized by great renewable energy potential[70].

In the framework of the Łódzkie Voivodship, the renewable energies sector has seen several developments. In the Lodz region there are 195 wind power installations of 404MW total power. There are also 40 hydropower stations of 6.6 MW, while second generation biofuels are produced in the location of Leśmierz. Furthermore, five biogas power plants are located at municipal wastelands, three at sewage treatment works and two agricultural biogas power plants[71].

5.3 ENEREA Eszak-Alfold Regional Energy Agency Nonprofit Ltd., Northern Great Plain, Hungary

According to OECD's environmental review, although Hungary has progressively reduced its reliance on coal and gas standing *pro* low-carbon energy sources, its energy supply is still dominated by fossil fuels. Renewables have definitely been increased since 2000, with their share in energy consumption in 2015 reaching 14, 5%. Biomass is among other renewables sources is predominant in the renewable energy supply. Furthermore, reducing gross greenhouse emissions efforts have proven successful, as the decrease amounts for 35% since 1990, but recently (GHG) emissions seem to grow[72].

It is vital to mention that Hungary has implemented a renewable energy support scheme (METÁR), a Warmth of Home programme to bolster buildings' energy efficiency, and the E-mobility programme in order to increase the use of electric vehicles by 2020[73].

Regarding renewable energy targets in the framework of the EU, Hungary's target of 13% by 2020 has already been exceeded, even from 2016, when the percentage accounted to approximately 14%. However, the EU had higher expectations for the progress of Hungary. In fact, the proportion of renewables has declined further in the past years[74].

To conclude, Hungary has great potential to profit from renewable energies including solar power, biomass and even geothermal energy. It is also central in the country's energy

[70] http://www.bioenergiadlaregionu.eu/en/renewable-energy/

[71] Renewable and Sustainable Energy Reviews, Volume 58, May 2016, Pages 737-750 – Renewable energy production in the Łódzkie Voivodship. The PEST analysis of the RES in the voivodship and in Poland by panel Bartłomiej Igliński, Anna Iglińska, Marcin Cichosz, Wojciech Kujawski, Roman Buczkowski

[72] https://www.oecd.org/environment/country-reviews/highlights-hungary-2018-performance-review.pdf, p. 4

[73] https://www.oecd.org/environment/country-reviews/highlights-hungary-2018-performance-review.pdf, p. 11

[74] https://kki.hu/assets/upload/16_KKI-elemzes_HUN_Szoke_20180423.pdf, p. 9

strategy, to progressively increase the share of renewable energy sources in the micro regions[75]. Finally, Hungary is exceptionally active in the United Nations climate discussions, being the first EU member state ratifying the Paris Climate Agreement of 2015[76].

5.4 South-West Oltenia Regional Development Agency, South-West Oltenia Region, Romania

Romania's energy mix is among the most balanced in the EU, with renewable energies having a considerable share in power generation.

According to recent data, the electricity consumption in Romania will increase in the following period leading to a rise in the renewable energy production. By 2030, it is estimated that the country will exceed the targets for renewable energy. By 2020, renewable energies will reach 26, 8% of total energy consumption exceeding again the EU target set at 20%. The previous percentage will reach 35, 5% in 2030, also surpassing the EU target of 32%[77].

Concerning the production of local electricity, it is estimated to reach 73, 1 TWh in 2030. From the above mentioned capacity, 24% will be generated in hydropower projects, 23% in wind parks, 22% will maintain nuclear generation and 10% will be available from photovoltaic parks. The total installed capacity of local power plants ought to reach 26, 6 GW, with shares of 26% for hydro and wind and 18% for solar[78]. By 2030, electricity consumption per capita will also be increased, reaching 54% from 45% expected in 2020[79].

Generally in Romania, there is a controversy regarding nuclear, coal and natural gas state owned units, because promoting these conventional energy sources for energy production, limits the scope for using clean and environmentally friendly energy sources.

Sud-Vest Oltenia has ranked, in the previous years, second nationally regarding the orchard and fruit tree cultivation. Especially Dolj and Olt provide with a high interest in smart specialization for agricultural purposes. This is mainly the reason why the major hydropower infrastructures in Romania are based in Sud-Vest Oltenia and generate the majority of hydropower[80].

[75] http://www.enerea.eu/files/Energysummary_2.pdf

[76] https://kki.hu/assets/upload/16_KKI-elemzes_HUN_Szoke_20180423.pdf, p. 10
[77] www.economica.net/romania-va-avea-32prc-energie-regenerabila-in-anul-2030-iar-facturile-vor-scadea-consilier-al-ministrului-energiei_160430.html
[78] https://www.romania-insider.com/renewable-energy-romania-consumption-2030/

[79] https://www.romania-insider.com/renewable-energy-romania-consumption-2030/
[80] https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/south-west-oltenia

Regarding wind power exploitation for electricity, it is apparent that the country experienced growth and there is great potential for future exploitation. In fact this potential is considered to be the highest in South Eastern Europe, reaching approximately 14,000 MW, with the ability to produce approximately 23 TWh annually[81].

