Myths and facts about deploying renewables in the power systems of South East Europe

Fanni Sáfián, Dóra Csernus, Ágnes Kelemen, Gabriella Dóci and Xuenan Mao

November 2019

KLIMA POLITIKA

Delivered by Klimapolitika Ltd. to Agora Energiewende

Prepared by Fanni Sáfián, Dóra Csernus, Ágnes Kelemen, Gabriella Dóci and Xuenan Mao

Contributed by Christian Redl and Sonja Risteska

Supervised by Ágnes Kelemen

Disclaimer

The analysis for the EU countries was performed under the project "South East Europe Energy Transition Dialogue" which is part of the European Climate Initiative (EUKI). EUKI is a project financing instrument by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The EUKI competition for project ideas is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. It is the overarching goal of the EUKI to foster climate cooperation within the European Union (EU) in order to mitigate greenhouse gas emissions.

Agora Energiewende acknowledges support by the Austrian Federal Ministry of Sustainability and Tourism through the project "Western Balkans Energy Transition Dialogue"

The opinions put forward in this publication are the sole responsibility of the authors and do not necessarily reflect the views of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Austrian Federal Ministry of Sustainability and Tourism.

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

European Climate Initiative EUKI

Federal Ministry Sustainability and Tourism

This document relies heavily on the results of the SEERMAP project. Therefore, all information in this document – which is not cited from another source – is originated from the SEERMAP Reports (Szabó et al., 2017)[1].

[1] Szabó, L., Mezősi, A., Pató, Z., Kelemen, Á., Beöthy, Á., Kácsor, E., Kaderják, P., Resch, G., Liebmann, L., Hiesl, A., Kovács, M., Köber, C., Marković, S., & Todorović, D. (2017). SEERMAP: South East Europe Electricity Roadmap - South East Europe Regional report 2017. All country reports can be downloaded from: http://seermap.rekk.hu/.

Acknowledgements

We would like to express our gratitude for the valuable comments and inputs received from our reviewers: Christian Redl and Sonja Risteska, Agora Energiewende; Emanuele Bianco, IRENA and Pippa Gallop, CEE Bankwatch Network.

About SE3T.net

SE3T.net is a regional network of independent energy transition think tanks which focuses predominantly on Southeastern Europe.

Partners

Association for Sustainable Development (ASOR), Center for the Study of Democracy (CSD), Energy Policy Group (EPG), Green Alternative, Institute for Development Policy – INDEP, Macedonian Center for Energy Efficiency (MACEF), National Observatory of Athens (NOA), NERDA, RES Foundation, University of Zagreb

Table of contents

List of figures

List of tables

Introduction

The Paris Agreement sets out the ambition of holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C. The EU has responded to this increased international ambition by setting ambitious emission reduction targets for 2030 as well as by reviewing its current target for 2050.

The 2030 targets adopted by the EU entail at least 40% cuts in greenhouse gas emissions (from 1990 levels), a 32% share for renewable energy as a share of consumption, and at least 32.5% improvement in energy efficiency. The joint fulfilment of the renewables and energy efficiency target is expected to lead to emission reduction of 45%, going beyond the official 40% target.

The EU adopted an emission reduction target of 80-95% reduction for 2050 in 2011, but in response to the Paris Agreement a net zero emissions target has been proposed by the European Commission. The Commission's background analysis for the EU's Long Term Strategy shows that net zero emissions are technically and economically feasible by 2050. Net zero economy-wide emissions will require complete decarbonisation of the electricity sector. At the same time, an increase in electrification in demand sectors will mean that electricity becomes the dominant energy carrier with the share of electricity within final energy demand increasing from 22% in 2015 to between 41% and 53% by 2050. Electricity demand also increases in absolute terms, with electricity demand in 2050 36-75% higher than in 2015 in different decarbonisation scenarios. This implies an ambitious effort for the European electricity sector: complete decarbonisation while increasing supply.

RES will play an important role in decarbonisation according to the long term analysis of the European Commission. "The share of renewables in gross electricity generation is very similar across scenarios, reaching 81%-85% in 2050 (compared to 57% in 2030 and 30% in 2015) and remaining at this level afterwards. This finding falls within the range of studies assessed, which gives, for the EU, value from slightly above 75% in 2050 (IEA ETP B2DS204 and Shell Sky scenario203) to an almost fully renewables power system (IRENA's global energy transformation)." Wind and solar drive the development of renewables, jointly reaching around 70% of power production in all decarbonisation scenarios. "The power sector has only very small residual emission left in 2050 between some 10 $MtCO_2$ (EE scenario) and 110 $MtCO_2$ (P2X scenario) and even negative emissions (some 140 $MtCO_2$) in the 1.5TECH scenario." (European commission, 2018)

Decarbonisation implies a need to change the direction of energy policy and energy investment throughout Europe, including in the SEE region. Ambitious EU targets for 2050 are in stark contrast to the ambition of several governments in the SEE region to build new coal plants. The idea that an electricity mix based largely on renewables is physically and economically infeasible still persists among policy makers in the region. At the same time, an increasing number of studies, many of which have been written by experts within the region, show that a transition to a decarbonised electricity system in SEE is not only feasible but also desirable.

An analysis of the NECPs of EU MS in SEE (Bulgaria, Croatia, Greece and Romania) showed that current efforts laid out in the National Energy and Climate Plans of these countries are insufficient to transition to a low carbon economy by 2050. Specifically, the analysis showed that "all four countries display insufficient ambition in terms of setting targets for developing renewables and for improving energy efficiency. The measures set forth for achieving declared targets also appear to be inadequate. The European Commission has already advised governments to raise their targets and adopt additional measures." In addition, the countries "do not project significant reductions in coal use during the 2020–2030 period." (Agora Energiewende, 2019) Countries in the Western Balkans also have plans for replacing obsolete with new coal and lignite plants. They have increased their ambition in investing in renewables in recent years, but are still far from utilising the technical and economic potential in the region.

The current document is essentially a review of the existing literature on the transition to a low carbon electricity sector in the SEE region. There is a growing body of analysis showing that phasing out coal and decarbonising the electricity sector is technically and economically feasible in the SEE region. This document summarises the conclusions these studies, structured along the myths related to renewable energy. We summarise the available evidence on the physical and economic feasibility of renewables, security of supply issues, environmental sustainability and social impacts of renewables, thereby debunking some persistent negative myths about renewable energy.

A. Physical and economic feasibility of RES

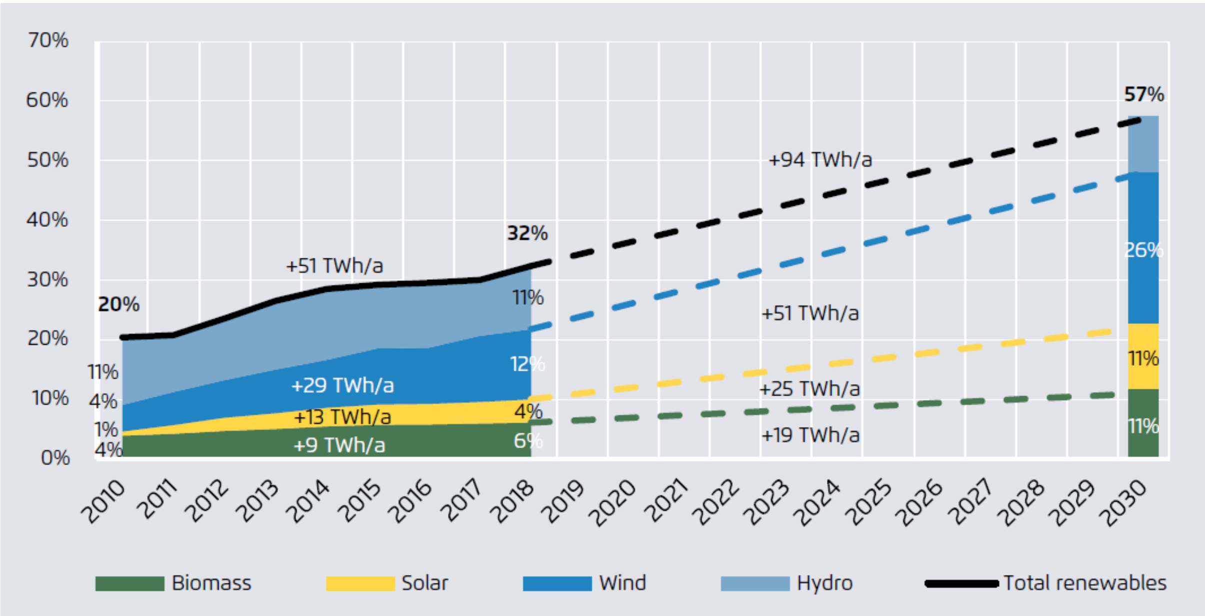
MYTH A1: RES potential is insufficient to cover energy demand

RES development plans are not realistic. Renewables can contribute only a small share of energy needs. RES alone can never fulfil market demands. We do not have sufficient RES potential.

FACT: In most countries of the SEE region RES would be able to cover the majority of energy needs or even more.

The background analysis of the EU's Long Term Strategy has shown that a completely decarbonised electricity system relying mostly on renewables is technically and economically feasible. The European Commission's Long-Term Strategy for the decarbonisation of the European economy, released at the end of 2018, contains one modelled pathway to 2030, meeting the EU's RES target of 32% for 2030 and its energy efficiency target of 32.5% for the same deadline. The strategy also presents pathways towards 2050, which differ from each other only after 2030, depending on the technology option chosen. The modelling shows that from 32% in 2018, the share of renewable electricity must increase to 57% by 2030. Figure 1 shows that wind energy capacity has to increase from 12% to 26%, similarly, biomass almost doubles from 6% to 11%, while solar capacity has to reach 11% by 2030, which is almost three times its share of 4% in 2018. Hydro capacity remains the same as in 2018 (Agora Energiewende and Sandbag, 2019).

Figure 1 2030 PROJECTION OF RENEWABLE ELECTRICITY SHARE IN EUROPEAN COMMISSION'S LONG-TERM STRATEGY



Source: Agora Energiewende and Sandbag (2019) based on EUROSTAT data to 2016; own calculations for 2017 and 2018; 2030 projection from "Long Term Strategy", European Commission 2018

"In all scenarios, the additional electricity demand is satisfied by production using resources from EU territory, mostly local wind and solar, but also nuclear." (European commission, 2018)

The SEERMAP project (Szabó et al., 2017) uses a model-based assessment of different long-term electricity investment strategies for Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Kosovo*, North Macedonia, Montenegro, Romania and Serbia. Five models incorporating the electricity and gas markets, the transmission network and macro-economic system were used to assess the impact of three core scenarios:

1. The 'no target' scenario reflects the implementation of existing energy policy (including implementation of renewable energy targets for 2020 and construction of all power plants included in official planning documents) combined with a CO_2 price (which is only envisaged from 2030 onwards for non-EU member states). The scenario does not include an explicit 2050 CO_2 target or a renewables target for the electricity sectors of the EU member states or countries in the Western Balkans;
2. The 'decarbonisation' scenario reflects a long-term strategy to significantly reduce CO_2 emissions, in line with indicative EU emission reduction goals for the electricity sector as a whole by 2050, driven by the CO_2 price and strong, consistent RES support;
3. The 'delayed' scenario involves an initial implementation of current national investment plans (business-as-usual policies) followed by a change in policy direction from 2035 onwards, resulting in the realisation of the same emission reduction target in 2050 as the 'decarbonisation' scenario. Decarbonisation is driven by the CO_2 price and increased RES support from 2035 onwards.

For the SEE region, the SEERMAP study demonstrated that it is possible to reach an electricity mix with 83-86% renewable generation in the SEE region by 2050. The 'decarbonisation' scenario demonstrates that it is technically possible to reach decarbonisation targets suggested by the EU 2050 Roadmap in the SEERMAP region due to high RES potential. The utilisation of long-term RES potential in the 'decarbonisation' scenario will reach 51% for hydro, 58% for wind and 53% for solar, so further technical potential can be utilised if needed.

Pleßmann & Blechinger (2017) investigated a cost-efficient strategy for SEE region to achieve EU decarbonisation targets by 2050. According to their models, this pathway is possible, reaching 97.4% emission reduction by 2050, with dynamic development in renewable utilization and phase-out of coal in line with the other EU countries by 2035. The capacity of PV is expected to grow from 3.76 GW in 2016 to 120.7 GW in 2050 (on average 3.44 GW growth per annum), the increase in the capacity of wind from 2.86 in 2016 to 92.4 GW will necessitate a growth of 2.63 GW per year.

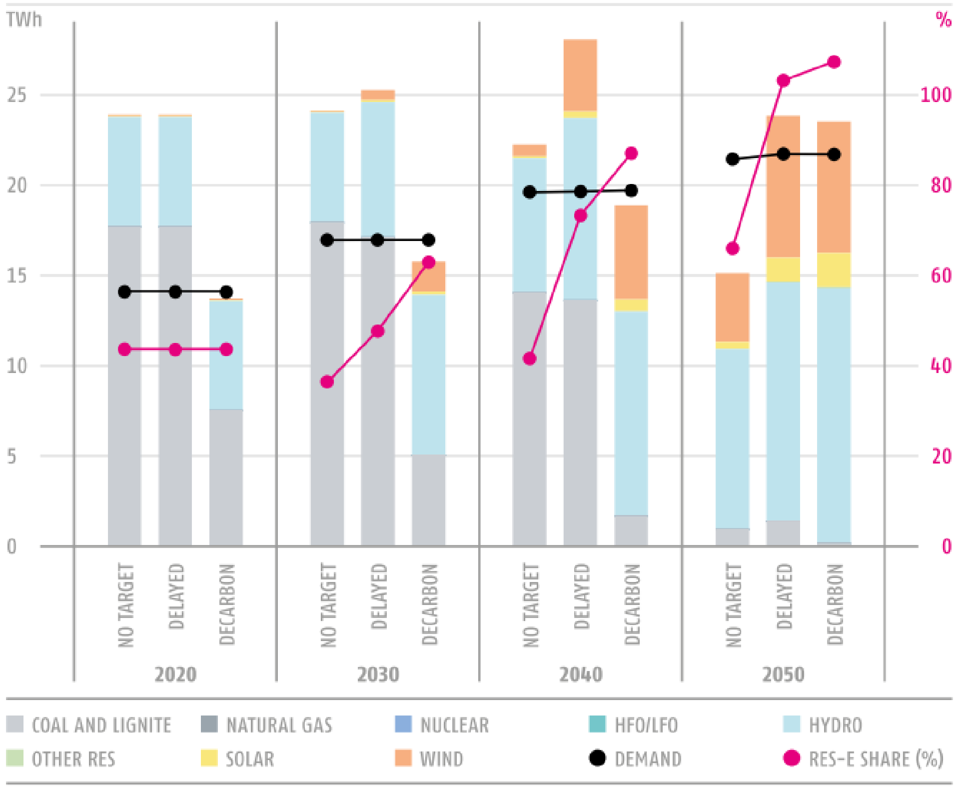
IRENA et al., (2017) show that the SEE region has a large untapped technical RES potential at around 740 GW, mainly wind (532 GW) and solar (120 GW) resources, with significant differences across the region in terms of available locations for large-scale RES investments Due to EU nature and landscape protection requirements, the implementable RES potential – especially hydro – may be lower in reality than often assumed. It is expected for example that the protected areas (which are considered to be minimal in some accession countries) will be expanded in the future.

INSIGHTS FROM BOSNIA AND HERZEGOVINA

SEERMAP modelling has demonstrated that achieving a very high share of renewables in the electricity mix by 2050 in Bosnia and Herzegovina is both technically feasible and financially viable.

In Bosnia and Herzegovina, more than 35% of current fossil fuel generation capacity is expected to be decommissioned by the end of 2030 and nearly 85% by 2050. The country has remarkable renewable energy potential. The SEERMAP modelling exercise showed that across all scenarios, Bosnia and Herzegovina will experience a significant shift away from fossil fuel-based electricity generation towards renewables.

Figure 2 ELECTRICITY GENERATION AND DEMAND (TWH) AND RES SHARE (% OF DEMAND) IN BOSNIA AND HERZEGOVINA, 2020-2050



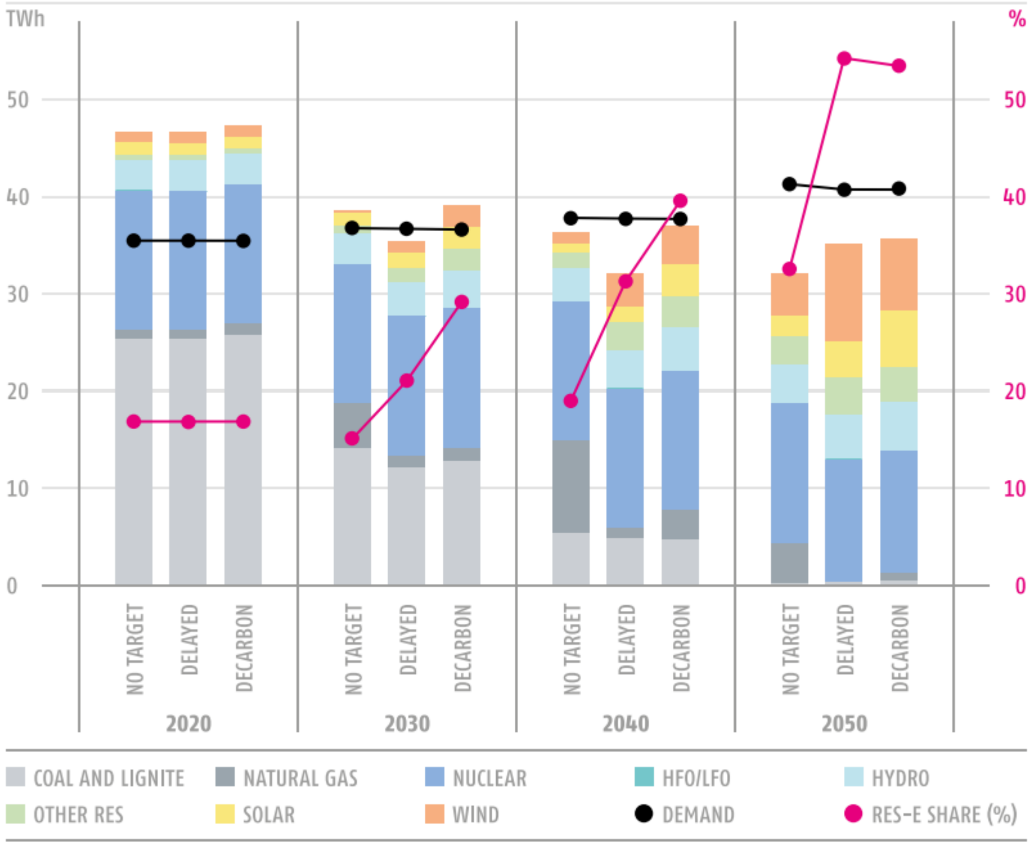
Source: SEERMAP Country Report Bosnia

The share of renewable generation as a percentage of gross domestic consumption reaches 66% in the 'no target' scenario, 103% in the 'delayed' scenario and 107% in the 'decarbonisation' scenario by 2050. Hydro and wind capacities will play a prominent role, contributing around 60% and 30% of total RES generation by 2050 respectively in the 'decarbonisation' scenario, while solar contributes 8%. The share of biomass in the generation mix increases but remains negligible in all three scenarios. Concerning potential conflicts due to competing water uses, nature protection requirements and the NIMBY effect, a sensitivity analysis was performed with respect to large-scale hydropower and onshore wind power potential. The results show that high RES scenarios are still feasible assuming 25% lower potential than in the core scenarios, resulting in increased PV capacity, although this also implies higher RES support.