According to the National Energy Strategy, Romania's solar potential can produce 1.2 TWh of electricity annually, which is 2.5% of present consumption in Romania, which compared to other studies is a relatively conservative estimate[82].

5.5 Ministry for Economic Affairs and Energy, State of Brandenburg, Germany

The State of Brandenburg has shown an exemplary dedication towards renewable energies. Innovative energy technologies, as well as climate protection policies, definitely focus on energy efficiency and maintenance but also on the implementation of renewable energy. The resourceful employment of all the above mentioned will contribute to the reduction of Greenhouse gas emissions and the preservation of natural resources among others. In addition, the State of Brandenburg will constitute a business location, while its importing dependence will be significantly diminished.

At the time being, 11m tones of CO2 is circumvented every year in the State. A further expansion of renewables will lead to a rapid growth of jobs related to energy infrastructures. The energy and climate policy goal is to enhance the employment of renewable energy at least at 32% of primary energy consumption. As far as future goals are concerned, the State of Brandenburg will play a significant role in the future supply of renewable energy. The State strives to achieve a 100% of the electricity consumption share, a 39% heating consumption share, and an 8% transport share reaching 44% of total energy consumption based on renewables by 2030[83].

The aforementioned goals may sound overambitious, nevertheless, progress is already apparent as 30% of the electricity production in Berlin and Brandenburg is already generated by wind power. By 2030 renewable sources will be able to cover the 100% of electricity needs in both cities with wind power reaching 80%. Moreover, the 7.9 TWh of wind power in 2011 is about to be expanded to 22.2 TWh by 2030, while more than 9.000 additional jobs will be created in the field of renewable energies. Solar energy is estimated to expand to 3, 25 TWh

[81] https://bankwatch.org/beyond-coal/the-energy-sector-in-romania

[82] https://bankwatch.org/beyond-coal/the-energy-sector-in-romania

[83] https://bankwatch.org/beyond-coal/the-energy-sector-in-romania

by 2030 while the State of Brandenburg has also implement policies focusing on the expansion of sustainable use of biomass[84].

5.6 House of Energy, Denmark

Denmark has the lowest energy consumption in the world in terms of gross output while being one the most energy efficient economies[85]. While lacking in hydropower resources, Denmark achieved becoming a global leader in renewable energies, covering currently the 25% of the country's energy consumption. Renewable energy, reaches 50% of domestic production and is mainly depended on wind power for electricity. By 2013, Denmark had already 4,810 MW3 of installed energy capacity (1, 271 MW3 of which being offshore) [86].

What is central in the Danish 2050 Energy Strategy, is the accomplishment of 100% independence from fossil fuels. To achieve that, the government targeted to drop oil, gas and coal consumption by 33% between 2009 and 2020, decreasing as well the thermal generation share from 71% to 40% over the same period. Denmark also aims to reach 100% of electricity from renewables. To achieve that, the country focuses on wind power. The latter is anticipated to provide for 40% of total needs in electricity along with biomass and biogas[87]. About the heating sector, the transition will be implemented through a district heating network fueled by renewable heat that is generated from biomass.

To meet with the reducing dependency from fossil fuels goal, Denmark will employ a long term energy policy focusing on the gross energy consumption's reduction by 6% from 2006 rates. In the same framework, the government will implement a building code, encouraging the use of biomass, biogas and solar power for house applications while outlawing oil boilers. Furthermore, taxes to conventional energy sources will discourage their consumption, leading to more renewable energy use[88].

[84] https://mlul.brandenburg.de/cms/detail.php/bb1.c.295380.de

[85] https://stateofgreen.com/files/download/1401, p. 3

[86] https://stateofgreen.com/files/download/1401, p. 8

[87] https://house-of-energy.dk/wp-content/uploads/2018/04/House-of-Energy.pdf

[88] https://www.iea.org/policiesandmeasures/pams/denmark/name-25113-en.php

5.7 Regional Association of Local Governments of Western Macedonia, Western Macedonia, Greece

The Greek energy mix maintains its dependence on fossil fuels, the majority of which is imported. More than 54% of the country's total energy requirements are covered by petroleum products, while the same percentage in the EU is 33, 4% in average. Renewable energies in Greece reached a percentage of 8% for the total national consumption in 2008 and this rate increased relatively rapidly in the past few years.

Solar power is rapidly developing in Greece, as well as its share in the national energy mix. Greece's installed solar power capacity reaches 2.9 GW, spread within 4.1 million square meters and consequently appoints Greece as the second in solar thermal power capacity after Germany. Finally, regardless that the existing installations are mostly individual, there is great potential of manufacturing greater solar thermal systems. At the end of 2016, the total installed capacity was 2,605MWp, from which 375 MW of small photovoltaic systems and the below 10 kWp are installed in the framework of the Special Photovoltaic Rooftop Programme. In the same year, there was a production of 3,417 GWh, which means that the solar power production reached 25, 4% of total RES electricity and 6% of total[89].

As far as wind power is concerned, Greece's wind energy plants are highly attractive among other member states. Their average capacity factors is around 25% in mainland and 30% for the islands, while the economic potential from wind power is estimated at 10,000-12,000 MW. The 2020 wind energy objective is to reach 7,500 MW, which includes 300 MW in offshore installations. It is important to note, that there has been an increase in installed capacity by 279 MW (13, 3%). More specifically, by December 2016, Greece has installed a total capacity of 2,370 MW, accounting for the 38, 3% of renewable energy electricity, counting for 9% in total.

Furthermore, Greece had as of 2016 an installed capacity of 233 MW in small hydropower plants with an individual capacity less than 15 MW. The latter produced 721 GWh in 2016 producing approximately 5, 4% of renewable electricity and 1, 3% total. Regarding biomass,

[89] https://energypedia.info/wiki/Greece_Energy_Situation#.5B1.5D.5B2.5DMarket_Situation_for_Renewable_Energies

only few projects are implemented mostly for municipal waste management. In 2016 only a 58MW capacity has been noted, generating a total of 252 GWh of electricity from biomass.

Nonetheless, in Greece there is significant potential for the future for the exploitation of geothermal energy, for which the target has been set to 120 MW, until 2020. There is a significant potential for the utilization of geothermal energy for electricity generation, especially on some of the Aegean islands and the North-Eastern part of the mainland. The national target for geothermal electricity is 120 MW until 2020[90].

As far as Western Macedonia is concerned, there is an undoubted effort to achieve a transition to the post-lignite era. Renewable energy projects have been implemented in the regions with considerable energy capacity and their further development will be crucial for the role of the region in the national future energy mix. The projects implemented, are the Ptolemaida III and IV with a capacity of 425 MW (11/2014); KardiaI-IV, with a capacity of 1250 MW (until2023); Amyntaio I-II, with a capacity of 600 MW (until2023); Ag. Dimitrios I-IV with a capacity of 1220MW (until2030); and the 2014-2030 with a retirement of 3495 MW in WMR[91].

To conclude, renewable energies are going to penetrate more in the country's energy mix. According to the Independent Power Transmission Operator, the capacity of renewable energies will be doubled from 4, 872 MW in 2018 to 9,538 MW in 2027. Photovoltaic will be doubled. Wind power plants will become more than doubled with biomass capacity will be quadrupled[92].

5.8 Energy Agency of Savinjska, Saleska and Koroska Region, Savinjska, Saleska and Koroska Region, Slovenia

According to the EU energy policy, in Slovenia's forecast, 40% of the country's electricity consumption will be generated by renewables in 2020[93]. Slovenia will still be the least developed regarding wind power accounting for about 1, 3% of electricity consumption, while

[90]https://energypedia.info/wiki/Greece_Energy_Situation#.5B1.5D.5B2.5DMarket_Situation_for_Renewable_Energies

[91]https://ec.europa.eu/energy/sites/ener/files/documents/7_roadmap_for_the_transition_of_western_macedonia_to_the_post-lignite_era_nikos_mantzaris_wwf_greece.pdf

[92] Αποστόλου Ιφ., 2018, ΟΙ ΑΝΑΝΕΩΣΙΜΕΣ ΠΗΓΕΣ ΕΝΕΡΓΕΙΑΣ ΣΤΗΝ ΕΛΛΑΔΑ: ΕΞΕΛΙΞΗ ΕΝΕΡΓΕΙΑΚΩΝ ΜΕΓΕΘΩΝ ΚΑΙ ΠΡΟΒΛΕΨΕΙΣ, p. 17

[93]http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/EWEA_EU_Energy_Policy_to_2050.pdf

in other cases, Ireland for example, the percentage reaches 36%. Slovenia seems more willing to meet with its renewable energy targets with the implementation of hydropower which counts for 5, 1 TWh and biomass 0, 7 TWh. Wind power is estimated to cover 6%-9% of electricity demand by 2020. The latter, according to EWEA, will result from the new feed-tariff limiting support to less than 5MW projects[94]https://en.wikipedia.org/wiki/Energy_in_Slovenia - cite_note-6.

According to the 2017 energy sector report for Slovenia, in 2017, 944, 9 GWh was produced in facilities included in the support scheme. The latter strives to bolster electricity production from Renewable Energies (RES) and Combined Heat and Power (CHP) as their share was slightly decreased in 2016. The annual decrease deriving from low hydropower, wind power, biomass and CHP units' production accounted for 5, 8%. Solar power percentages were better, but overall decrease did not let it to maintain its rates. But the most infected field was the production of hydro power plants, while general production seems to have decreased as well. Unlike energy production, total capacity has not changed significantly, same for installed capacity of power plants included in the support scheme.