INSIGHTS FROM BULGARIA

Based on Bulgaria's status, trends and possibilities, the SEERMAP models show that a significant increase in RES in the electricity sector is not only feasible but also cost-optimal, whether or not an emission reduction target is set. Approximately 45% of current fossil fuel generation capacity, or more than 2600 MW, is expected to be decommissioned by the end of 2030, and 97% of today's fossil capacities will be decommissioned by 2050. The model results show that the contribution of renewables (especially wind and solar) will increase significantly under all scenarios under the assumed costs and prices: the share of RES in the electricity sector will reach 32.5% in the 'no target', 53.5% in 'decarbonisation' and 54.3% in 'delayed' scenarios by 2050. The latter means 4.6 TWh hydro, 10.0 TWh wind, 3.8 TWh solar and 3.4 TWh other RES power production by 2050.

Figure 3 INSTALLED CAPACITY IN THE 3 CORE SCENARIOS UNTIL 2050 (GW) IN BULGARIA, 2020-2050



Source: SEERMAP Country Report Bulgaria

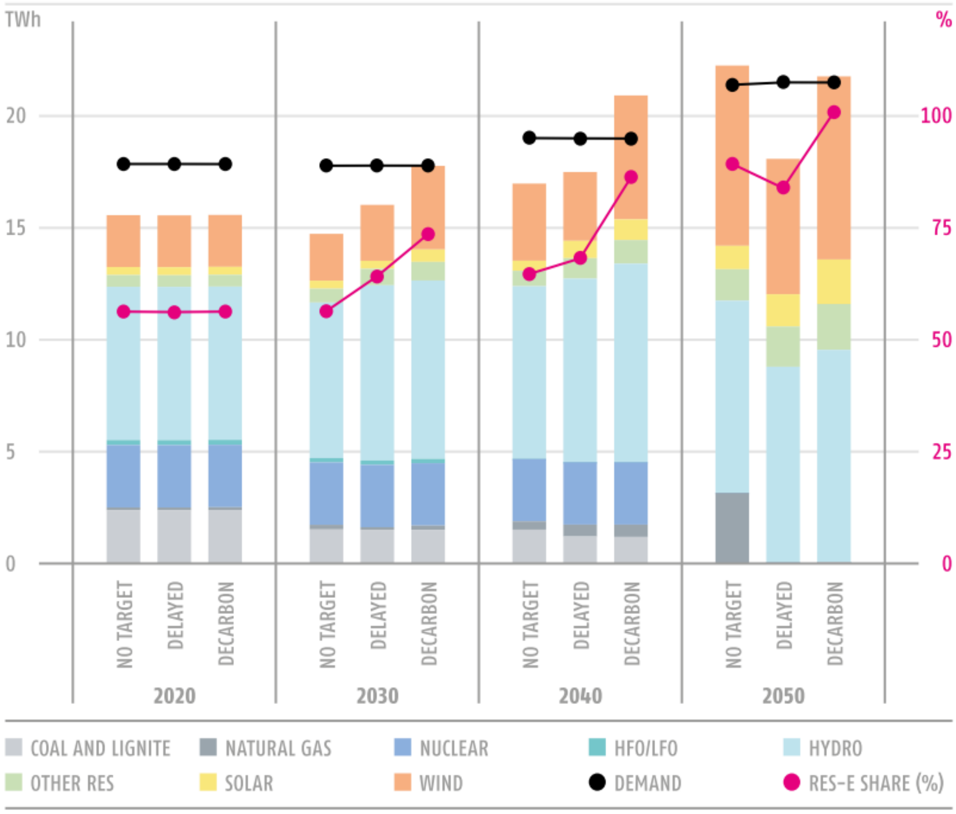
IRENA, Joanneum Research, & University of Ljubljana, (2017) also confirms that Bulgaria has high cost-competitive renewable energy potential, including up to 18 GW wind, more than 6 GW solar, up to 1 GW biomass and 1.6 GW hydro.

Bulgaria has significant renewable potential relative to the EU average. However, RES support is required. The recent failure of the Bulgarian support system is still a sensitive experience. The decreasing technology costs and an initially generous and non-capped FIT led to increasing electricity prices, which caused public resistance and ultimately led to the resignation of the government (IRENA, 2017). Thus, the introduction of well-designed policies to utilize the RES potential is indispensable. The SEERMAP model results show that under a well-planned decarbonisation pathway initial RES support is relatively high, at 7.8 EUR/MWh, but this drops to 3.7 EUR/MWh by 2025 and decreases further to 1.4 EUR/MWh in 2050. This implies that the cost of a transition to a mainly RES based energy system can be kept in check if implemented in a planned way.

INSIGHTS FROM CROATIA

The SEERMAP study has shown that Croatia has a high renewable energy potential, and renewables become the dominant mode of electricity production by 2050, even with a phasing out of renewable support. This is due to the increase in both the price of carbon and the price of gas which makes alternatives to RES economically unattractive. It is therefore not primarily renewable energy support which drives investment for this technology. According to the model results, Croatia is expected to achieve a minimum of 84% of RES-share in electricity consumption even if no renewables target is set, and a 101% RES share is achieved in the 'decarbonisation' scenario.

Figure 4 ELECTRICITY GENERATION AND DEMAND (TWH) AND RES SHARE (% OF DEMAND) IN CROATIA, 2020-2050



Source: SEERMAP Country Report Croatia

The 'decarbonisation' scenario demonstrates that an energy mix based on renewables only is feasible in Croatia. It does not drive up wholesale prices compared to non-RES policy scenarios but, on the contrary, reduces them after 2045. Furthermore, it does not pose a security of supply risk. Installed domestic generation capacity is capable of satisfying Croatia's demand in all modelled hours of the year in all scenarios.

Rajšl & Tomšić (2017) created 3 different future energy scenarios, where RES utilization is expected as shown in Figure 5.

Figure 5 RANGE OF RENEWABLES UNDER DIFFERENT SCENARIOS (NU1 AND NU2) ANALYSED BY RAJŠL & TOMŠIĆ

		2015.	2030.	2050.
Capacity				
HPP	MW	2.095	2.609	2.609 – 3.609
Wind	MW	418	1.520 – 2.200	2.200 – 6.720
SE	MW	48	1.140 - 1860	3.299 – 6.381
Other RES	MW	88	385 - 450	410 - 530
Biomass PP	MW	25	140 - 170	140 - 220
Biogas PP	MW	27	90 - 100	90 - 120
Geothermal PP	MW	0	35 - 40	40 - 50
Small HPP	MW	36	120 - 140	140

Source: Rajšl & Tomšić, 2017

The results showed a significant RES share increase in all scenarios especially in photovoltaic and wind power. An important change will happen by 2042, when the existing nuclear power plant will be decommissioned, while more flexible power plants will enter the market to compliment intermittent RES production.

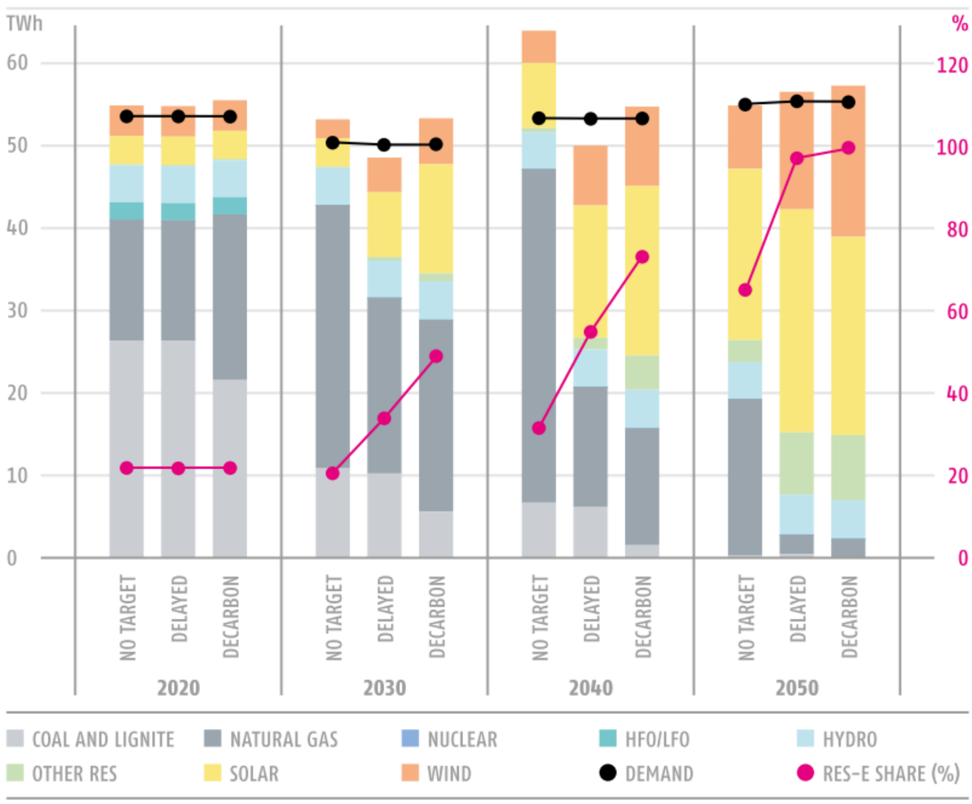
A similar analysis, carried out by Pukšec et al. (2018) analysed three different future energy scenarios for Croatia: a reference, an intensive transition and a complete transition scenario. The results showed a significant RES share increase in all scenarios especially in case of photovoltaic (1000 MW, 6000 MW and 6500 MW in the three scenarios, respectively) and wind power (2200 MW, 4500 MW and 6000 MW) by 2050. This enables a significant reduction in fossil-based power generation by 2050: compared to the reference scenario with gas-fired electricity production of 5.6 TWh, the complete transition scenario would be able to reduce this to 1.6 TWh. Coal power is phased out in all scenarios by 2050.

The "Green Book" published by Energy Institute "Hrvoje Požar" shows that Croatia can reach a 32% renewables share in gross energy consumption by 2030 and a 56% share at least, by 2050. By 2030, solar capacity is planned to reach 350 MW, which would require 20 MW of solar capacity to be built annually on average, while wind energy capacities will increase by a factor of three. This means that compared to the historical average of around 50 MW per year, approximately 110 MW of new wind capacity needs to be installed annually. (Balkan Green Energy News, 2019b)

INSIGHTS FROM GREECE

Under the SEERMAP scenarios with an ambitious decarbonisation target and corresponding RES support schemes, Greece will have an electricity mix with close to 100% renewable generation, mostly solar and wind, and some hydro by 2050. If renewable support is phased out and no CO_2 emission target is set, the share of RES in electricity consumption will reach around 65% in 2050.

Figure 6 ELECTRICITY GENERATION AND DEMAND (TWH) AND RES SHARE (% OF DEMAND) IN GREECE, 2020-2050

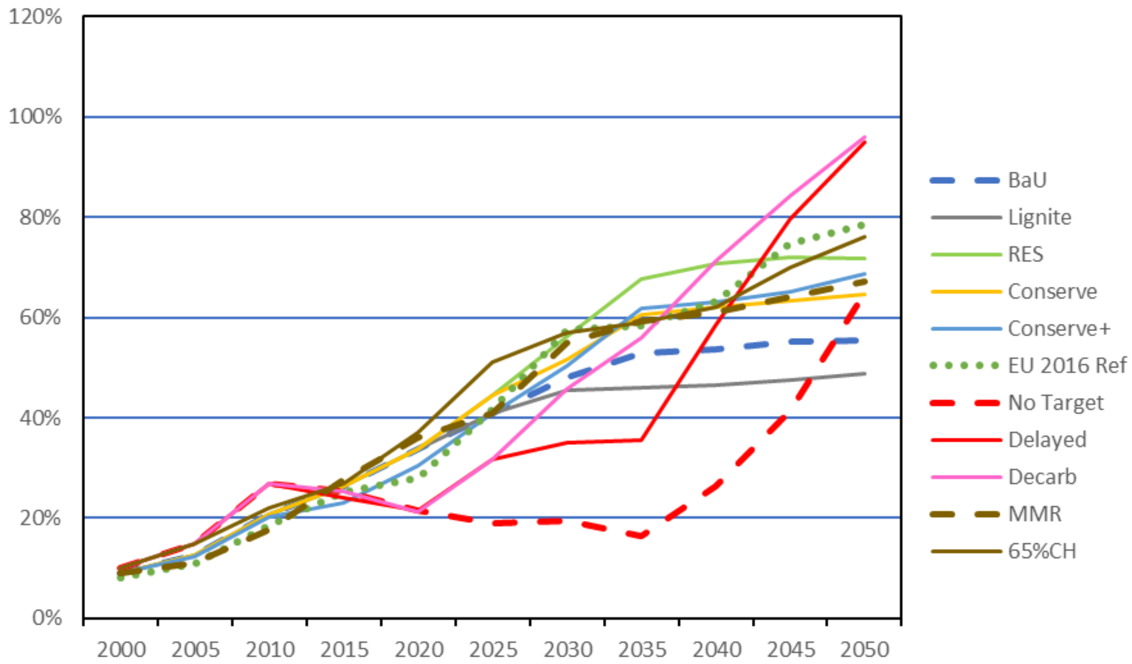


Source: SEERMAP Country Report Greece

In the scenario with the highest RES share in 2050 (the 'decarbonisation' scenario) long term RES potential utilisation reaches 33%, 68% and 64% for hydro, wind and solar respectively. This means that approximately two thirds of Greek wind and solar potential will be utilised by the end of the modelled period if this scenario is implemented, and a further technical potential exists which can be utilised when this becomes economically viable.

Lalas & Gakis (2017) summarised the results of 11 scenarios for Greece based on the results of several studies. This is presented in Figure 7Figure 7. According to the reviewed studies, the lowest RES shares are around 45-47% by 2050 in BAU or lignite scenarios, and they are above 50% in all other scenarios already by 2030. By 2050, independently of the policy applied, the RES share in electricity generation in Greece is between 50% and 80%.

Figure 7 RES IN ELECTRICITY GENERATION IN GREECE BETWEEN 2000-2050, ACCORDING TO RESULTS OF DIFFERENT ENERGY MODELLING REPORTS



Source: Lalas & Gakis (2017)

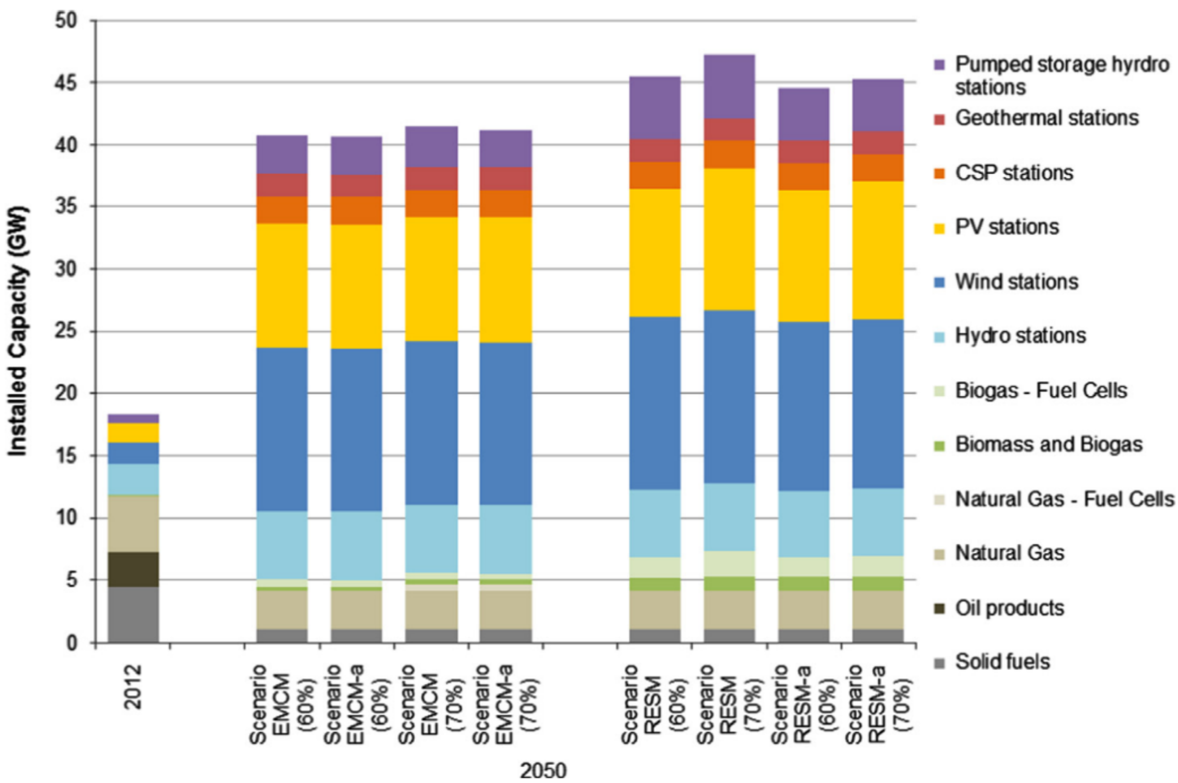
The report from WWF and NOA created and analysed five different energy development paths until 2030. The RES share in gross final electricity consumption can be seen in Figure 8. According to these scenarios in 2050, wind capacity amounts to 6.7-10.6 GW while PV capacity is expected to grow to 8. GW by 2030 and 11.3 GW by 2050 in the RES scenario (WWF & NOA, 2017). The study concludes that decarbonisation level which complies with the EU targets cannot be achieved in the BAU and lignite expansion scenarios, while 61-65% emission reduction could be realised in the other scenarios.

Figure 8 EVOLUTION OF THE RES SHARE IN THE GROSS FINAL ELECTRICITY CONSUMPTION BASED ON THE SCENARIOS CONSIDERED – BLUE REGTANGLE: TARGET FOR GREECE FOR 2020

Source: WWF & NOA (2017)

Tigas et al. (2015) modelled 3 different scenarios (current policies, renewable electricity share maximisation and environmental measures and cost minimisation) with several versions: 60% and 70% relates to the level of CO_2 emission reduction by 2050 compared to 2005; the RESM-a scenario assumes electricity imports, the EMCM-a assumes that CCS technology is used in lignite power plants. The renewable energy share maximisation scenario with a 70% emission reduction target results in an 85% RES share in the electricity sector by 2050. (Tigas et al., 2015).

Figure 9 DISTRIBUTION OF INSTALLED ELECTRICITY GENERATION CAPACITY IN 2050 FOR VARIOUS SCENARIOS

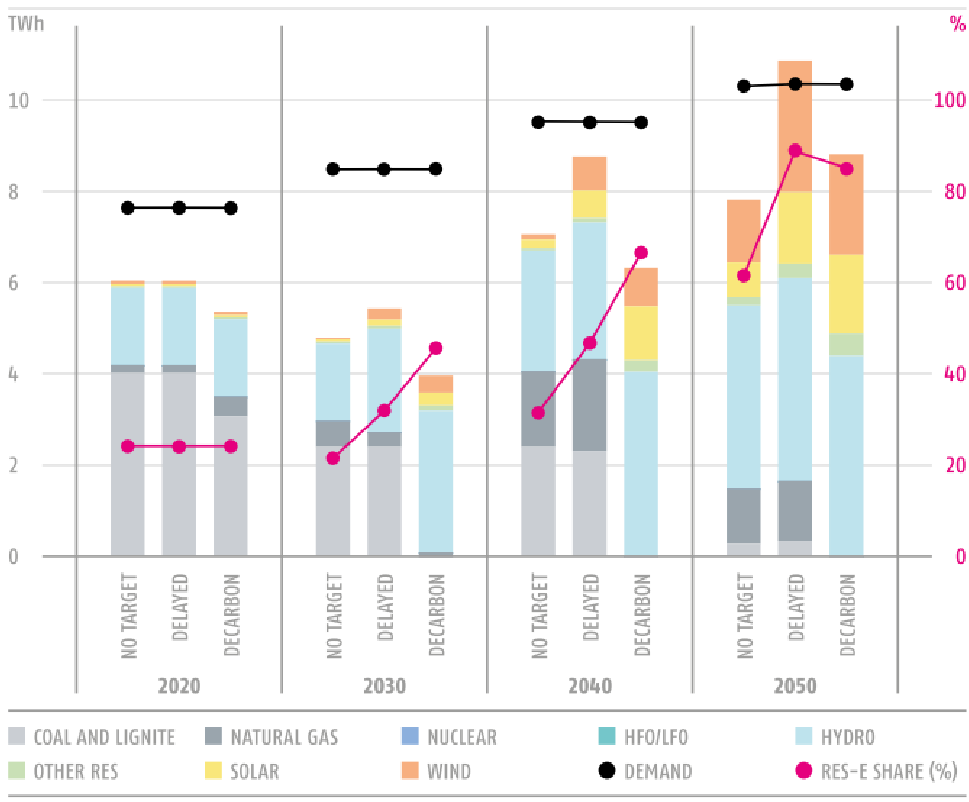


Source: Tigas et al. (2015)

INSIGHTS FROM NORTH MACEDONIA

According to the SEERMAP results, North Macedonia can significantly increase its current share of RES generation in all scenarios by 2050, reaching a 61% share of consumption in the 'no target' scenario and 85-89% in the two scenarios with a decarbonisation target. At the same time, the share of fossil fuels will be reduced significantly by 2050, falling to 19% in the 'no target' and zero in the 'decarbonisation' scenario.

Figure 10 ELECTRICITY GENERATION AND DEMAND (TWH) AND RES SHARE (% OF DEMAND) IN NORTH MACEDONIA, 2020-2050



Source: SEERMAP Country Report North Macedonia

In all scenarios hydro emerges as the dominant RES technology in North Macedonia, reaching 40-50% of total generation by 2050. SEERMAP modelling shows hydro capacity increasing to 1754 MW by 2050, and to 1388 MW in the restricted potential scenario. A UNDP study for Macedonia shows very similar results; the study proposes three optimal generation capacity mix scenarios expecting 1279 MW hydro by 2030.

Consequently, energy efficiency and demand side management measures are of utmost importance, as the development of hydro always raises nature protection issues. The contribution of wind and solar is also significant. In the 'decarbonisation' scenario, wind is responsible for 25% of total generation and solar adds almost 20% by 2050. This represents a 30-fold increase in wind generation and more than 50-fold increase in solar generation by 2050 compared with current levels. Biomass remains insignificant (below 6%) in all scenarios.

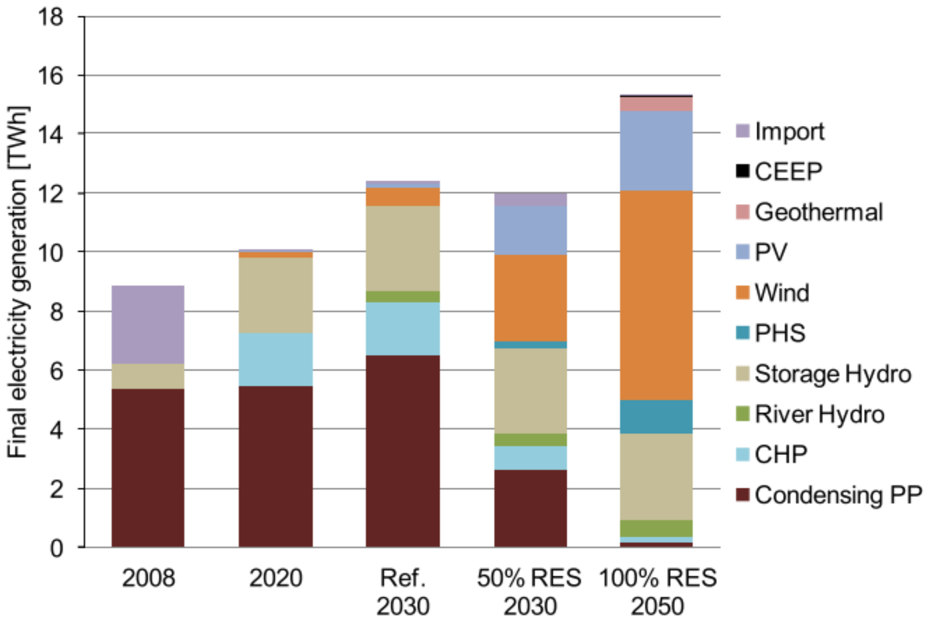
Ćosić, Markovska, Krajačić, Taseska, & Duić (2012) analysed four different RES scenarios by 2020. The results of scenario analyses show that the CO_2 emissions from the energy sector can be reduced even in relatively short timeframe: by between 0.84% and 9.54% compared to the reference scenario within 8 years.

Ćosić, Krajačić, et al. (2012) analysed a 100% RES-scenario for Macedonia. They used an hourly detailed simulation and minimised electricity imports and exports as well as fuel use. They assumed rising electricity demand from 7.68 TWh in 2008 to 12.37 TWh in 2030 (a 2.11% annual increase). By 2030 (50% RES) and 2050 (100% RES), they expected the following main capacity changes:

- Bitola 1, Bitola 2 and Oslomej coal power plants phased out by 2030, all coal and gas fired power plants phased out by 2050;
- Wind capacity increases to 1500 MW by 2030;
- PV capacity increases to 1100 MW by 2030 and to 1600 MW by 2050;
- 50 MW geothermal power capacity by 2050;
- 50 MW large heat pumps in district heating systems by 2050;
- Storage hydro expands from 700 MW to 1500 MW in 2030 and 1800 MW in 2050.

The results of the model are presented in Figure 11.

Figure 11 ELECTRICITY GENERATION BY TECHNOLOGIES FOR DIFFERENT SCENARIOS



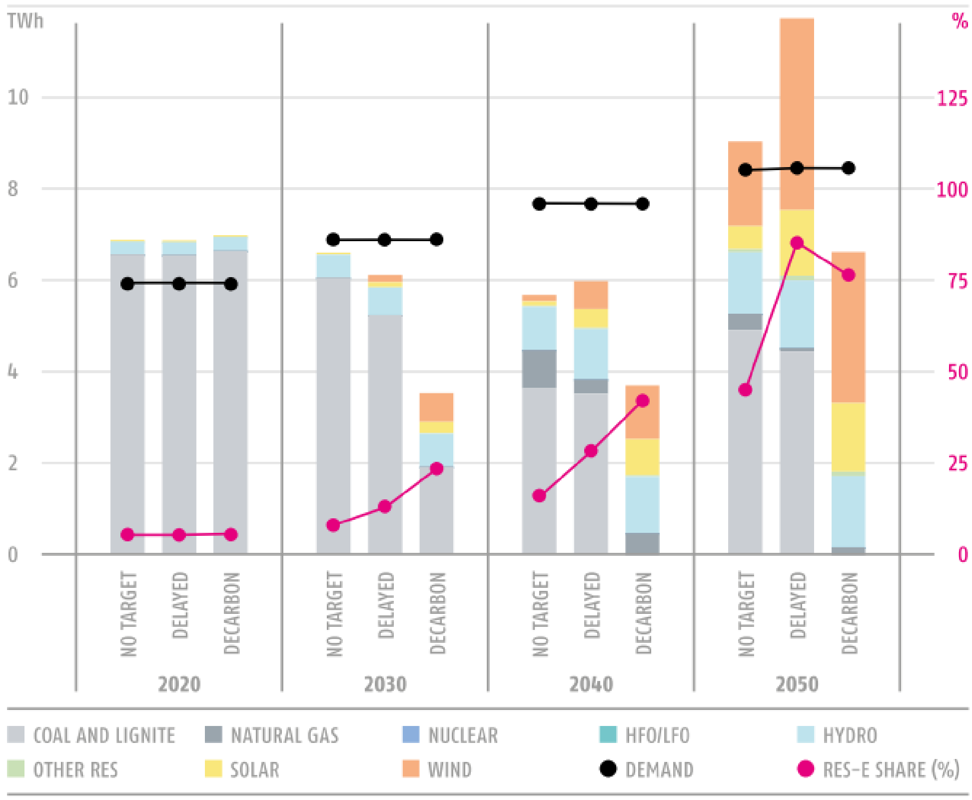
Source: Ćosić, Krajačić, et al. (2012)

As Ćosić, Krajačić, et al. (2012) conclude, results of the analysis show that a "100% renewable energy system in Macedonia is possible, however, to achieve this goal high share of biomass, wind power and solar power as well as different storage technologies are needed." They also included flexible technologies such as electric cars and heat pumps to help balance load. They highlight that the calculated biomass production (19.8 PJ) "may be too high for Macedonia by 2050" and they recommend implementation of energy efficiency policies to prevent high biomass consumption.

INSIGHTS FROM KOSOVO*

Regardless of whether or not Kosovo* pursues an active policy to decarbonise its electricity sector, RES-based capacities will expand significantly from current low levels. Kosovo* is set to achieve 44% RES-share in electricity consumption by 2050 even if no emission reduction target is set; the share of RES reaches 85% in the 'delayed' scenario and around 75% in the 'decarbonisation' scenario. The high penetration of RES found in all scenarios suggests that the energy policy of Kosovo* should focus on enabling RES integration. The above results can be achieved by utilising a mix of renewable energy sources including solar, hydro and wind. Achieving these RES penetration rates would necessitate high levels of utilisation of RES potential; the utilisation of RES technical potential is highest in the 'delayed' scenario in 2050, over 80% for hydro, 91% for wind and 71% for solar. In the 'decarbonisation' scenario, utilisation of wind potential is significantly lower at 72%.

Figure 12 ELECTRICITY GENERATION AND DEMAND (TWH) AND RES SHARE (% OF DEMAND) IN KOSOVO, 2020-2050*



*Source: SEERMAP Country Report Kosovo**

FACT: Decarbonisation is cheaper in the long run

The cost of decarbonisation is influenced by a number of factors, including:

1. a decline in the technology costs of renewables is expected, RES are becoming cheaper;
2. the investment cost of renewables can be further reduced via reducing investment risks and by pooling resources to address high initial investment costs;
3. long-term RES support schemes help decrease the initial level of subsidies needed for the expansion of RES;
4. a mix of technologies and solutions needs to be used to reach decarbonisation targets most cost-effectively;
5. RES has multiple benefits for health, environment, etc., which make the overall social cost-benefit calculation even more favourable.

This section is structured along these factors and discusses evidence both from SEE as well as global trends.

RES technology costs are falling and these technologies are becoming increasingly competitive

The cost of renewable technologies has been continuously decreasing in the past decades and the trend is continuing. According to IRENA et al. (2017) the technology costs of renewables as well as the cost of capital will further decline in the coming decades, which will increase the cost-competitiveness of both solar and wind, thereby making these technologies more cost effective. The World Energy Outlook for 2017 of the International Energy Agency (IEA, 2017) highlights "the rapid deployment and falling costs of clean energy technologies" as the first major trend in global energy system.

In particular, the "growth in solar PV capacity was larger than for any other form of generation" in 2016. Since 2010 new PV panel costs have decreased by 70% (while wind energy costs decreased by 25% and the cost of batteries by 40%)(IEA, 2017). Between 2014 and 2016, the average photovoltaic system price decreased by 23% (EY & Solar Power Europe, 2017). "From an unsubsidised cost of approximately 76 USD/watt in 1976, solar photovoltaic (PV) modules have declined in price to below $0.50 USD/watt in 2017, with the total installed costs for ground-mounted PV systems having recently fallen below 1 USD/watt. This rapid cost reduction is evidenced in recent auction rounds that have taken place around the world" (Couture, Jacobs, & Appleman, 2018).

"In the wind power sector, similar cost declines have been observed. At the windiest locations, the levelised cost of wind power generation in the U.S. averaged around 55 USD cents/kWh in 1980. By 2000, the levelised cost of wind power had declined by over 90 % to approximately 6 USD cents/kWh" (Couture et al., 2018). "Despite coming relatively late to the party, offshore wind power is experiencing an equally remarkable evolution: the first offshore wind auctions in the North Sea in 2010 yielded costs of just over 160 EUR/MWh; more recent tenders have yielded prices in the range of 60 EUR/MWh, representing a remarkable 60 % cost decline in just under seven years. As larger turbine models come online and offshore operations and maintenance (O&M) teams grow in scale and sophistication, further cost reductions are expected" (Couture et al., 2018).

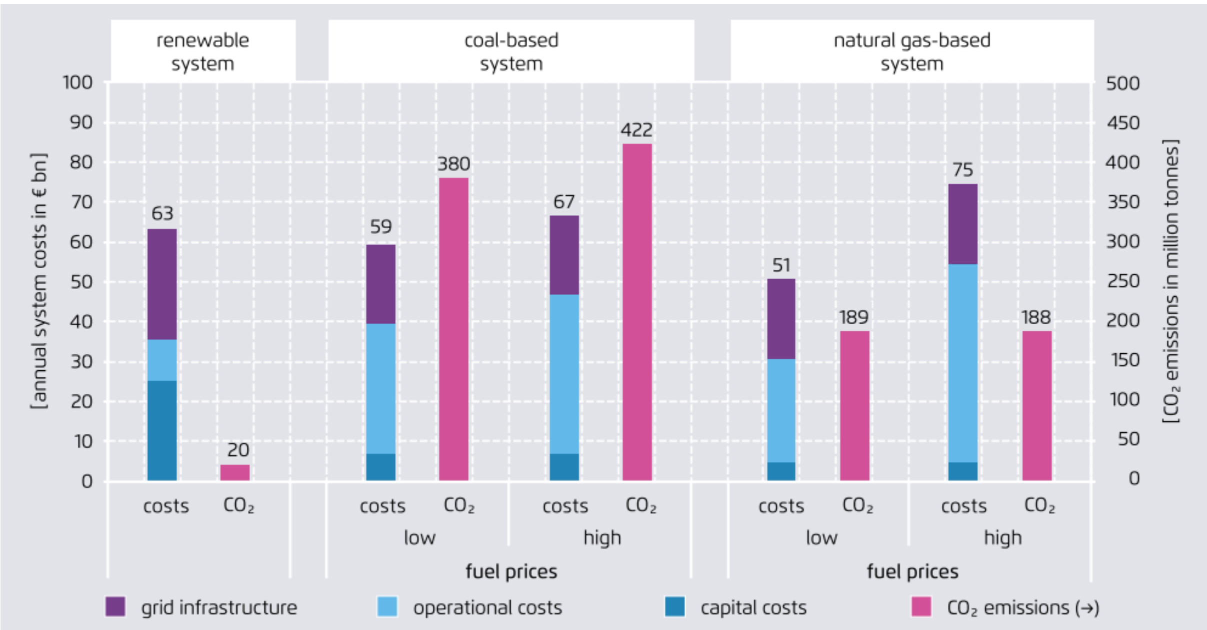
Due to this rapid decrease in the cost of renewable technologies in some countries these technologies are already cheaper than traditional fossil fuel-based electricity generation (IRENA et al., 2017). In 2017, more investments were made in new renewable energy capacities than in fossil-fired units. In fact, IRENA, IEA, & REN21 (2018) claim that renewables have become a "technologically mature, secure, cost-effective and environmentally-sustainable energy supply option". According to the IEA's New Policies scenario, renewables become the most economic generation option for many countries by 2040, when the majority (two-thirds) of global power generation investments is expected to be in renewables (IEA, 2017). However, in most locations renewable technologies still require support. In addition, initial investment costs are often high for RES technologies.

In Bosnia and Herzegovina, Wpd Adria is planning to build wind farms of a total of 900 MW capacity until 2030, and an additional 300 MW investment is planned in Croatia where the company has already installed wind farms of 100 MW capacity in total. According to the management of Wpd Adria, the company doesn't need feed-in tariffs for this investment totalling EUR 1.5 billion. Instead, what it needs is a clear regulatory framework. This shows how important the rule of law and clear regulations are to attract investments and reduce the need for financial support (Spasić, 2019g).

The competitiveness of RES technologies depends on a number of factors which vary by location, including for example physical potential and cost of capital. Currently renewable energy technologies in general are not yet fully competitive in the SEE region, but SEERMAP results show that over the short to medium term the support required to ensure RES expansion will be relatively low. Required support will reach 6.6 EUR/MWh at its highest on average in the SEERMAP region. However, by 2050 the necessary RES support level will drop to 2 EUR/MWh. At the same time, a reduction in the wholesale electricity price by 16 EUR/MWh can be achieved by 2050 compared with scenarios with a lower share of RES, thereby benefitting society.

An analysis was carried out by Öko-Institut commissioned by Agora Energiewende to determine and compare total system costs – including generation, grids and storage – of alternative (RES-based, coal-based and natural gas-based) energy systems in Germany by 2050 (Öko-Institut, 2017). The results are presented in Figure 13.