The region of Savinjska covers the east of central Slovenia, in the borderline with Austria (north) and Croatia (south). The region constitutes a key supplier for the Slovenian energy mix because of its lignite mine and thermal power plant. Electricity accounts for only 16% of the total final demand while the scope for improvement of the production is considerable, given that the renewables' share was only 10% (2013 data). Solar energy seems to have the most prevailing potential and is followed by hydro and bioenergy. Concerning heating, wood is the major renewable energy source[95].

[94] Wind energy and EU climate policy Achieving 30% lower emissions by 2020, EWEA October 2011 p. 39
[95] http://www.cep-rec.eu/concept-regions/savinjska-region-slovenia/results-of-energy-analysis/

Indicative topics for discussion on the situation of renewable energies implementation in DeCarb territories:

- Presentation of each partner's contribution in the Decarb project and in the implementation of renewable energy.
- Regional economic, societal and environmental aspects not been evaluated by the EU.
- The role of stakeholders in the support and adoption of renewable energy.
- Monitoring and examination of potential and reality regarding the future energy mix and the share of renewable energy.
- Determination of the needs in partnership regions, in order to proceed in the implementation of renewable energy.

6 Large-scale renewables introduction projects in the EU

This section focuses on the presentation of four large-scale renewable energy projects, implemented by EU Member States. These projects constitute best practices, and DeCarb partners can find valuable information regarding finance possibilities of such projects, infrastructures needed and technological advancements employed for their installation, and economic aspects, such as growth and employment. In addition, the fact that, these projects have posed considerable economic impact in their region/country, can be motivational for DeCarb partners, in order to implement relevant renewable energy projects in their regions.

6.1 Horns Rev Offshore Wind Farm (Denmark)

Source: https://powerplants.vattenfall.com/en/horns-rev

The Horns Rev Offshore Wind Farm stands on the western coast of Jutland in Denmark, and is one the largest offshore wind farms globally. It is situated approximately 20 kilometers from shore, while wind conditions in the area are ideal for generating the turbines. The Horns Rev farm contains 80 turbines. Their capacity can generate power for approximately 150,000 households in the country[96], which is around 2% of Denmark's total energy consumption. The cost of the project reached DKK2bn (about €270m). The project was initially installed by Elsam in 2012 in the North Sea's Blåvands Huk, but it is currently owned by Vattenfall (60%) and Dong Energy (40%)[97].

The Horns Rev Wind Farm has been implemented in three phases. The first phase reflects the government's ambitions to increase electricity production by offshore wind farms. Offshore

[96] https://powerplants.vattenfall.com/en/horns-rev

[97] https://www.power-technology.com/projects/hornsreefwind/

wind farms tend to be more efficient because wind conditions are superior and can produce twice the electricity conventional wind farms produce. Water depth is important, in order to maintain a relatively low cost for the project. At Horns Rev, water ranges from 6 to 14 metres. Striving for optimum capacity, turbines are dispersed 560 metres from each other covering a 20 square kilometres area. The blades are 39 metres in length with a capacity of 94, 8 MW[98]. A 33 kilovolt cable system interconnects the turbines and the generated power passes through a transformer platform on the fringe of the offshore farm, where voltage is transformed up to 150 kV. The electricity is taken to shore via a 19, 2 centimetres Norse made 21-kilometre submarine cable to Hvidbjerg Strand[99].

The Horns Rev Wind farm expansion started at 2008, when Dong Energy commenced the construction of a second wind farm in the area, complemented on September 2009[100]. In 2012, Horns Rev 2 reached a capacity of 52, 0% receiving 51.8 øre/kWh for the first 50,000 hours, compensated by electricity buyers. This second phase consists of 91 Siemens Wind Power SWT 2.3-93 wind turbines with a generating capacity of 209 MW. This project have the first accommodation platform globally, called Poseidon. It is 750 square metres large with 3 decks weighting 422 tons and is connected by walkway to the transformer platform[101]. On-site accommodation is therefore cheaper and more efficient as transportation is minimized.

The third phase of the wind farm, Horns Rev 3 commenced in 2012, when the Danish parliament agreed to send out tenders in 2013 for a 400 MW wind farm at Horns Rev and a 600 MW at Kriegers Flak in the Baltic Sea, estimated to receive 90 øre/kWh for the first 50,000 hours. The latter is anticipated to increase the current 39% of annual electricity production by wind power. Under Vatetenfall's supervision, three transformers were installed in July 2016, while the third phase turbines were launched only recently, in December 2018[102].

Wind power is central to Danish culture and primordial to their future energy goals. Furthermore, wind power contributes considerably to reducing CO2 emissions and especially in the North Sea is also very resourceful[103].