Figure 13 COMPARISON OF TOTAL SYSTEM COSTS OF PREDOMINANTLY RENEWABLE, COAL AND NATURAL GAS-BASED POWER SYSTEMS WITH CO_2 PRICES OF 50 EUR, 2050



Source: Öko-Institut (2017)

The analysis resulted in three key findings:

1. In most cases, a 95% RES energy system is cheaper or is on the same price level as other, fossil-based scenarios. High coal share is only significantly cheaper if the CO_2 prices stay around 20 EUR/t which is lower than expectations (and than current EUA prices). Gas-based electricity systems require low gas prices and CO_2 prices below 100 EUR/t.
2. High renewable shares stabilize energy prices as variable costs are only 5% compared with 30-67% in fossil-based systems, depending on variability of fuel and CO_2 prices.
3. While estimated CO_2 damage costs are 80 EUR/t over the short-term and 145-260 EUR/t over the long-term, a high share (95%) RES-based electricity system is able to decrease CO_2 emissions by 96% at a cost of only 50 EUR/t, providing a cost-efficient solution for tackling climate change. (Öko-Institut, 2017)

Capros et al. (2014) claim that in a cost-optimal pathway, less than 1% of GDP in the period 2015-2050 in cumulative terms is needed to reach the European emission reduction targets.

The SEERMAP study shows that in order to achieve a 94% decarbonisation of the electricity sector by 2050, RES support relative to the electricity cost (wholesale price plus RES support) is only 2.6% at its highest level in the 'decarbonisation' scenario, indicating that if renewable energy deployment is well planned and forward-looking policies are in place, the impact of decarbonisation on households and businesses can be kept low.

If Europe aims for a 100% renewable based energy system, then "the total calculated annual socio-economic cost of the (SEE) region is approximately 20 billion EUR lower in the year 2050 than in the base year (2012)" (Dominković et al., 2016), which proves that decarbonisation is not only environmentally but also economically the most efficient and sustainable solution.

In general, according to the report of Energy Union Choices (2017), decarbonisation of the power sector that is faster than that needed to reach the 2030 targets is technically feasible and an increase of ambition to 55% emission reduction could save 600 mEUR on system costs and add 90 000 net jobs in Europe.

Transition to a smarter energy system requires an increase in investment in RES according to a report by IRENA (IRENA, 2016); "doubling the share of RES in the global energy mix by 2030 would increase global GDP by up to 1.1% or USD 1.3 trillion". Most of this effect is due to higher amounts of investments in RES, and the indirect effect this has on other sectors of the economy. The doubling of the share of renewable energy would have an even higher impact on welfare: by 2030 it would increase by 2.7 %. The indicator used to assess welfare is a combination of factors like economic impacts (based on consumption and investment), social impacts (based on health and education expenditures) and environmental impacts (measured as GHG emissions and the consumption of materials). Another co-benefit of this rise by a factor of 2 is its effect on jobs: the direct and indirect employment in the renewable energy sector could attain 24.4 million people in 2030. We can therefore say that contrary to the statement formulated in this myth, we need more RES because of the numerous benefits their deployment brings.

Investment risks need to be addressed to further lower costs of RES

The fact that initial investment costs are higher for RES than for traditional fossil fuel-based technologies implies that the cost of capital is an important factor in determining the economic viability of RES investment. The weighted average cost of capital (WACC) is significantly higher in the SEE region than in countries in Western Europe. In the SEERMAP report, WACC values in the region are assumed to be between 10 and 15% in 2016. Ecofys – Eclareon (Ecofys, 2017) estimated current WACC values for onshore wind to be between 7-13.7% and for PV between 7-12.4% for Bulgaria, Greece and Romania. IRENA et al. (2017) assumed medium level WACC values of 8 to 12% for SEE countries in 2016.

A high cost of capital can result in low RES shares despite high physical potential. This can be illustrated by comparing physical RES potential and realised RES potential in Germany and North Macedonia. North Macedonia has a significantly higher physical solar potential than the European average. Even sites with lower solar potential in North Macedonia have higher potential than the best sites in Germany (SOLARGIS 2017). However, electricity production from PV is much higher in Germany. This is due to the differences in investment risk as well as differences in support schemes. (Fraunhofer ISE 2018).

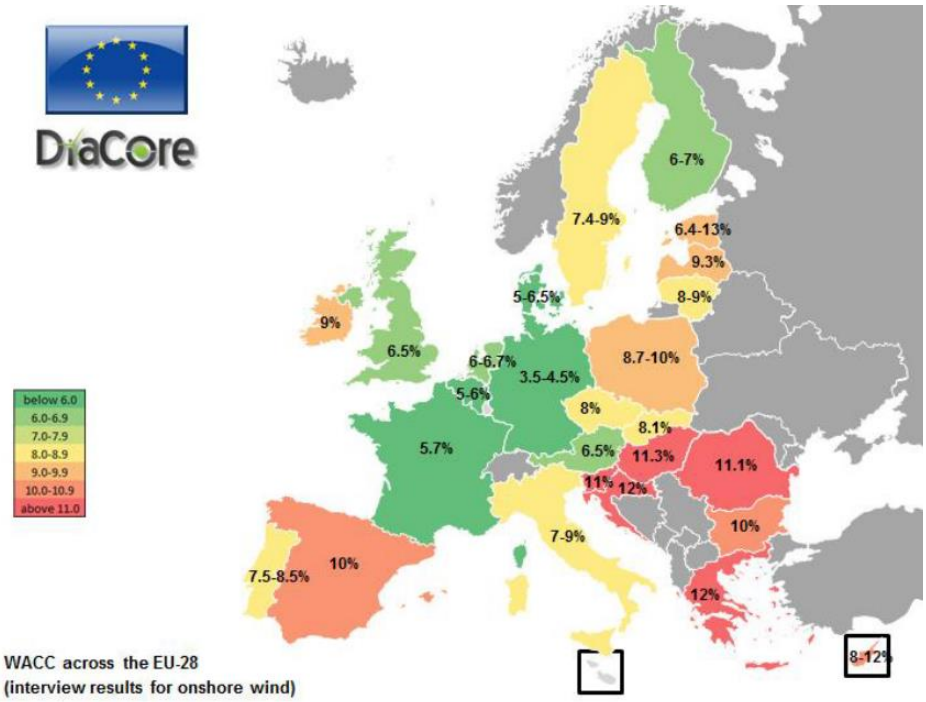
The components of the risk premium which needs to be paid to investors include general country risk, policy risks specific to the energy sector, as well as technology related risks. Some of these risks can be reduced using de-risking policies, making RES investment more attractive, and resulting in a lowering of necessary subsidies to ensure RES investment takes place.

NewClimate Institute researched the effect of de-risking policies on investments in the RES sector (NewClimate Institute, 2019). The study outlines that in South East Europe financing costs of RES are higher, because investors feel that investment risk is higher. This perceived risk could be lowered by different measures including long-term RES targets, long-term RES remuneration systems, effective and efficient intraday markets, corporate power purchase agreements and a newly proposed EU budget guarantee mechanism for the 2021-2027 period. The analysis shows that these de-risking measures could lower the cost of renewable energy projects by 20 percent, significantly increasing the financial viability of RES projects. The study concentrates on two country case-studies: de-risking measures for onshore wind in Greece and in Serbia. According to the study, the 3 main risk categories that contribute to high financial costs of wind energy investments in Greece are power market risk, social acceptance risk, and financial sector risk. In Serbia, these are power market risk, political risk and counterparty risk.

The DiaCore project results confirm that insufficient RES policies and unreliable frameworks increase risk and thereby capital costs for investors (Noothout et al., 2016) in South East Europe. Figure 14 illustrates the difference between WACC levels in Europe, clearly showing higher expected returns in the SEE region than elsewhere.

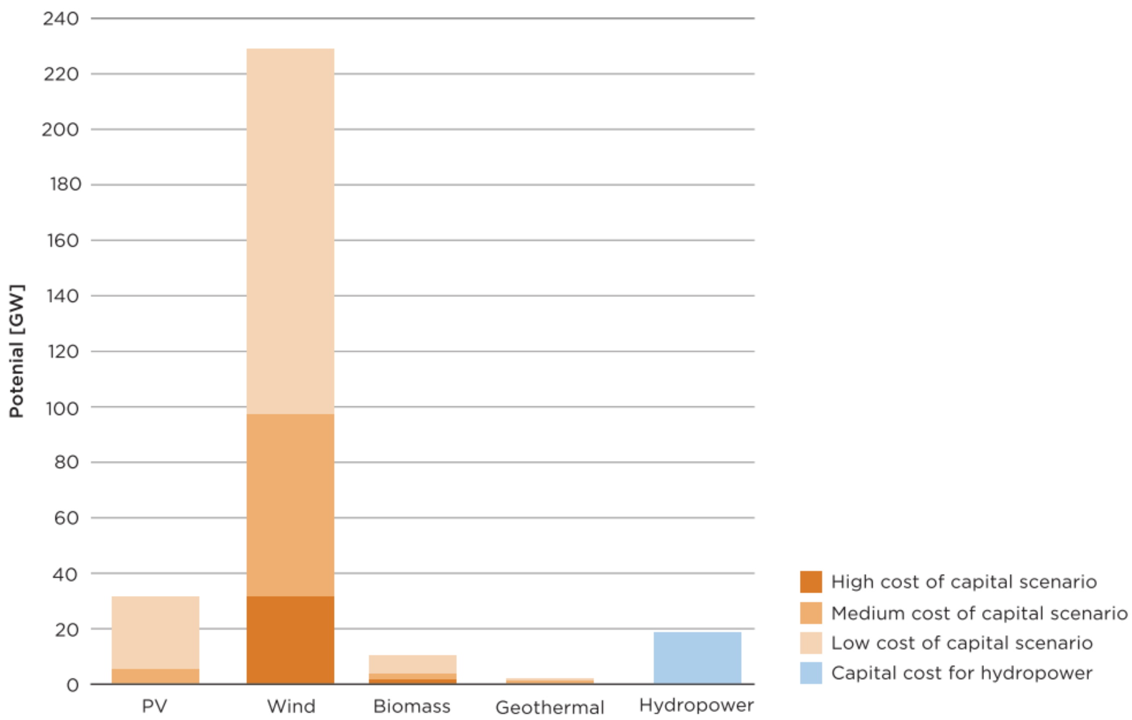
Technology risk is also an important factor in increasing the cost of RES investment. The choice of investing in wind and PV increases the overall risk of the investments in question, as renewables are considered to be more risky than other average investments, which means “an additional 7% points to the cost of equity in Bulgaria and Romania, 5% points in the Slovak Republic, and 6% points in Hungary. However, in Greece, renewable energy investments are regarded as safer compared to average investments and decrease the risk by 2% points in the case of wind onshore and 3% points in the case of solar PV”, according to Ecofys (2017).

Figure 14 WACC ESTIMATIONS FOR ONSHORE WIND PROJECTS IN 2014



Source: Noothout et al. (2016)

Figure 15 CUMULATIVE ADDITIONAL COST-COMPETITIVE RENEWABLE POWER POTENTIAL FOR SEE IN 2016 UNDER DIFFERENT COST OF CAPITAL SCENARIOS



Source: IRENA et al. (2017)

A 2018 study commissioned by Friedrich Ebert Stiftung confirms the fact that renewable energy potential in SEE is bigger than what could be implemented in a cost-competitive way today, due in part to risks being perceived as high by potential investors. (Nabiyeva, 2018).

IRENA et al. (2017) show that if these issues associated with higher risks are managed, then under a low cost of capital scenario almost 300 GW of additional RES potential could be utilised compared with the current high-risk scenario in the SEE region. Under a medium cost of capital scenario (compared to today's high investment risk), 17% of the identified technical potential, equivalent to 126.9 GW RES could be installed in a cost-effective way in the SEE region. This is "15 times higher than the 8.2 GW of additional total capacity planned up to 2020, as required by the NREAPs".

The SEERMAP report also demonstrates that de-risking policies to address high cost of capital are important for the SEE region and that options for implementing regional level de-risking facilities should be considered.

Policy related risks can be reduced at the national level, by ensuring stable, long term renewable energy policy frameworks are in place. This should be a priority for subsequent governments in countries of the region. Another way of addressing the barriers associated with high initial investment costs is to pool resources. Community renewable energy production has already achieved success in low cost local energy production which is effective in dealing with energy poverty in some Western and Northern European countries (Dryzek, Norgaard, & Schlosberg, 2011; Sáfián, 2014). For example in a peripheral Danish region of Samsø island, locally grown renewable-based community district heating solutions offer cheap residential district heating prices (sometimes defined by a local committee) and also jobs to the island which was lacking of it before (Jørgensen, 2007). Alternatively, Temperton, Buck, Graf, & Brückmann (2018) recommended a Renewable Energy Cost Reduction Facility towards the EU to reduce investments costs of RES and therefore save taxpayers' money.

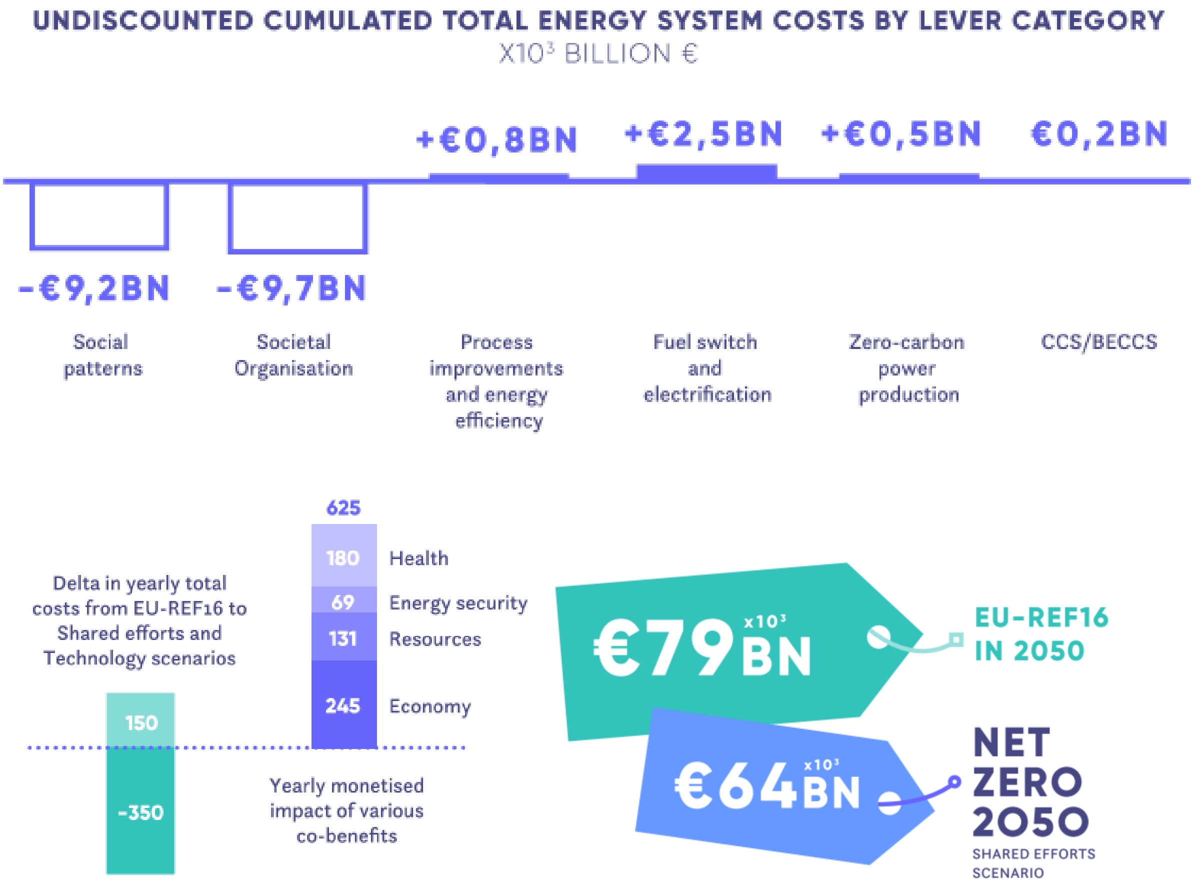
Long-term planning is important to lower costs

According to the SEERMAP reports, strong, well-planned and consistent RES support schemes – starting as soon as possible – help the implementation of a feasible and effective decarbonisation of the energy sector. Delayed action on renewables is also an option but has distinct disadvantages compared to a long-term planned RES support scheme, such as stranded costs and higher RES support requirements over the long term. The RES support relative to the electricity cost (wholesale price plus RES support) is only 2.6% at its highest level in the 'decarbonisation' scenario, indicating that if renewable energy deployment is well planned and forward-looking policies are in place, the impact of renewable subsidies on households and businesses can be kept very low.

A mix of different solutions and technologies can lower system cost

A fresh study of Climact & ECF (2018) modelled a wide range of methods (here: levers) to reduce emissions in all sectors, including power production, industry, buildings, transportation, agriculture, forestry and land-use, in order to identify cost-optimal pathways to reach net zero emissions by 2050 in the EU. The levers, categorised in six groups, where not only technological but also organisational and included other soft solutions such as dietary changes. They study developed different scenarios where these levers were used in different mixes. The 'Shared efforts' scenario utilizes all levers in all sectors with no specific emphasis; the 'Technology' scenario focuses on "efficiency and innovative technological options by raising their ambition to the highest levels"; the 'Demand-focus' scenario utilizes demand-side levers to reduce demand for energy, meat, technological solutions etc. The results show that "social patterns, societal organisation and energy efficiency are key to make it easier to reach net-zero" future in the EU. Different results of the 'Shared effort' scenario can be seen in Figure 16 compared to the EU Reference scenario.

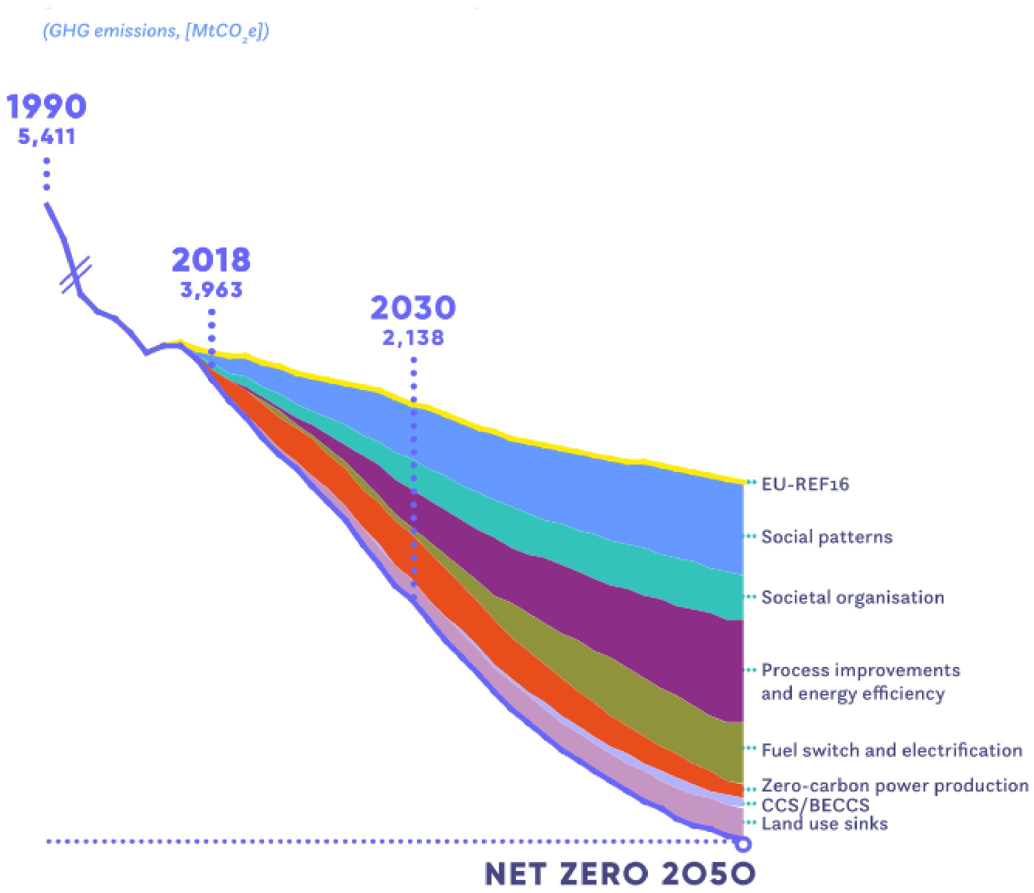
Figure 16 DIFFERENCE IN TOTAL SYSTEM COSTS BY LEVER GROUP BETWEEN THE EU-REF16 AND THE SHARED EFFORTS NET-ZERO SCENARIO (UPPER FIGURE); COSTS AND INVESTMENTS COMPARED TO THE POTENTIAL IMPACT OF CO-BENEFITS AND CLIMATE DAMAGES (BOTTOM, LEFT); UNDISCOUNTED CUMULATED TOTAL ENERGY SYSTEM COSTS BY LEVER CATEGORY [x10³ BILLION EUR] (BOTTOM, RIGHT)



Source: Climact & ECF (2018)

The results show that if a more holistic approach is applied the total system costs of reaching a net zero GHG emission scenario are lower than the cost of a reference scenario, a win-win situation for all of society. “Essentially a net-zero society uses its resources much more efficiently across all sectors: products with longer lifetimes and increased asset utilisation (e.g., using fewer cars but using them more than the 5% of the time that is currently the case). (…) It shows how strong the impact of improving the way our society is organised can be.” (Climact & ECF, 2018)

Figure 17 GHG EMISSION REDUCTIONS BY LEVER TYPES IN A SHARED EFFORTS (SEE THE SECTION ON THE "ANALYTICAL BASIS" P.7 TO READ ON THE VARIOUS SCENARIOS USED IN THIS REPORT.) NET-ZERO SCENARIO [$MTCO_{2E}$]



Source: Climact & ECF (2018)

INSIGHTS FROM ROMANIA

The SEERMAP modelling assumes that current coal and lignite fired generation plants are retired in all scenarios by 2030, in accordance with national plans. The model does not build any new lignite or coal capacities and the total share of fossil fuel-based generation decreases in all scenarios compared with current levels by 2050. This confirms that coal is not a cost-efficient generation option in Romania. In contrast to this result, the draft of the new Energy Strategy of Romania does contain a new 600 MW lignite power plant to be built until 2030 (Romanian Ministry of Energy, 2018).

A sensitivity analysis showed that a low carbon price which is half of the level assumed in the 'decarbonisation' scenario is still not enough to make lignite and coal-based generation profitable in Romania over the medium term.

Renewables play an increasingly important role in all three scenarios of the SEERMAP study meaning that they represent an economically feasible solution in the future. New wind capacity investment is particularly strong, almost tripling by 2050 in the 'delayed' scenario and also increasing significantly in the 'decarbonisation' scenario due to a combination of high wind potential, decreasing cost of technology and the price of carbon. New solar investments increase at an even higher rate, reaching five times 2016 levels by 2050 in the 'decarbonisation' scenario. In absolute terms wind power dominates, with solar additions more moderate, and the same applies to biomass. Meanwhile hydro capacity increases by approximately 20% until 2050 in both the 'delayed' and 'decarbonisation' scenarios.

IRENA et al. (2017) also confirm that the cost-competitive renewable energy potential is comparably high in Romania. Moreover, it “has the largest additional cost-competitive solar capacity in the whole SEE region (up to 16.9 GW)” and it also has a significant wind potential of 84 GW. IRENA et al., (2017) also highlight that “the total additional cost-competitive renewable energy potential (up to 71 GW) is approximately six times higher than the deployment level today or the level envisaged in the NREAP by 2020”.

INSIGHTS FROM GREECE

SEERMAP results show that coal, lignite and oil capacities are phased out under all scenarios by 2050. The decrease in the share of these fuels begins early, mainly driven by the rising price of carbon and the low marginal cost of RES which results in unprofitable utilisation rates of existing fossil fuel capacities. The share of coal falls to around 10% of total generation by 2040 in all scenarios. Whether or not Greece pursues an active policy to support renewable electricity generation, fossil fuel generation capacity will decline driven by the price of carbon. Investments in coal and oil made at any time during the modelled time period will result in stranded assets.

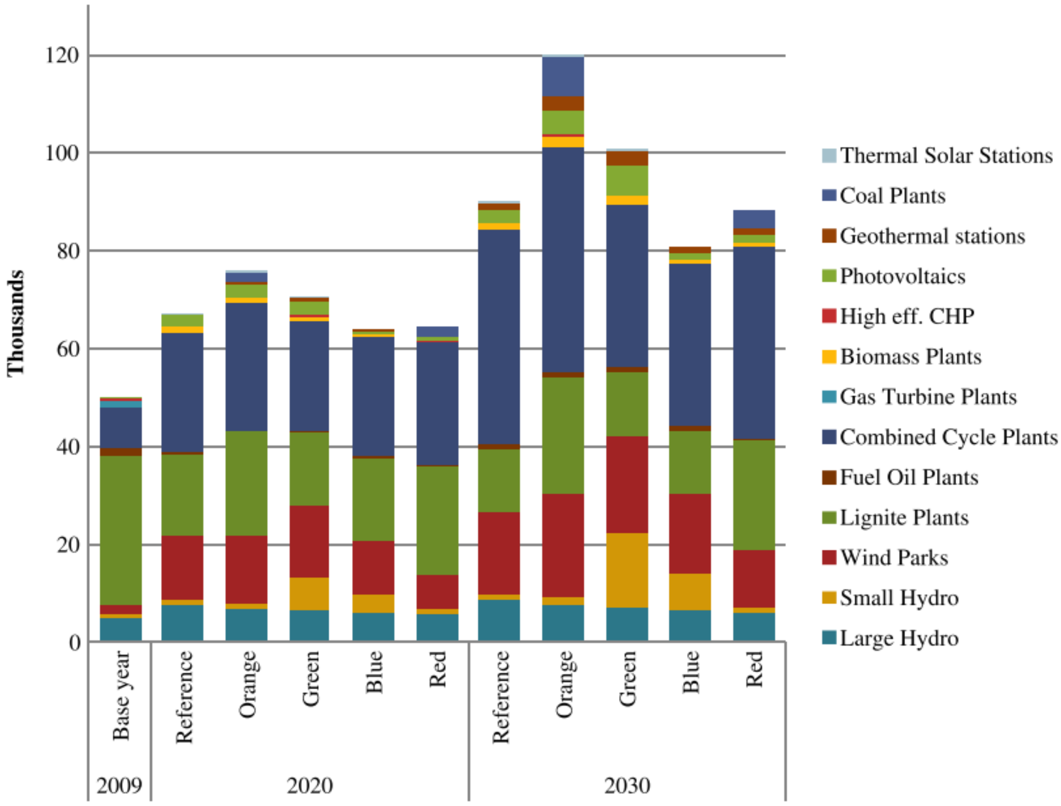
The decarbonisation of the electricity sector in Greece is “inevitable with or without new measures and policies and even without very high CO_2 prices”, based on the results of the 10 scenarios from CRES, NOA, SEERMAP and the EU 2016 Reference Scenario (Lalas & Gakis, 2017). At the same time the air emission abatement costs related to fossil energy production should be also considered, when comparing costs of fossil-based and RES-based capacities in the energy system. The Dimitrios ST I-II power plant in Greece has NO_X emissions more than 150% above BREF (Best Available Techniques Reference document) (Gerrard Wynn & Coghe, 2017). This means, that by 2021, the plant should be ready with new technological investments – which could add 2-4 EUR/MWh cost on electricity generation (Gerrard Wynn & Coghe, 2017) – or it has to be closed.

Roinioti, Koroneos, & Wangensteen (2012) designed and calculated 4 different long-term scenarios in addition to a reference scenario to provide an outlook for the Greek electric system by 2030 focusing on RES development. The scenarios’ narratives are:

- Green scenario: low emissions, high growth; advanced RES technologies;
- Orange scenario: high emissions, high growth; traditional energy & RES;
- Red scenario: high emissions, low growth; traditional energy;
- Blue scenario: low emissions, low growth; advanced RES & traditional energy.

The results of the analysis are shown in Figure 18.

Figure 18 ELECTRICITY GENERATION PER TECHNOLOGY TYPE AND SCENARIO (GWH)

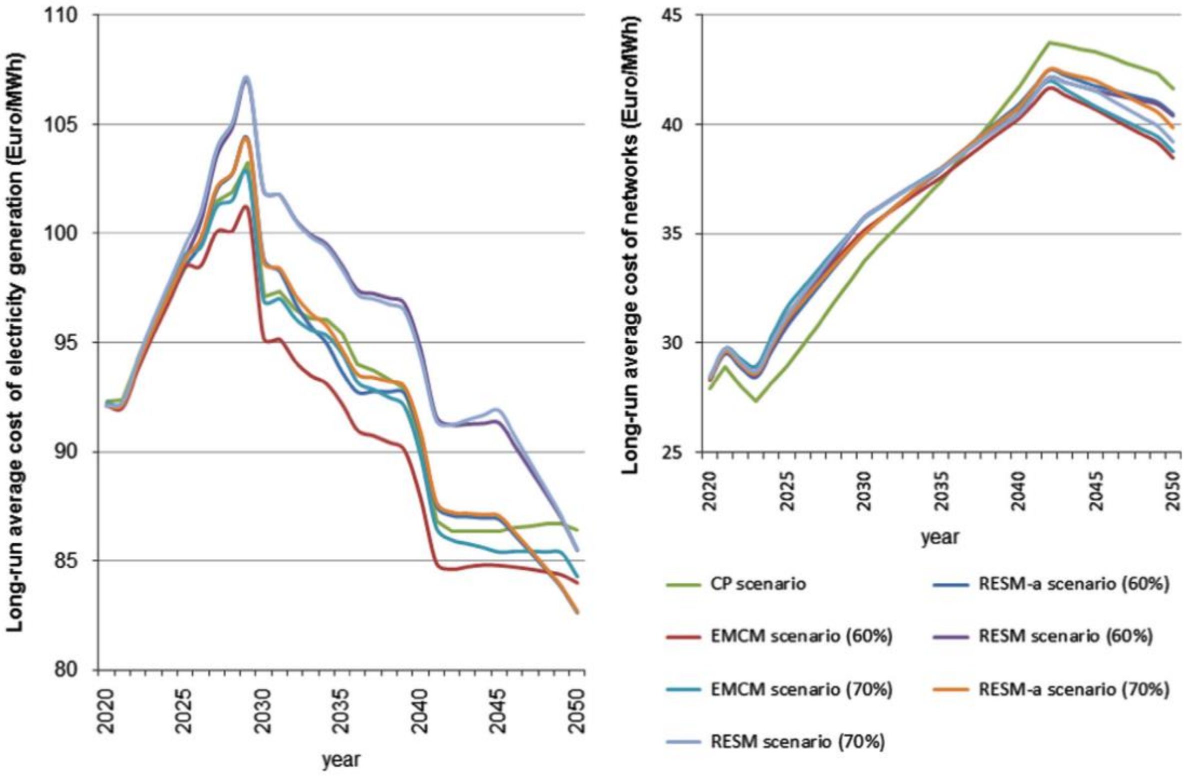


Source: Roinioti et al. (2012)

Under the Reference scenario, natural gas-based electricity will expand from 19% in 2009 to 48% in 2030. In the Green scenario, it increases to 32% by 2020 and does not change afterwards until 2030. The RES share reaches 53.1% in the Green, 41.9% in the Blue, 33.7% in the Orange and 25.4% in the Red scenario by 2030 (Roinioti et al., 2012). This research clearly shows that in any scenarios, including the Reference scenario, the role of lignite-based power production will decrease while electricity from gas, wind and PV will increase dynamically by 2030.

Tigas et al. (2015) modelled 3 different scenarios (current policies, renewable electricity share maximisation and environmental measures and cost minimisation) with several versions (RES-a with electricity import, EMCM-a uses CCS in lignite power plants).

Figure 19 LONG-RUN AVERAGE COST OF ELECTRICITY GENERATION AND NETWORK EXPANSION IN GREECE BETWEEN 2020 AND 2050



Source: Tigas et al. (2015)

The model results showed that Current Policies Scenario results in the most expensive generation and also network costs by 2050, while expenditures in other scenarios fall after 2030. The renewable electricity share maximisation and environmental measures and cost minimisation scenarios provide 60-70% emission reduction compared to 2005 while lowering import dependency, resulting in more stable energy prices and creating a domestic RES industry (Tigas et al., 2015).

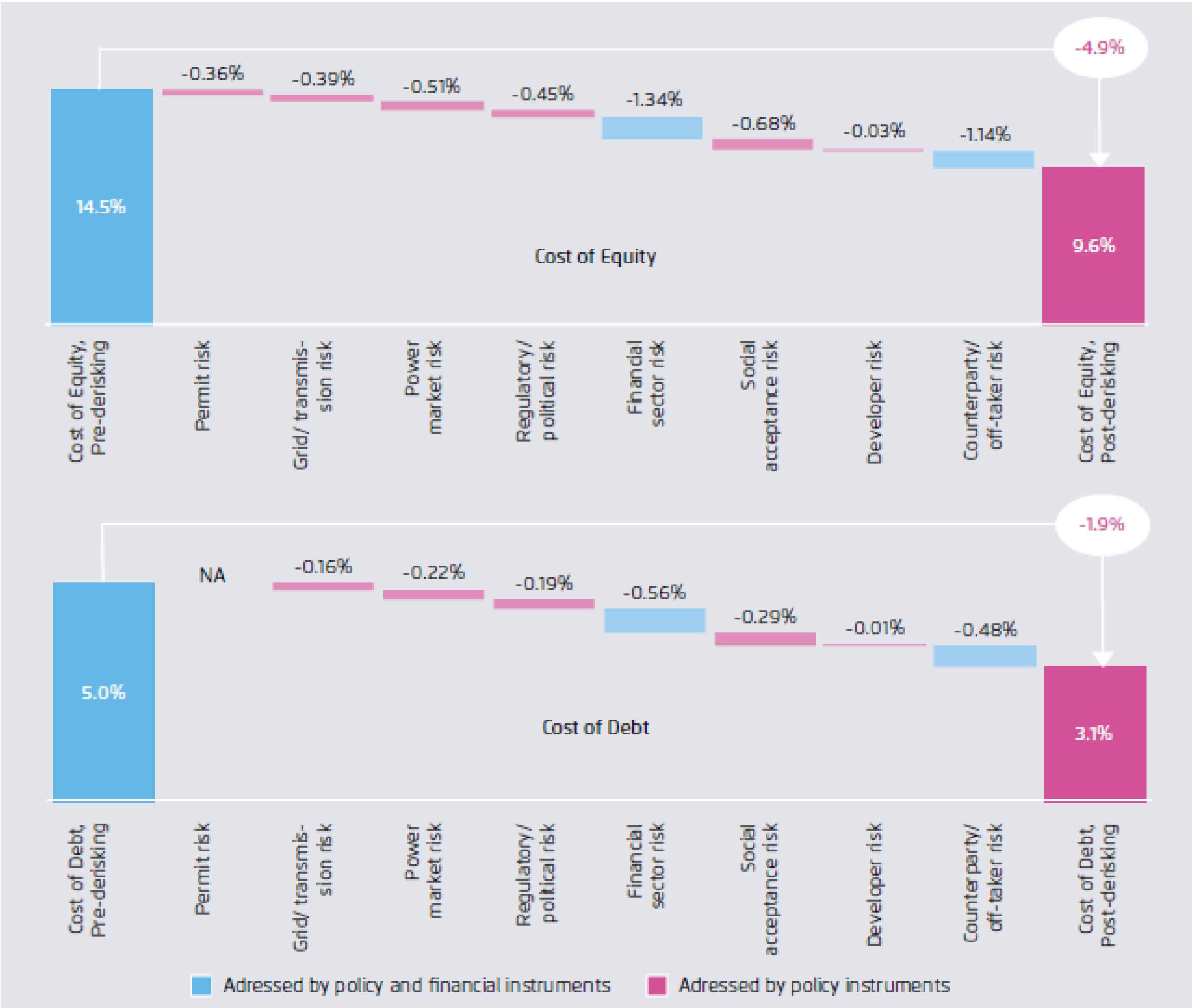
A new research report from WWF and National Observatory of Athens investigating the potential for significant decarbonisation in Greece analysed the following scenarios (WWF & NOA, 2017):

1. Business as Usual (BaU)
2. Expansion of Lignite Use (LIG)
3. Expansion of RES Use (RES)
4. Energy Efficiency (EE)
5. Efficiency and Lignite Phase-Out (LPO)

The analysis shows that without phasing out lignite the EU targets for 2030 cannot be achieved. The RES share increases in all scenarios which requires – depending on the scenario– total investment costs of between EUR 23 and 33 billion (including new conventional power plants in some cases). The BaU and LIG scenarios provide more expensive electricity compared with scenarios with a higher share of wind, as with lignite the fuel as well as emission allowances (25 EUR/t CO_2 in the study) have to be purchased.

Targeted de-risking policies aimed at reducing the cost of capital would lower the levelised costs of electricity in Greece by 20 percent compared to a scenario with no de-risking measures (“from 5.7 euro cents/kWh to 4.6 euro cents/kWh”) according to a study by NewClimate Institute (2019).