98 https://powerplants.vattenfall.com/en/horns-rev

99 https://powerplants.vattenfall.com/en/horns-rev

100 James Kanter. Largest Offshore Wind Farm to Go Online *Green Inc.*, 15 September 2009.

101 https://orsted.com/

102 https://www.4coffshore.com/news/first-power-for-horns-rev-3-nid11002.html

103 https://www.power-technology.com/projects/hornsreefwind/

6.2 Cestas - The largest solar farm in Europe (France)

Source: https://www.pv-tech.org/

Cestas is undoubtedly the largest solar farm infrastructure in Europe. Cestas solar project was constructed, by a consortium led, Eiffage and Schneider Electric and managed by NEOEN. NEOEN was selected because of its long experience and know-how concerning renewable energies for over a decade[104]. The project's total investment reached 360 million euros estimating a generation of more than 350 GWh per year with a 300 MW peak. The latter roughly parallels with Bordeaux's quotidian consumption. At the first year of operation, 343 GWh of electricity have been produced.

The site consists of 1 million solar panels (accounting for the 45% of the investment cost)[105] covering 250 hectares of land, which is further divided into 25 individual solar plants[106]. It is interesting that Cestas is connected to the French power grid (Réseau de Transport d' Electricité - RTE), which supplies with power the whole country[107]. The price given to the RTE is EUR 105 per MWh over the next 20 years, while in other cases as stated by NEOEN's CEO, price may reach EUR 300 per MWh[108].

Furthermore, what was of significant importance about the implementation of the Cestas project, was the intervention of the European Investment Bank (EIB). The later was proved a valuable contributor. The EIB evaluated the project and its goals and decided to provide with financial assistance because the project contributes to the EU and member states' goals in

[104] http://reports.eib.org/eib-operations-inside-the-eu-2017/solar-park-in-cestas-near-bordeaux-gironde-france

[105] https://renewablesnow.com/news/neoen-opens-europes-largest-pv-power-plant-of-300-mw-504052/

[106] https://www.energymarketprice.com/energy-news/french-cestas-farm--europe-s-largest-solar-facility-to-be-connected-with-nexan%E2%80%99s-cables?act=ps&pid=17&prid=4

[107] http://www.energia.eiffage.es/en/2016/08/18/cestas-solar-power-plant-among-the-ten-largest-in-the-world/

[108] https://renewablesnow.com/news/neoen-opens-europes-largest-pv-power-plant-of-300-mw-504052/

producing renewable energy, increasing energy security and mitigating climate change by diminishing GHG emissions from energy production. Cestas is the first photovoltaic project financed by the EIB and involved a loan of EUR 56 million, representing 16% of the total cost and was implemented via a French financial intermediary as an allocation of a greater framework loan from the institution[109].

In conclusion, Cestas is one of the most competitive solar photovoltaic project and definitely plays a significant role in the French and European energy mix, with great forthcoming potentials[110].

6.3 Larderello Geothermal Complex (Italy)

Source: http://www.reuk.co.uk/

The Larderello geothermal plant (formerly called Valle del Diavolo/ Devil's Valley) constitutes a significantly important site of Tuscany. Larderello's geothermal plants exists for over 200 years and initiated by the French-born merchant Francesco Giacomo Larderel who commenced working on geothermal waters in order to produce boric acid[111]. In 1846, grand Duke of Tuscany Leopoldo II inaugurated Larderel, as Count of Montecerboli and changed the town's name in his honour.

Besides its aesthetic unpleasantness, Larderello, has played a knowingly important role for the energy development in Italy. It was destroyed during the World War II and then was rebuild[112]. Nowadays after two centuries of persistent technological advancements, Larderello is an efficient renewable source, which produces low emission, clean electricity. Larderello's generations account for 10% of global geothermal energy production[113]. As of Larderello, Italy is leading in the EU, as far as geothermal energy generation is concerned, with total installed capacity reaching 790 MWe. Moreover, the plant energy generation

[109] http://reports.eib.org/eib-operations-inside-the-eu-2017/solar-park-in-cestas-near-bordeaux-gironde-france

[110] https://www.energymarketprice.com/energy-news/french-cestas-farm--europe-s-largest-solar-facility-to-be-connected-with-nexan%E2%80%99s-cables?act=ps&pid=17&prid=4

[111] https://www.enelgreenpower.com/stories/a/2018/05/egp-celebrates-two-centuries-of-geothermal-energy-in-larderello

[112] https://www.pdx.edu/geography/sites/www.pdx.edu.geography/files/Larderello.pdf

[113] https://www.pdx.edu/geography/sites/www.pdx.edu.geography/files/Larderello.pdf

covers the 26% of energy demand for the region of Tuscany[114]. According to the latter, Larderello's capacity exceeds the 95% of EU-27 installed capacity[115].