Figure 20 POST-DERISKING FINANCING COSTS – GREECE



Source: NewClimate Institute (2019)

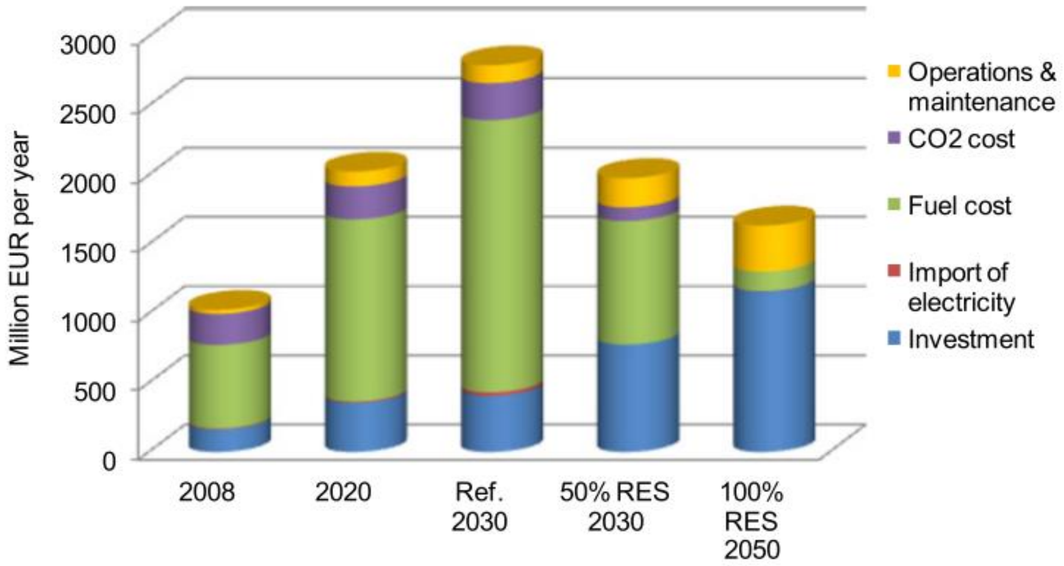
INSIGHTS FROM NORTH MACEDONIA

The SEERMAP results showed that based on market model simulations, in all scenarios, phasing out lignite and reaching 61-89% RES share is the cost-optimal solution by 2050.

Taseska et al. (2011.) created three different energy scenarios for Macedonia with software modelling and optimisation tools to analyse the consequences of substituting two lignite power plants with gas-based CHPs (first mitigation scenario) or with renewables (second mitigation scenario). According to the results, the total system cost in the first mitigation scenario is slightly higher than in the baseline scenario, resulting in mitigation costs of 7.84 \$/t CO_2-eq. Taseska et al. (2011) conclude that that significant potential exists in inexpensive decarbonisation options. Negative cost emission reduction options are made possible by the liberalisation of the electricity market and by the increasing investment cost of lignite power production resulting from the EU Industrial Emissions Directive.

A study of Ćosić, Krajačić et al. (2012) reveals that by implementing energy efficiency measures that decrease consumption levels and with the installation of new generation capacities, a 100% renewables based electricity system is achievable by 2050. The results are shown in Figure 11. According to this study, biomass makes the most significant contribution to primary energy production (19.8 PJ). In order to achieve an electricity system relying 100% on renewables, a high share of hydro (2.9 TWh), wind (7.08 TWh) and solar power (2.69 TWh) is necessary as well as the application of different storage technologies (including electric vehicles and heat pumps). If a high share of biomass and hydro is to be avoided for sustainability reasons, additional energy efficiency measures may be required especially in a region where numerous conflicts between renewable energy development and nature protection exist.

Figure 21 ANNUAL OPERATING COSTS OF THE VARIOUS SCENARIOS



Source: Ćosić, Krajačić, et al. (2012)

According to the hourly detailed energy system model of Ćosić, Krajačić & Duić (2012), with a CO_2 price of 25 EUR/t, the reference scenario in the year 2030 is the most expensive scenario due to the cost of emissions. A 100% renewable energy system has the lowest fuel cost but the highest annual investment costs. Total annual investment cost for the 50% renewable energy system amount to 776 mEUR while the annual investment costs for the 100% renewable energy system are 1161 mEUR.

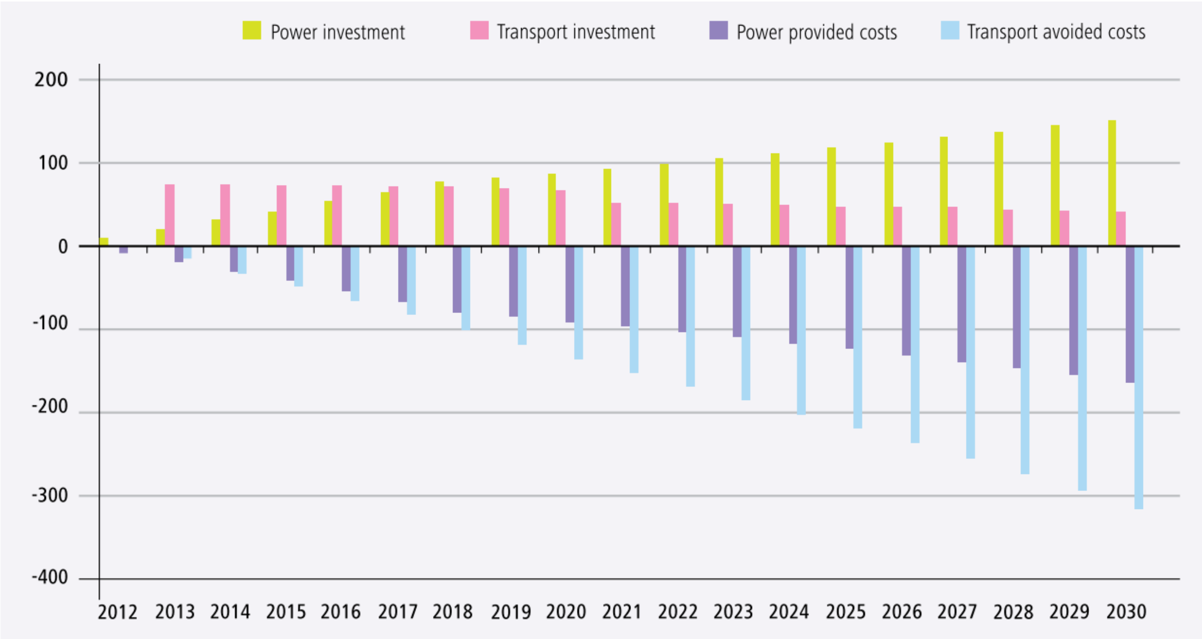
INSIGHTS FROM SERBIA

A UNEP (2013) report on Serbia's transition to a green economy finds that "there are significant long-term benefits from a transition to a green economy in each of the (analysed) sectors" of energy demand, supply, agriculture and transportation and that decarbonisation could also decrease electricity prices making renewables a more affordable solution. A comparison of the annual investment needs and avoided costs is presented in Figure 22.

The report finds that on the demand side "avoided costs will be higher than investments by 2030, reaching a cumulative net benefit of EUR 1 to 2 billion, or approximately EUR 50 to 100 million per year. Simulation reveals that the overall payback time is 7 to 10 years, with the breakeven point (from an economy-wide perspective) being reached in 2019-2022."

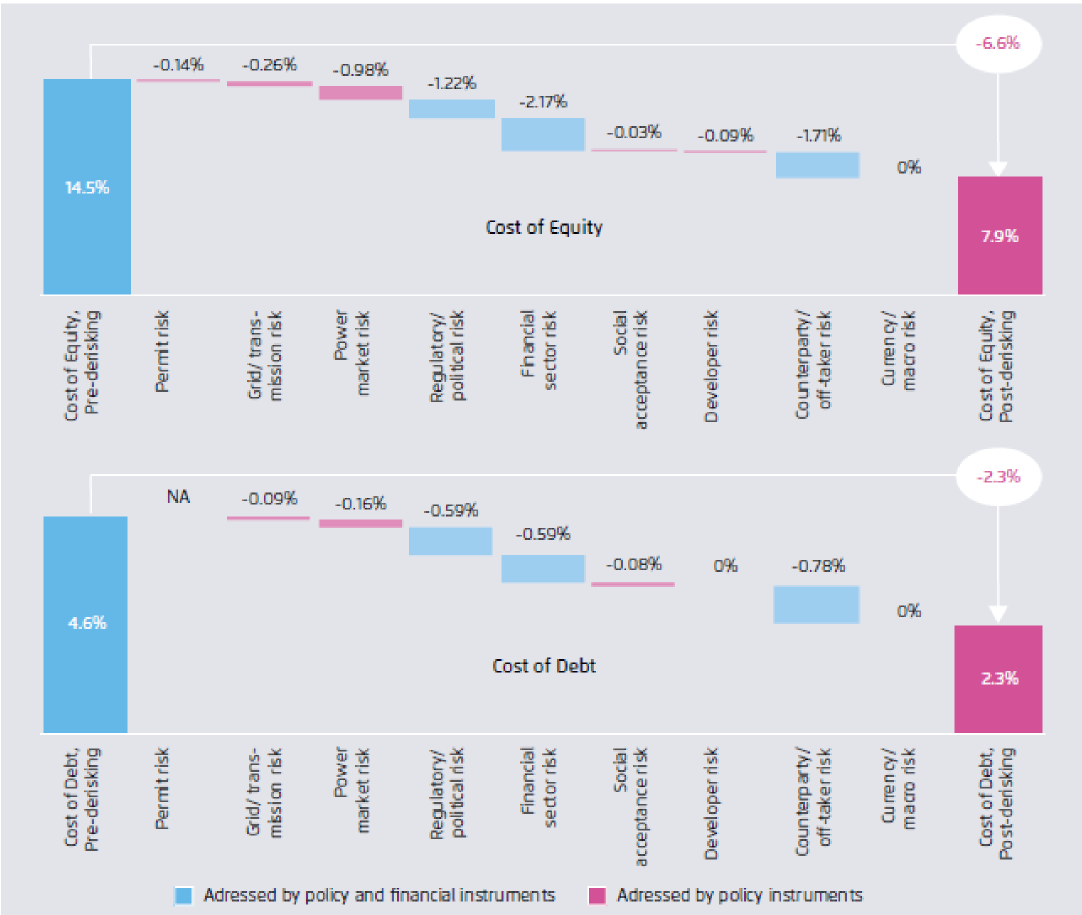
On the supply side, 5 000 to 10 000 GWh coal-based energy production is avoided in 2030, resulting in approximately EUR 1.3 billion of capital savings. "Based on rough assumptions (at 20 EUR per ton) on the current and future cost of coal for power generation, the net investment for energy supply reaches a total of 10 to 40 million EUR in 2030, or reaching up to 50% of the annual investment." (UNEP, 2013)

Figure 22 COMPARISON OF ANNUAL INVESTMENTS (POSITIVE VALUES) AND AVOIDED COSTS (NEGATIVE VALUES) FOR POWER AND TRANSPORT IN SERBIA BETWEEN 2012 AND 2030



Source: UNEP (2013)

Figure 23 POST-DERISKING COST OF EQUITY AND COST OF DEBT IN SERBIA



Source: NewClimate Institute (2019)

Targeted de-risking measures could reduce the WACC by over 40 percent in in Serbia according to NewClimate Institute (2019), and would bring the levelised cost of renewable electricity below that of new lignite plants ("5.4 euro cents/kWh compared to 7.3 euro cents/kWh for lignite and not considering CO_2 costs for lignite plants" (NewClimate Institute, 2019).

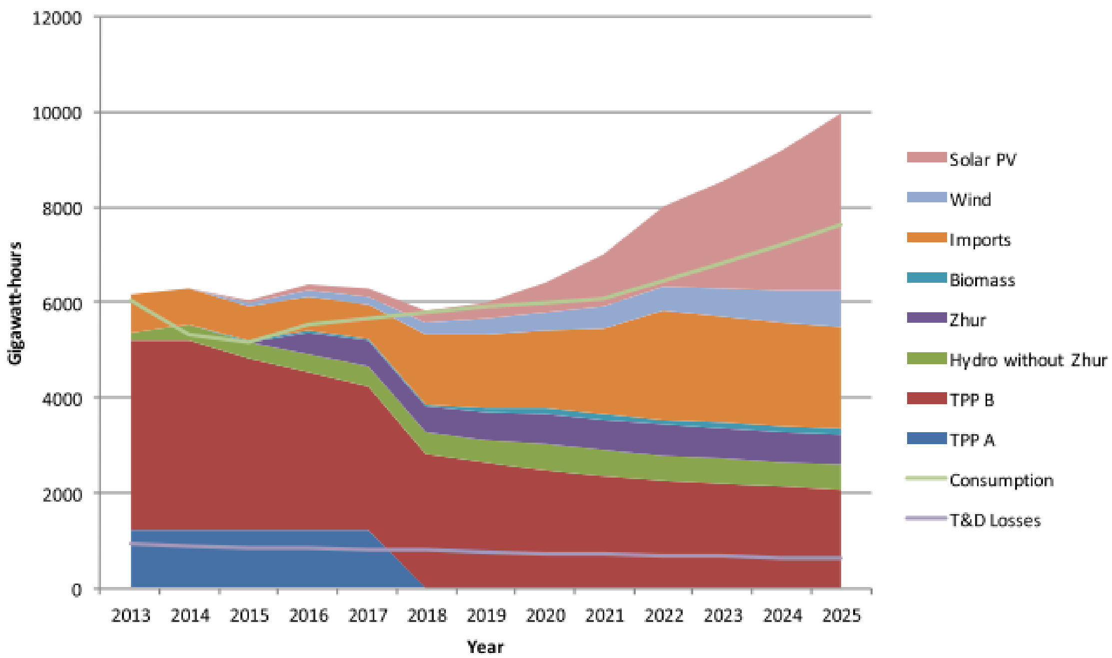
In Serbia derisking measures can lower "LCOEs of onshore wind energy by around 20 percent. This offers an additional opportunity for significant cost reductions, going beyond the recent technology cost reductions of renewables with potentially high benefits for taxpayers and consumers." (Turković, 2019)

As a UNEP (2013a) report on Serbia shows, the long-term economic, social and environmental benefits of an energy transition can be substantial. This is why "policy packages that include mandates/targets to ensure action, incentives to share costs, and capital investments to stimulate research and development and emerging sectors" are required to find balance regarding costs, responsibilities, benefits and also to provide support to sensitive social groups (UNEP, 2013).

INSIGHTS FROM KOSOVO*

Kittner, Dimco, Azemi, Tairyan, & Kammen (2016) find that a range of alternatives exist to meet demand at a lower cost than constructing Kosova e Re, the proposed 600 MW coal plant. The options include energy efficiency measures, combinations of solar PV, wind, hydropower, biomass and the introduction of natural gas. For example, the Euro 2030 path results in a 27% increase in energy efficiency, 27% reduction in CO_2 emissions and 27% RES share in final energy consumption by 2030. Under this scenario the share of renewables grows steadily, while fossil fuel generated electricity is reduced. By 2025 electricity generated by solar PV is expected to increase steeply leading to higher domestic electricity production than consumption, resulting in net electricity exports.

Figure 24 EURO 2030 PATH: ENERGY EFFICIENCY MEASURES 27% INCREASE, 27% CO_2 REDUCTION, >27%RENEWABLE CONSUMPTION, EXPANDED POWER EXCHANGE



Source: Kittner et al. (2016)

FACT: Fossil-based energy production used to be cheap but will lose competitiveness due to upcoming market and legislative changes.

In the current legislative and market environment in South East Europe, especially countries which are not yet EU Member States, electricity production from existing fossil fuel power plants may be the cheapest option, as most of them are depreciated and investment costs have been recovered, enabling them to operate at prices which recover short term marginal costs only. However, policy makers also need to consider the following additional factors:

1. The projected increase in the carbon price compared with current levels will make fossil fuel plants, especially coal and lignite less competitive and, eventually, render them non-competitive. A carbon price is already applicable to those countries in the SEE region which are EU MS. Although according to the Energy Community Secretariat there is no timeframe for introducing a CO_2 price in countries not subject to the ETS, but talks on this topic are being introduced. (Spasić, 2019c) The countries of the Western Balkans will need to apply a carbon price once they become EU member states, which for some of these countries could be as early as 2025.
2. The phasing out of direct and indirect subsidies to fossil fuel plants needs to take place to fulfil the requirements of the EU State aid rules. State Aid rules also apply to Parties to the Energy Community Treaty. In the Western Balkans such support is still significant. This will decrease the competitiveness of fossil-based generation;
3. New emission BAT requirements for large combustion plants published in 2017 need to be implemented for all new plants being permitted and from 2021 onwards for existing plants in the EU. This will make investment in new coal installations and compliance with the rules for existing installations significantly more costly;
4. The cost of negative externalities caused by fossil fuel generation is high, especially environmental and health costs.

Carbon pricing will make coal expensive

The SEERMAP project took into account only the first of these factors, i.e. the carbon price. The carbon prices in the SEERMAP models were applied for all EU member states, and from 2030 onwards also in non-member states. The carbon price is assumed to increase from 33.5 EUR/tCO_2 in 2030 to 88 EUR/tCO_2 by 2050, in line with the EU Reference Scenario 2016. The corresponding carbon price, although significantly higher than the current price, is a medium level estimate compared with other estimates of EU ETS carbon prices by 2050. The EU ETS carbon price is determined by the marginal abatement cost of the most expensive abatement option needed to stay within the emissions cap.

Even if the other three factors are ignored, the analysis shows that over the medium to long term coal and lignite-based electricity generation will be priced out of the market by cheaper options. Policy makers therefore need to address the trade-offs which characterise fossil fuel investments. In particular stranded costs related to coal, lignite and natural gas generation assets need to be weighed against any short-term benefits that such investments may provide.

The common belief is that stranded costs are higher under a high RES scenario than under a low RES scenario. However, in the SEE region this is not the case, as most existing coal and lignite plants are old and have already recovered their initial investment costs. It is therefore not these generation assets which risk becoming stranded, but those newly built assets which are currently included in national plans and strategies. These new plants will not be profitable for long enough to recover the initial investment cost if the carbon price increases and the cost of renewable technologies continues to decrease, resulting in stranded assets. A well-planned high RES share pathway can help avoid such an outcome as it enables policy makers to switch to RES early on, avoiding significant investment in fossil fuel technologies.

Europe has experienced a high increase in the carbon price, which has risen to around EUR 25 per tonne of CO_2 at the time of publication of this report. (Markets Insider, 2019).

Figure 25 EU CARBON PRICES CONSTANTLY GROWING IN 2017-2019 – CO_2 EUROPEAN ALLOWANCES PRICE IN EUR

Source: Markets Insider (2019)

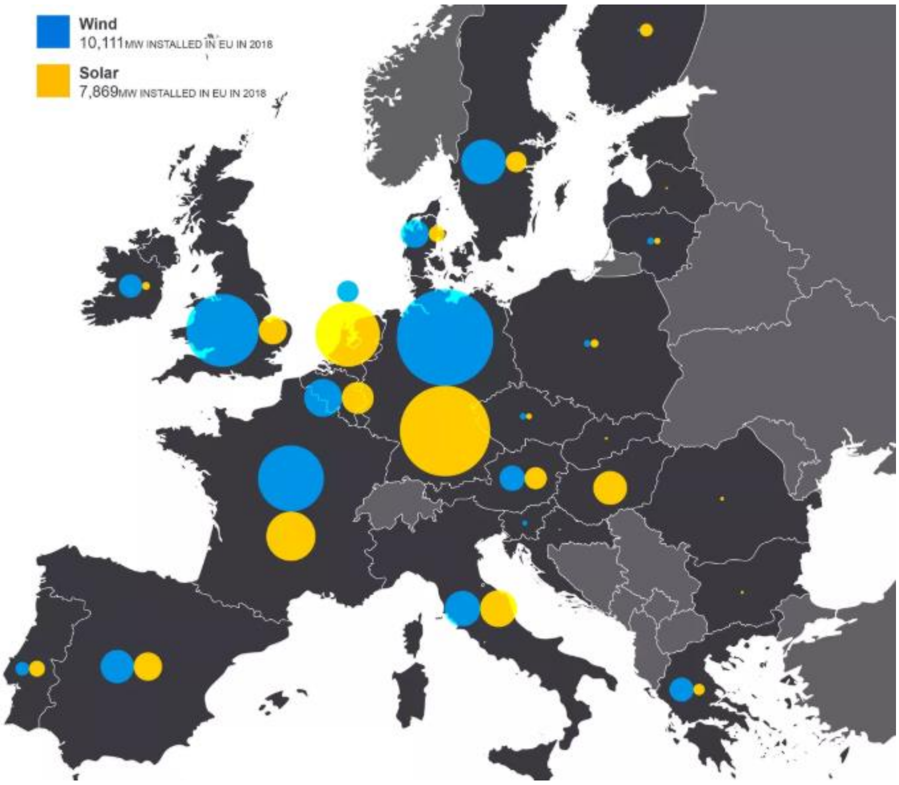
This increase in the price of EUAs is expected to continue in the future. The European Commission's revision for ETS phase 4 (2021-2030) is meant to ensure the achievement of the EU's overall greenhouse gas emissions reduction target by 2030, according to which "sectors covered by the EU Emissions Trading Scheme (EU ETS) must reduce their emissions by 43% compared to 2005 levels" (European Commission, 2018a). It also includes plans for the EU to double the carbon price by 2021 and further increase it to 55 EUR/t by 2030 (Carbon Tracker, 2018).

If we consider exclusively the accession countries, investment in coal, which is there still planned, is politically and economically suboptimal. A recent study of CEE Bankwatch Network (2017a) reveals that once the power plants in the Western Balkans become subject to the ETS, even the small Pljevlja II coal-based power plant in Montenegro would have to pay nearly 8 mEUR annually with an extremely low (5 EUR/t) CO_2 price, while considering a more realistic price (35 EUR/t) by 2030, the yearly costs rise to 55.6 mEUR. The same development would mean 21-146 mEUR extra costs for Ugljevik III in Republika Srpska, which will be the largest plant in the region if built.

Due to carbon pricing, investment made in coal power plants, and to some extent also natural gas power plants, will be stranded. Regarding stranded costs of fossil generation, a financial calculation was carried out in the SEERMAP project to determine the costs of stranded fossil generation for plants that are built in the period 2017-2050. The utilisation rate of coal generation assets drops below 15% and gas generation below 25% in most SEERMAP countries in the 'delayed' and 'decarbonisation' scenarios by 2050. This means that capacities which generally need to have a 30-55-year lifetime (30 for CCGT, 40 for OCGT and 55 for coal and lignite plants) with a sufficiently high utilisation rate in order to ensure a positive return on investment will become stranded. Large stranded capacities will likely require public intervention, whereby costs are borne by society/electricity consumers. If these costs are collected as a surcharge on the consumed electricity over a period of 10 years after these capacities finish their operation then fossil plants which are retired early would have to receive 2.6 EUR/MWh, 2.5 EUR/MWh and 0.6 EUR/MWh surcharge to cover their economic losses in the 'no target', 'delayed' and 'decarbonisation' scenarios respectively. This result shows that switching from fossil fuels to renewables early on can result in lower stranded assets. Stranded costs are particularly high in Bosnia and Herzegovina, Greece and Kosovo* in both the 'no target' and 'delayed' scenarios. Stranded costs reach 7.3 EUR/MWh, 3.9 EUR/MWh and 7.8 EUR/MWh in the 'no target' scenario in these three countries, respectively. Most of these costs can be avoided by taking early action to decarbonise the electricity sector and avoiding investment in additional fossil fuel plants.

The collapse of coal-fired electricity generation is already underway in the EU, due to the high carbon price and the availability of cheaper RES capacities. According to an analysis carried out in July 2019 (Sandbag, 2019a), coal-generation declined by 19% in the first half of 2019. Switching to gas and switching to wind and solar were responsible for 50% of this decrease, respectively. The fall in Eastern-European countries was much smaller than in Western-European countries, due to lack of alternatives in low carbon technologies. In 2018, only 5% of newly installed wind and solar capacity was in Eastern-Europe. (Sandbag, 2019a).

Figure 26 WIND AND SOLAR INSTALLED IN 2018 – AREA OF CIRCLE IS PROPORTIONAL TO CAPACITY INSTALLED IN 2018



Source: Sandbag (2019a)

The analysis also finds that at the end of 2018, gas price decreased significantly while carbon price was rising, which resulted in gas running before hard coal in most countries for most of the hours in 2019. This means – according to the report – that coal-gas switching might have reached its maximum. At the same time, there is still some potential in the switch from lignite to gas.

A report by Carbon Tracker (Carbon Tracker, 2019) shows a dire future for coal in Europe. The report finds that hard coal generation in the EU has declined 39% between March and August 2019 compared with the same period in 2018 while lignite generation has decreased by 20%. This is due to a number of factors, including a high carbon price, lower gas prices which have resulted in gas replacing some coal, and competition from wind and solar. Based on Carbon Tracker modelling, 84% of lignite and 76% of hard coal generators are operating at a loss currently, with total losses at EUR 3.54 bn and EUR 3.03 bn, respectively, in 2019.

In relation to the collapse of coal and lignite generation, it is interesting to take a closer look at the case of Germany, as another 2019 study did (Sandbag, 2019b). When coal generation dropped in the EU in the first half of 2019, there was also a drop in coal and lignite fired electricity production in Germany. "The gross profit of the German lignite fleet collapsed by 54% in the first half of 2019" and "As a result, the German lignite fleet lost €664 million so far this year, compared to a loss of €68m in the first half of 2018". The lignite-fleet will remain uneconomical in the upcoming years. Old lignite plants will remain loss-making, whereas new plants will barely make profit. This trend takes us back to the need for early closure of old lignite plants and to the need for further deployment of renewable energies.

Coal subsidies will need to be phased out, making coal even less competitive

The fossil-based energy production can appear to be cheaper because it is financed by complex systems of state aids and other subsidies. The subsidies for fossil fuels can be extremely high in the SEE region compared to GDP. Table 1 shows the extent of these subsidies; the figures include not only direct government support but also indirect support and externalities such as health costs.

Table 1 FOSSIL FUEL SUBSIDIES IN THE SEE REGION

	Estimation of fossil fuel subsidies (% of GDP, 2005-2009)	**Energy subsidies (% of GDP, 2015)**
Albania	7-8%	1.9%
Bosnia and Herzegovina	9-10%	37.0%
Bulgaria	n.a.	33.9%
Croatia	5-6%	3.7%
Greece	n.a.	2.6%
Kosovo*	35-36%	n.a.
FYR of Macedonia	8-9%	18.0%
Montenegro	10-11%	16.7%
Romania	n.a.	6.50%
Serbia	7-9%	34.7%

Source: Kovacevic (2011); REN21 & UNECE (2017), via Kopač (2018)

The Energy Community Secretariat produced a document in 2019 presenting the amount of state aid that was given to the production of energy from coal and from renewable energy between 2015 and

2017 in Bosnia and Herzegovina, Kosovo*, Montenegro, North Macedonia, Serbia and Ukraine. The analysis shows that significantly more state was given to coal than to RES.

Figure 27 AMOUNT OF STATE SUPPORT TO PRODUCTION OF ELECTRICITY FROM RENEWABLES AND COAL

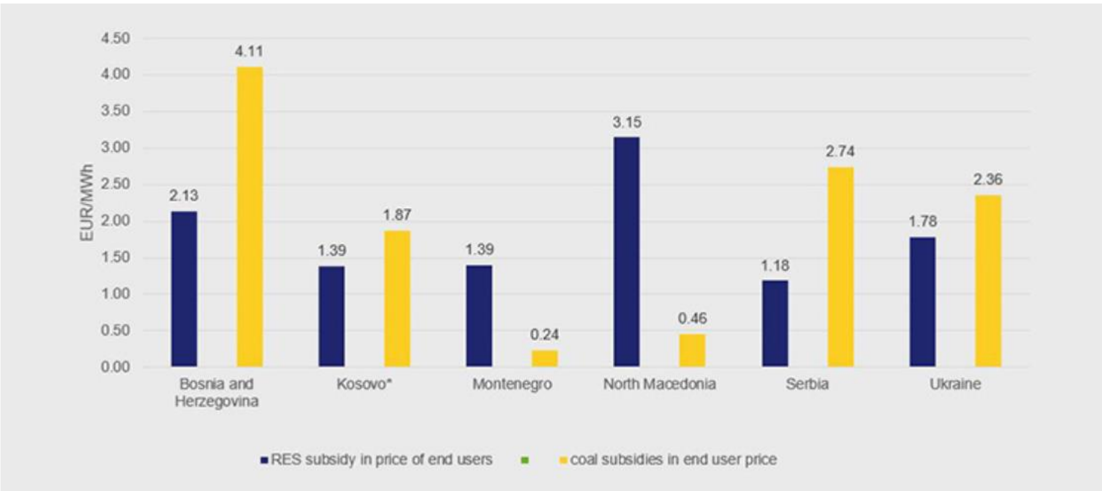
in '000 eur

Contracting Party	Paid incentives for production from renewables			Paid direct subsidies for production from coal		
	2015	2016	2017	2015	2016	2017
Bosnia and Herzegovina	17.595	20.160	25.040	26.189	35.550	48.245
Kosovo*	1.630	7.670	5.560	30.894	8.768	7.501
Montenegro	960	3.960	4.100	881	1.156	700
North Macedonia	15.462	20.526	20.085	4.379	3.722	2.927
Serbia	17.170	24.470	34.800	90.746	115.751	80.606
Ukraine	151.490	n/a	212.170	194.732	263.399	280.442

Source: Spasić (2019a)

This means that the real price of coal is much higher than what end users experience, and that the cost of fossil fuel generated electricity can be kept low only because of these state incentives (Spasić, 2019a). In the SEE region the subsidies for coal are higher than subsidies for renewables, with the exception of Montenegro and North Macedonia. Citizens "are aware of their direct contribution in subsidies for renewables since the cost is shown on electricity bills, while in the case of coal, citizens are not aware since the subsidies are granted directly from the budget" (Jovičić, 2019).

Figure 28 DIRECT COAL SUBSIDIES VS RES INCENTIVES IN THE END USERS PRICES (2017) – PAID SUBSIDIES FOR RES AND COAL IN THE END USERS PRICES IN 2017



Source: Energy Community Secretariat via Jovičić (2019)

A 2019 analysis of fossil fuel subsidies contained in draft NECPs of EU Member States (van der Burg, Trilling, & Gençsü, 2019) shows that none of the documents submitted provides a satisfying overview of the subsidy system or the plans to phase out fossil fuel subsidies, although this is a compulsory element of NECPs. The estimation made by the European Commission cited in that analysis regarding the extent of fossil fuel subsidies is presented in Table 2.

Table 2 FOSSIL FUEL AND RENEWABLE ENERGY SUBSIDY ESTIMATES IN DRAFT NECPS – NOTE: FOR ROMANIA AND CROATIA THERE IS VERY LIMITED INFORMATION AND TRANSPARENCY ON FOSSIL FUEL SUBSIDIES

Country	**Draft NECP**	**Fossil fuel subsidy estimates per year (annual average 2014–2016)**	**Renewable energy subsidy estimates per year (annual average 2014–2016)**
Bulgaria	It claims that no fossil fuel subsidies exist in the country.	EUR 0.19 billion	EUR 0.44 billion
Croatia	The section on energy and fossil fuel subsidies is not included.	EUR 0.12 billion	EUR 0.16 billion
Greece	There is no section on energy and fossil fuel subsidies, but there are plans for wider green fiscal policy reforms, although the NECP discusses the introduction of new fossil fuel subsidies.	EUR 0.71 billion	EUR 1.31 billion
Romania	Commitments to end fossil fuel subsidies are reinforced. Fossil fuel subsidies are discussed but no concrete steps to phase them out.	EUR 0.07 billion	EUR 0.01 billion

Source: van der Burg et al. (2019)

The 2018 study commissioned by the Friedrich Ebert Stiftung on energy transition in the region (Nabiyeva, 2018) highlights that an important characteristic of fossil fuel subsidies is that these subsidies are inequitable, they benefit the wealthier segments of the population, contributing to growing social inequalities. At the same time, the reform of energy prices is a very sensitive social issue as it can lead to the increase of energy poverty. Consequently, an energy tariff reform must be coupled with social assistance for the poorest segments of society. Funding for this assistance can be guaranteed by financial resources released with the elimination of fossil fuel subsidies.

The study highlights that fossil fuel subsidies are present throughout South and Eastern Europe. Bosnia and Herzegovina and Serbia are amongst the countries which have the highest fossil fuel subsidies in the world. Fossil fuel subsidies cause multiple problems: they artificially lower fossil fuel prices, which leads to an increase in energy consumption, GHG emissions and air pollution. This also diverts potential funding from the social sector, e. g. the health care or the educational systems. The artificially lowered price makes also renewable energy seem relatively more expensive than it would be otherwise, if equal market conditions were guaranteed. Thus, the return on investment becomes too long for investors. (Nabiyeva, 2018)

Electricity prices are often under their level of cost-recovery: for example, in the European Union, the average level of cost-recovery is 0.2 EUR per kWh while in Serbia, it is 0.07 EUR and 0.09 EUR in Albania. (Nabiyeva, 2018)

One has to see that when subsidies are used to lower the price of fossil fuels, this means that this price is paid by the population somewhere else, in a different form: “through taxes, forgone expenditure, lack of investment in energy infrastructure and quality of service”. (Nabiyeva, 2018)

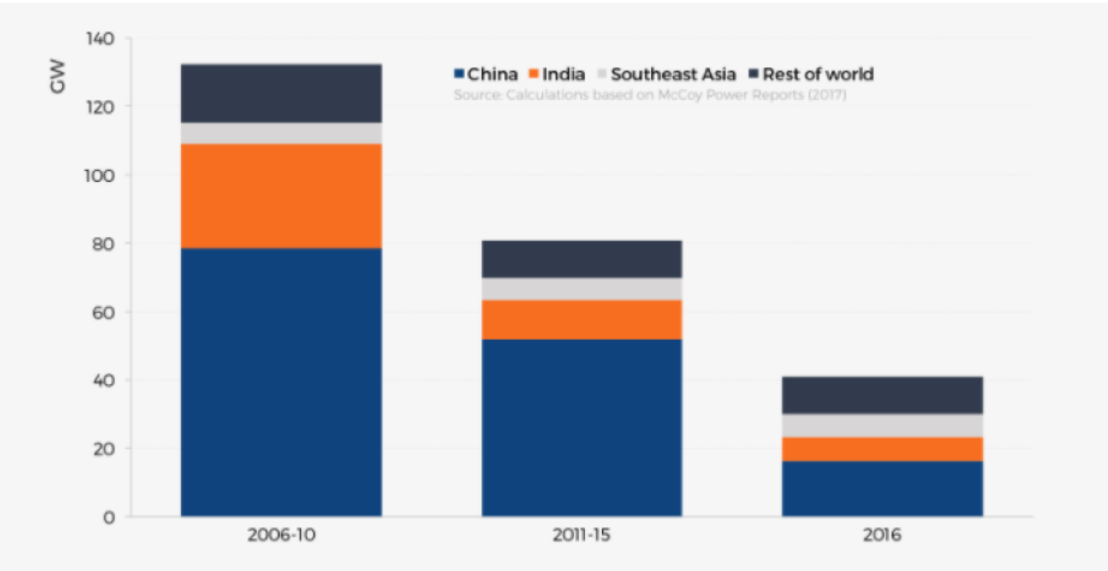
An important characteristic of fossil fuel subsidies is that these subsidies are inequitable, they generally benefit the wealthier part of the population, contributing to growing social inequalities. At the same time, the reform and rise of energy prices is a very sensitive social issue, as it can lead to the increase of energy poverty. Consequently, an energy tariff reform must be coupled with social assistance for the poorest part of the population. Funding for this assistance can be guaranteed by financial resources released with the elimination of fossil fuel subsidies. (Nabiyeva, 2018)

Subsidising coal is not only inefficient and leads to undesirable outcomes in terms of pollution and GHG emissions, but it is also forbidden by State Aid rules. For example, the Energy Community Secretariat started “a dispute settlement procedure on the planned Federal guarantee for a EUR 614 loan from the China Eximbank to build the Tuzla 7 coal power plant in Bosnia and Herzegovina. The procedure can potentially lead to delays in the EU accession process and temporary suspension of financing by EU banks.” (CEE Bankwatch Network, 2019)

In addition, it is becoming increasingly difficult to raise funding for coal power plant investment. The EBRD decided in its new energy strategy that it would not finance investment in coal any more. The bank will also stop funding any upstream oil exploration and will not finance upstream oil development projects except in rare and exceptional circumstances, where such investments reduce greenhouse gas emissions (Bennett, 2018). The EIB also presented a draft energy lending policy in August 2019 that stops financing investment in fossil fuels “The coal industry’s future is getting gloomy indeed, independently of RES generation.” (Spasić, 2019b)

A study commissioned by SQ Consult (Voogt, 2018) concluded that investors are moving away more and more from coal as a result of global shift in climate change thinking and due to investment risks (environmental effects, legislative changes such as requirements for LCPs, industrial emissions directive of the EU etc., and technological developments leading to a fall in RES prices).