The Larderello area is about 250 square kilometres with 200 wells generating superheated steam at pressure between 2 and 18 bars and a temperature range between 150°C to 270°C. To be efficient for energy production it must reach or exceed 180°C [116].The non-condensable gas content ranges from 1 to 15% by weight. Regarding the generation procedure, steam either naturally or via the drilling practice, mentioned earlier, rises up to the surface. Then, it is channeled through a pipeline, for kilometres, and continuously is used to generate the turbines, which consequently produce energy[117]. Since 2013, Larderello consists of 23 units in operation with an installed capacity is 594.5 MW[118].

Larderello sources have been exploited for over two centuries, and therefore many practices have been implemented. An important practice that has contributed, is the upgrading of the existing plant by using biomass. More specifically, there is a geothermal integrated biomass plant that is composed of super heater boiler for steam, with combustion grate supplied by local forestry woodchip, agricultural residues or crops[119]. That practice is particularly innovative and allows an increase of approximately 5MW.

6.4 Aldeadávila Hydroelectric Power Plant (Spain)

The Aldeadávila dam is placed on the Douro River, which is the natural border between Spain and Portugal; and is owned by Iberdrola in third party ownership model. The Aldeadávila dam has the design of an arch and was built by Spain after the signature of a treaty concerning the development of hydroelectric infrastructures[120].

The height of the dam is 140 meter and its estimated construction cost is US$60million, equal to current 443.5 million. The design labour started in 1956 and the project was finished in 1963. The dam was built with high-quality granite rock, while grouting was used through the

[114] http://paolocagnacci.it/?page_id=835

[115] https://www.pdx.edu/geography/sites/www.pdx.edu.geography/files/Larderello.pdf

[116] https://www.pdx.edu/geography/sites/www.pdx.edu.geography/files/Larderello.pdf

[117] http://paolocagnacci.it/?page_id=835

[118] https://pangea.stanford.edu/ERE/db/WGC/papers/WGC/2015/01075.pdf

[119] https://pangea.stanford.edu/ERE/db/WGC/papers/WGC/2015/01075.pdf

[120] Dominy, Floyd E. "Spain Increases Dam Building." The Reclamation Era. 51:160,000 hp1 (February 1965), p. 1.

construction to fill cracks and stabilize the project's foundations. The project has eight overflow gates guiding water into four spillways, creating a water effect[121].

Source: https://travel.sygic.com

After the implementation of several technological advancements through time, as of 2018, the Aldeadávila dam is still the largest dam in Spain. Its total generating output is 1,150 MW[122]. The original I Power Station consists of six 120 MW Francis turbines, with the capacity to produce 720 MW. The project was expanded in 1986 (Aldeadávila II Power Station) and reinforced with two 211 MW Francis pump-turbines bolstering power generation by 420 MW[123]. These pumped-turbines are used in periods with low electricity demand, in order to improve reservoir capacity and store water for high electricity demand times[124].

The Aldeadávila dam is interconnected with the Spanish national energy grid. The operational range is relatively wide, changing from low, to partial load and to full load, on the basis of being frequently exposed to austere operational conditions. With this type of range fluctuations, the plant can stabilize the grid and compensate deviations in both production and demand[125].

The Aldeadávila dam, is one the largest dams in Europe and is definitely eye-capturing for its considerable role in the Spanish energy mix as well as for its future role in Spain's objectives regarding renewable energies.

The following and final thematic section focuses on the renewable energy developments in the EU by demonstrating the energy mix of every partner's region (wherever possible), and country. Selecting to discuss the energy developments in a national and not only regional

[121] https://en.wikipedia.org/wiki/Aldead%C3%A1vila_Dam

[122] Boronat, Ernesto. "Hydro Power" (PDF). Exergy. p. 34. Archived from the original (PDF) on 2010-08-13.
[123] https://www.energystorageexchange.org/projects/1710
[124] "Worldwide list of pumped storage plants". Bbjectifterre. Archived from the original on 2013-12-02.
[125] https://www.andritz.com/hydro-en/hydronews/26/hy-news-26-13-aldeadavila-hydro

scale, derives from the fact that energy policies are not in the exclusive competence of regions, but on the contrary, are dictated in the national level.

Indicative topics for discussion on best practices of large-scale renewable energy projects in the EU:

- Financial, political and legal incentives that led to the implementation of these projects.
- The impact of these projects to the regional and national development.
- Share of knowledge and lessons learnt by AGENEX and House of Energy as two of the selected projects are settled in Spain and Denmark respectively.
- Motivational aspects of these projects for national authorities and stakeholders.

7 Organisational issues

7.1 Date and venue

The Extremadura Energy Agency (AGENEX) will host the interregional thematic workshop on the large-scale introduction of renewables in partners' energy mix, in Extremadura, Spain. The workshop will last two days (**DATE**) and all DeCarb partners will participate, with members of their stakeholder groups and external experts. The working language of the workshop will be English, which means that participants must have a sufficient knowledge of the language to be able to fully participate in discussions. Following the completion of workshop proceedings, the Steering Group meeting will take place in the same venue.

Table 2: Interregional workshop details

DeCarb - Interregional thematic workshop on the large-scale introduction of renewables in partners' energy mix	
Thematic focus	Renewable Energies
Host organisation	Extremadura Energy Agency (AGENEX)
Date	
Venue	
Language	English
Number of participants	Approx. 40 participants
Type of participants	Regional authorities' officials, stakeholders, external experts
Format	Oral presentations, round-table discussions, interactive exercises
Contact details	

7.2 Participation

The DeCarb Application Form (AF) foresees that approximately 40 people are able to attend the interregional thematic workshop, to be held in Extremadura, Spain.

The target audience that can be impacted by the project outcomes potentially interested in utilising project outputs to support or reach consensus for the proliferation of renewables, includes:

- Local/regional/national authorities;
- Energy and environmental agencies;
- Utility providers;
- Public and private service providers;
- Plant operators;
- Workers' unions;
- Universities;
- Research centres and institutes involved in renewables and cleaner coal research;
- Organisations providing clean energy services.

ANNEX A provides a list of key regional stakeholders per project partner as they appear in the Application Form. This is only an indicative pool of regional stakeholders identified at an initial stage (i.e. project development phase). During the project lifecycle, partners have managed to expand their network of contacts, adding new stakeholders and interested institutions from across Europe such as regional development agencies, higher education institutes and research centres, chambers of commerce, professional associations and public authorities.

In any case, DeCarb partners are advised to invite any other organisation or body involved in the decision making process and/or interested in triggering policy and behavioural changes through DeCarb.

7.3 Format

The interregional workshop may include three different types of activities to facilitate the transfer/exchange of knowledge and capacity building among regional authorities' representatives; namely: a) presentations, b) roundtable discussions and c) interactive exercises.

Presentations will provide an opportunity for participants to get a better understanding on the integration of different renewables for large scale energy production, which will provide energy efficiency and stability. The presentations will be delivered by field experts from various professional backgrounds (e.g. academics, policy makers, business executives, and researchers) and both theoretical and empirical knowledge on the topics under examination, in order to cover all its aspects. Round table discussions will follow the completion of each presentation. This will allow participants to discuss the issues in-depth and interact with each other, promoting networking and equal participation/contribution, triggering spontaneous conversations and allowing for faster decisions.

Finally, it is recommended that the workshop should include a structured set of facilitated activities (in the form of exercises) to stimulate participants' creativity and knowledge sharing through collaborative working. These exercises will enable regional authorities' participants to come up with new ideas for policy measures to promote the implementation of renewable energy through DeCarb, deciding on priorities, strategy and vision, and working towards common solutions.

7.4 Agenda (draft version)

DeCarb
Interreg Europe

European Union
European Regional
Development Fund

Action 3.1: Interregional workshop on the large-scale introduction of renewables in partners' energy mix

Extremadura, Badajoz, Spain

(DATE)

(DATE)	
9:30 – 10:00	Registration and opening of the meeting
10.00 – 10.45	Overview of the DeCarb policy framework in partnership countries: Weaknesses, delays and areas of improvement
10:45 – 11:15	Coffee break
11:15 – 12:00	Tools to evaluate the feasibility of large-scale renewables' implementation
12.00 – 13.30	Lunch break
13:30 – 14.15	The EU energy market the viability of the EU targets on Renewable Energy Sources
14:15 – 14:45	Coffee-break
14:45 – 15:30	Potential vs reality regarding the future energy mix and the share of renewable energy
15:30 – 16:00	Final discussion
20:00	Partner diner
(DATE)	
09.00 – 11.30	Presentation of each partner's contribution in the Decarb programme and in the implementation of renewable energy and lessons learnt
11:30-12:00	End of the Interregional workshop.

8 Guidelines for the summary report

The final stage of the conduction of the 2nd interregional thematic workshop includes the preparation of a summary report by the hosting partner. The summary report is considered the key output of activity A3.2. The summary report will present the final outcomes of the workshop and will be used by project partners as the main input for diffusing the lessons learned within their organisations.

Summary reports are short written communication documents, which aim to convey information related to the discussions and activities carried out during workshop activities. The summary report should include the following aspects:

- Document the interventions of participants and the overall discussion within each session of the interregional thematic workshop.
- Draw conclusions from debate and interactive exercises in each session of the workshop.
- Briefly present policy recommendations for the development of action plans based on the interventions of the participants and the conclusions drawn from the discussion.
- Present an evaluation of the workshop based on the comments and feedback from participants (evaluation questionnaire).
- Present the metrics of the workshop (number of registered participants, number of completed evaluation questionnaires, and number of participants from each category of the target groups).

The following guidelines have been developed to provide assistance and guidance to the host organisation (AGENEX) on how to summarise and present the main conclusions drawn from the workshop (in the format of a summary paper), in order to facilitate the integration of key policy recommendations into regional action plans. In particular, the summary report should be drafted as follows:

Step 1: Develop short summaries for each session of the workshop. The summaries should include a) the context and objectives of the session, b) the main points from oral presentations/keynote speeches, c) key argumentation from the interventions of participants, and d) conclusions and findings extracted from the overall discussion and interactive exercises.

Step 2: Review the evaluation forms. The author should summarise the key itches and ideas (as drawn from the forms completed by workshop participants), with regards to the themes

/ topics of the workshop. It is highly recommended that any idea (i.e. policy advice) that could contribute to the improvement of regional policies in the field should be integrated into regional action plans.

Step 3: Present the main conclusions with regards to the following themes:

- Financial, political and legal incentives that led to the implementation of these projects
- The impact of these projects to the regional and national development
- Barriers and constraints for implementing renewable energy technologies.
- Perceived enablers for engaging in DeCarb.
- Improving existing DeCarb policies to stimulate the application of renewable energy sources.

Step 4: Juxtapose the key arguments / conclusions drawn from the workshop with any relevant results and findings from DeCarb thematic studies and guides on similar policy aspects. Identify convergences and divergences between findings.

Step 5: Provide guidelines (in the form of policy recommendations) on how to utilise the key conclusions drawn to design policy measures and action plans to promote the implementation of renewable energies. The guidelines on how to integrate the lessons learnt in the DeCarb action plans, as well as any policy advice that may be derived from the analysis of evaluation forms, should be described in a way that is simple, brief, and easy to follow.

Step 6: Draft the summary report. The workshop summary report should be drafted in a clear and concise way, focusing on the conclusions drawn from knowledge sharing and consultation processes that took place during the workshop sessions.

9 Annex A: Key regional stakeholders per project partner

PARTNER	KEY STAKEHOLDERS
SZREDA	***Stara Zagora Regional Economic Development Agency, Stara Zagora Province, Bulgaria*** Ministry of Regional Development and Public Works Stara Zagora Regional Administration Municipalities of Stara Zagora, Kazanlak, Gurkovo, Nikolaevo, Opan, Radnevo, Bratya Daskalovi Trakia University Chamber of Commerce and Industry – Stara Zagora
LODZKIE	**Lodzkie Region, Poland** Ministry of Investment and Economic Development Lodz Regional Development Agency Municipalities of Lodz, Kleszczów, Uniejów University of Lodz, Technical University in Lodz Lodz Chamber of Industry and Commerce PGE GIEK Oddzial Elektrownia Belchatow Veolia Energia Lodz
ENEREA	**ENEREA Eszak-Alfold Regional Energy Agency Nonprofit Ltd., Northern Great Plain, Hungary** Ministry of National Development, Deputy State Secretariat for Environment and Energy Efficiency Operational Programmes Észak- Alföld (North Great Plain) Regional Development Agency Municipality of Debrecen University of Debrecen Chamber of Commerce and Industry of Hajdú-Bihar County MAVIR Hungarian Independent Transmission Operator Company Ltd.
SWORDA	**South-West Oltenia Regional Development Agency, South-West Oltenia Region, Romania** Ministry of Regional Development, Public Administration and European Funds Dolj County Council, Gorj County Council, Valcea County Council, Mehedinti County Council, Olt County Council Dolj Environmental Protection Agency, University of Craiova

MWE	**Ministry for Economic Affairs and Energy, State of Brandenburg, Germany** Lausitzrunde Lausitz University of Applied Sciences Innovationsregion Lausitz GmbH (iRL) Industrie- und Handelskammer (IHK) Cottbus - The Chamber of Commerce and Industry (CCI) Cottbus Cluster Energietechnik
HoE	**House of Energy, Denmark** North Denmark Region Aalborg University Ministry for Economic Affairs and Energy, State of Brandenburg Aalborg Energie Technik a/s (AET)
PEDDM	**Regional Association of Local Governments of Western Macedonia, Western Macedonia, Greece** Region of Western Macedonia University of Western Macedonia and University of Applied Sciences of Western Macedonia ANKO S.A. - Regional Development Agency of Western Macedonia Public Power Corporation S.A.
KSSENA	**Energy Agency of Savinjska, Saleska and Koroska Region, Savinjska, Saleska and Koroska Region, Slovenia** Ministry of Economic Development and Technology, Directorate for Entrepreneurship, Competitiveness and Technology Municipalities of Velenje, Celje, and Slovenj Gradec Faculty of Energy Technology, University of Maribor Public utility company Velenje Velenje Lignite Mine Šoštanj Thermal Power Plant
AGENEX	**Extremadura Energy Agency, Badajoz, Spain** Badajoz County Council and Cáceres County Council University of Extremadura Extremadura Cluster of Energy