Figure 29 AVERAGE ANNUAL FINAL INVESTMENT DECISIONS FOR NEW COAL-FIRED POWER CAPACITY – WORLD ENERGY INVESTMENT 2017



Source: Voogt (2018)

According to the study by SQ Consult, carbon pricing could be a good tool to facilitate a smoother transition towards decarbonization. “A key argument in this is that a gradual introduction of carbon pricing can help increase awareness of the long-term risks and help market actors base their investment decisions on the longer-term optimal choices.” An important element of the transition would be the use of revenues from carbon pricing to help market actors negatively affected by the process. This could take the form of investment support for energy efficiency measures or various forms of support to help just transition, or even cost compensation for heavily exposed sectors. In addition, measures to ease the transition from fossil fuels to renewables can include the use of tax revenues to compensate vulnerable consumers (e.g. by setting up revolving funds to pre-finance energy savings and to help address the social and economic impacts of coal transition) and analysing where other legislative changes can shift economic pressures from employment to the use of energy and material ('greening the tax system') (Voogt, 2018).

Changes in the LCP BAT REF will shut down many existing coal plants and make new coal plants more expensive

EU member states as well as accession countries need to adhere to the requirements of the Industrial Emissions Directive. On 28th April 2017, a new round of controls on air pollution was adopted. (Gerrard Wynn & Coghe, 2017; CEE Bankwatch Network, 2017b; DNV GL-Energy, 2016). The new limits for air pollutant emissions such as nitrogen, oxides of sulphur, particulate matter or mercury increase the cost of coal fired electricity production. New as well as existing large combustion plants will have to adhere to BREF requirements. Existing units will also have to comply by 2021, which means that management has to decide in the near future on investments in pollution control technologies (Gerrard Wynn & Coghe, 2017). According to DNV GL-Energy (2016), 84 823 MW hard coal and 53 432 MW lignite power plant capacities will be in operation in EU-28 countries by 2021. Only around 22% of hard coal plants with a total of 18 991 MW capacity and 11% of lignite plants with a total of 5 956 MW capacity will be compliant without further investment.

Gerrard Wynn & Coghe (2017) analysed the most polluting power plants in terms of SO_X and NO_X emissions above 300 MW thermal capacity. Most of them were concentrated in Eastern Europe and the Western Balkans and were at least 40% above the relevant BREF limits. The "best-in-class NO_X abatement would add 2-4 EUR/MWh" according to Wynn & Coghe (2017), and 0.3-7.7 EUR/MWh to generation costs according to DNV GL-Energy (2016). The "best-in-class SO_X abatement would add 6-7 EUR/MWh" according to Wynn & Coghe (2017) and 0.4-221 EUR/MWh according to DNV GL-Energy (2016). Gerrard Wynn & Coghe (2017) concluded that particularly in the case of older power plants, these costs are so significant that it will be more rational to shut down them down.

Pollution from coal incurs additional costs to society

In addition to the above costs, the costs of negative externalities, such as health costs should be also considered in the financial evaluation of fossil-based energy production as usually only a fraction of these costs (negative externalities) are taken into consideration. In general, among fossil fuels, coal-based energy production has an especially large effect on the climate and environment.

Coal-fired power plants emit more CO_2 for a unit of power produced than any other mode of commercial electricity production. In addition, in the SEE region, air pollution and related externalities are important aspects of daily life. If these costs are included in cost-benefit calculations, the costs of coal-fired electricity production outweigh the cost of RES deployment. In other words: RES scenarios can seem to be expensive, but they save lives and have lower overall social costs.

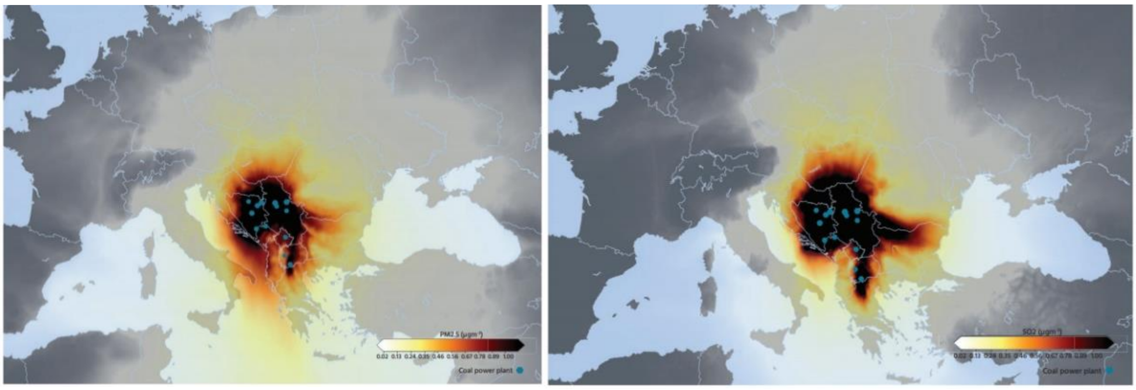
Annually around 400 000 people die prematurely in Europe because of air pollution. Coal plants in Romania cause 1 600 deaths abroad (Jones et al., 2016). Emissions include not only CO_2, but SO_x, NO_x, $PM_{2.5}$ and ash, as well as radioactive particles and heavy metals such as mercury which "can impact the immune system, with children most at risk". IRENA (2018) calculates that an amount between USD 19 and 71 billion could be saved yearly until 2030 through avoided negative health effects and that the increase of the share of renewable energy could help avoid further yearly environmental costs of a minimum of USD 8 billion and a maximum of USD 37 billion for the same period.

According to an analysis carried out by HEAL, CAN Europe, Sandbag, CEE Bankwatch Network, & Europe Beyond Coal (2019), 16 highly polluting coal power plants in the Balkans are responsible for severe health damages in the region, the EU and beyond. In 2016, these plants emitted more SO_2 than all EU coal power plants and almost the same amount of particulate matter. According to the report, emissions from these coal plants cause 3000 premature deaths and 8000 cases of bronchitis in children as well as other chronic diseases every year. The majority of the costs related to these effects are borne by the EU: Health costs amount to EUR 3.1-5.8 billion per year while that sum is between EUR 1.9-3.6 billion per year in the Western Balkan countries. This is a heavy burden for the economy not only because of the health costs, but also due to the decrease of productivity resulting from lost workdays (HEAL et al., 2019).

Another estimate for Serbia shows that within Serbia there were almost 11 000 premature deaths in 2014 due to air pollution from fossil power plants, while estimated health costs amount to 4 billion EUR annually (Burki, 2018). According to WHO data from 2016, the most important sources of pollution in Serbia are individual heating, transport, power plants and industry. Data shows that 5400 and 6592 people died prematurely in 2015 and 2016, respectively, due to air pollution from these sources. (Radović, 2019)

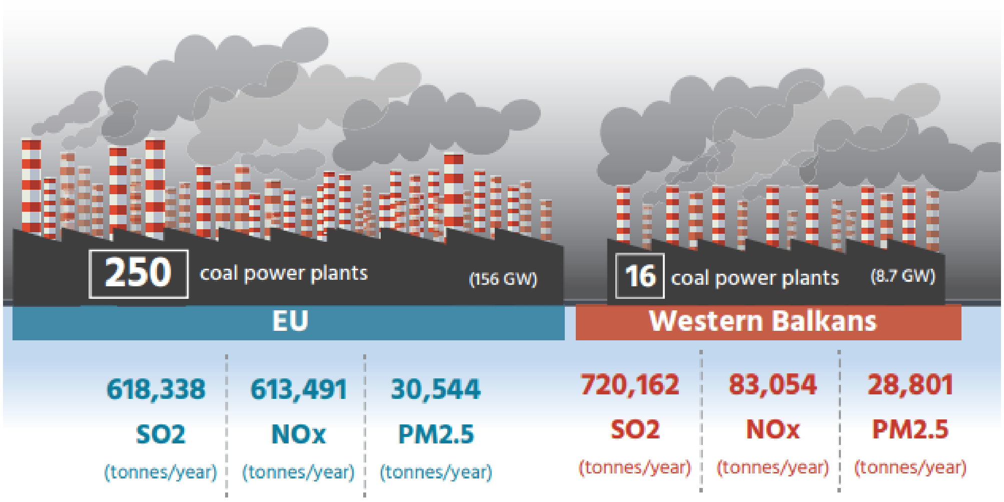
Bulgaria and Croatia's health budgets are the most heavily impacted. In Bulgaria costs needed to cover the health impacts of Western Balkan coal pollution amount to EUR 0.3-0.7 billion which equals 10%-18% of the country's total health expenditure in 2016. For Croatia, it amounts to 8%-14% of total health expenditure in 2016, at EUR 0.2-0.4 billion. In Romania additional health costs caused by coal pollution originating in the Western Balkans reach EUR 0.5 to 1.1 billion per year which equals 7%-13% of total health expenditure in 2016. (HEAL et al., 2019)

Figure 30 MODELLED POLLUTANT EXPOSURE TO PARTICULATE MATTER (PM2.5) (LEFT) AND SULPHUR DIOXIDE (SO_2) (RIGHT) CAUSED BY THE 16 COAL POWER PLANTS IN THE WESTERN BALKANS IN 2016, ANNUAL MEAN



Source: HEAL et al. (2019)

Figure 31 TOTAL EMISSIONS OF THE MAIN POLLUTANTS FROM COAL POWER PLANTS IN THE WESTERN BALKANS AND THE EU IN 2016



Source: HEAL et al. (2019)

INSIGHTS FROM BOSNIA AND HERZEGOVINA

The SEERMAP results show that if significant investment in additional fossil fuel capacities is made, stranded costs equal 7.3 EUR/MWh in the 'no target' scenario and 7.6 EUR/MWh in the 'delayed' scenario. This adds up to total 1513 mEUR and 1565 mEUR, respectively, over the whole modelling period. The annualised stranded cost figure is the second highest figure in the country (after Kosovo*) within the SEERMAP region and is significantly higher than the renewable support per MWh needed to enable Bosnia and Herzegovina to meet EU emission reduction targets in the 'decarbonisation' scenario.

INSIGHTS FROM KOSOVO*

SEERMAP results show that stranded costs equal 7.8 EUR/MWh in the 'no target' scenario and 8.1 EUR/MWh in the 'delayed' scenario. This adds up to a total of 629 mEUR and 664 mEUR, respectively, over the whole modelling period. This annualised stranded cost figure is the highest figure in the SEERMAP region and is significantly higher than the renewable support needed to enable Kosovo* to meet EU emission reduction targets in the 'decarbonisation' scenario. By contrast, the stranded asset surcharge is only 0.1 EUR/MWh, totalling 9 mEUR, in the 'decarbonisation' scenario.

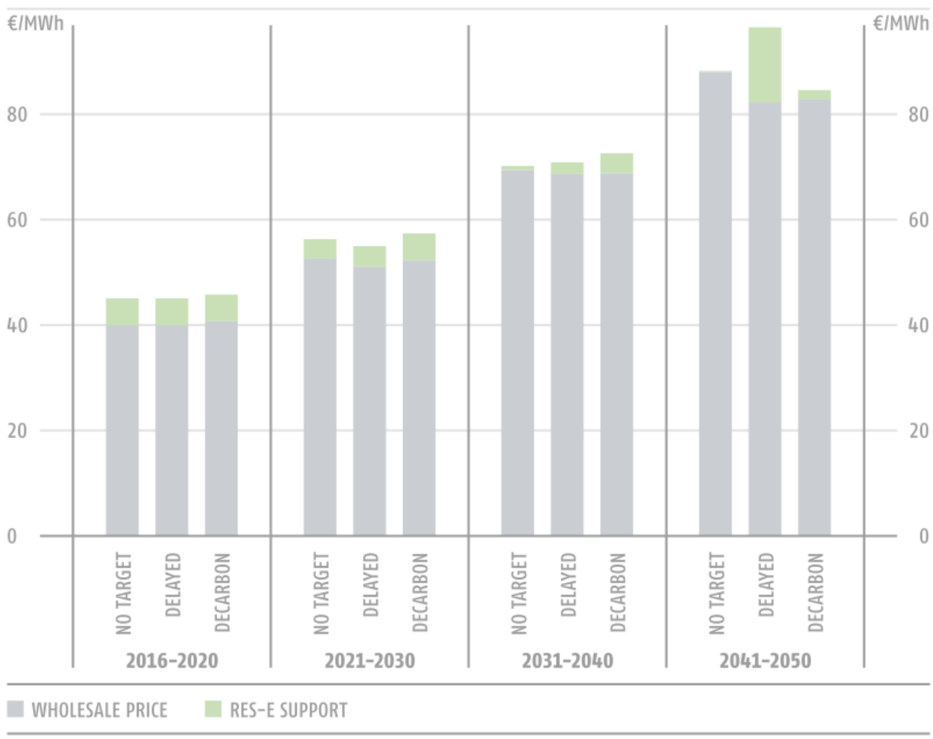
Other studies confirm that fossil-based energy production will be the most expensive solution in future in Kosovo*. According to the World Bank's Expert Panel's estimation, the new coal-based Kosova e Re power plant in Kosovo* cannot be competitive with renewable generation as its LCOE is estimated at 81.42 EUR/MWh. The official "target" consumer price of the contract is 80 EUR/MWh – which does not contain all costs (Gerard Wynn & Azemi, 2018). The contract includes "availability payments", which seems to be prohibited state aid according to the new guidelines of the Energy Community (Balkan Green Energy News, 2018)

Electricity prices will increase because of renewables. RES support and expansion will lead to increased electricity bills. RES-based systems are more expensive.

FACT: The increase of the electricity price is mostly driven by the increase in the price of carbon and natural gas

Retail prices consist of the wholesale price plus subsidies, taxes, fees and network costs. Of these retail price components, the SEERMAP report covered wholesale prices and RES support. The most important finding of the SEERMAP modelling exercise in this respect is that the wholesale price of electricity follows a similar trajectory in all scenarios in all countries in the SEERMAP region, only diverging after 2045 when prices are lower in the scenarios which have decarbonisation targets as a result of the low marginal cost of RES electricity production. The SEERMAP model calculations show that compared to a scenario with no emission reduction target, decarbonisation policies do not drive up wholesale electricity prices. The wholesale price of electricity is not driven by the level of decarbonisation but by the CO_2 price and the price of natural gas.

Figure 32 WEIGHTED AVERAGE RES SUPPORT PER MWH OF TOTAL ELECTRICITY CONSUMPTION AND WEIGHTED AVERAGE WHOLESALE PRICE, 2016-2050 (EUR/MWh)



Source: SEERMAP Regional Report South East Europe

The SEERMAP project also shows that although RES support is higher in the 'decarbonisation' scenario than in the 'no target' scenario, the renewables support needed to incentivise investments in the 'decarbonisation' scenario decreases over time. The RES support needed to achieve almost complete decarbonisation in the 'decarbonisation' scenario is only 10.8% of the electricity cost (wholesale price plus RES support) in the period 2020-2025, and 2.7% in 2045-2050. RES support decreases in the 'decarbonisation' scenario despite increasing investment in RES capacities, mostly because the rising wholesale electricity price reduces the need for additional support.

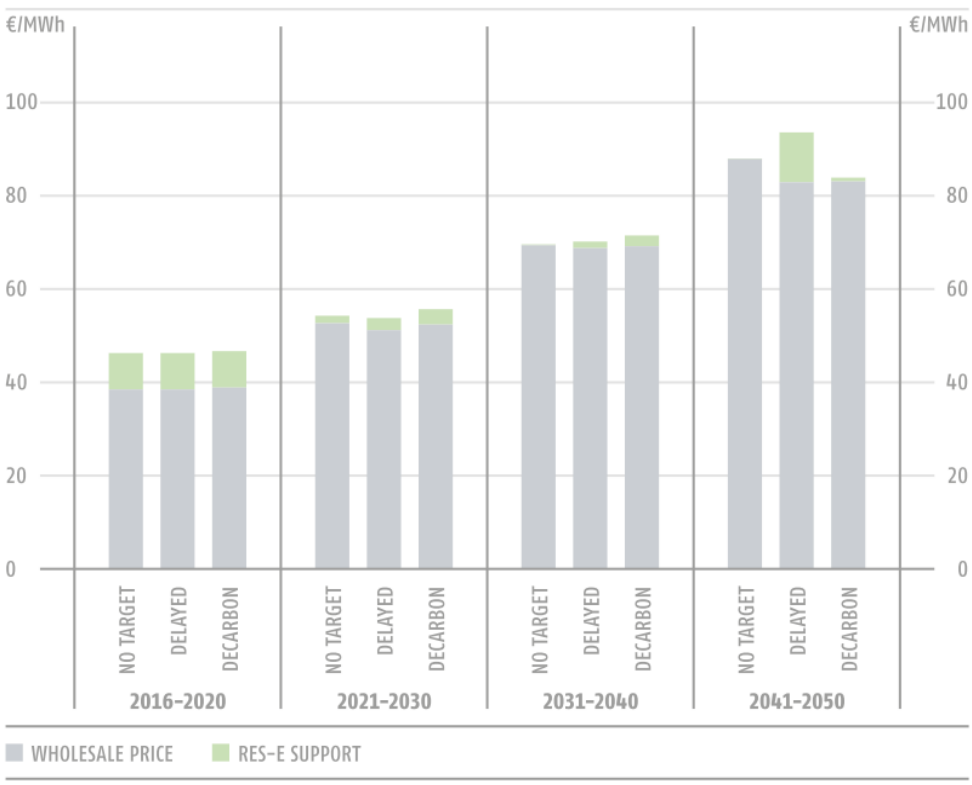
The SEERMAP analysis also shows that delayed action can result in very high RES support needs and that therefore planned long-term action on renewables is better. RES support needed in the 5-year period between 2045-2050 in the 'delayed' scenario is 24.3 EUR/MWh, compared with 2 EUR/MWh in the 'decarbonisation' scenario.

The positive consequences of the higher penetration of variable renewables (mainly wind and solar) in terms of lowering electricity wholesale prices in the EU is already visible. "Higher penetration of volatile RES with very low variable cost of production (due to no fuel cost) has brought low prices to day-ahead markets (DAM) in EU, which made competing fuel-based technologies uncompetitive during windy and/or sunny days." (Duić, 2015).

INSIGHTS FROM BULGARIA

Figure 33 clearly shows that the wholesale electricity price is expected to rise in the next decades independently of decarbonisation policy (therefore RES share). RES support relative to the cost of electricity (wholesale price plus RES support) in the 'decarbonisation' scenario is less than 15.9% in the 2020-2025 period, but only 1.8% in 2045-2050. If planned appropriately, RES support needed to achieve complete decarbonisation is moderate, staying below 4 EUR/MWh after 2025 and below 2 EUR/MWh after 2040. In the 'decarbonisation' scenario RES support falls over the course of the modelled period while investment in RES capacity increases. The broad decline in RES support is made possible mainly by the increasing wholesale price for electricity which reduces the need for residual support. In addition, the SEERMAP results show that ETS auction revenues can cover the necessary RES support over the modelled period, thereby relieving the corresponding surcharge to consumers.

Figure 33 AVERAGE RES SUPPORT PER MWH OF TOTAL ELECTRICITY CONSUMPTION AND AVERAGE WHOLESALE PRICE IN BULGARIA, 2016-2050 (EUR/MWh)



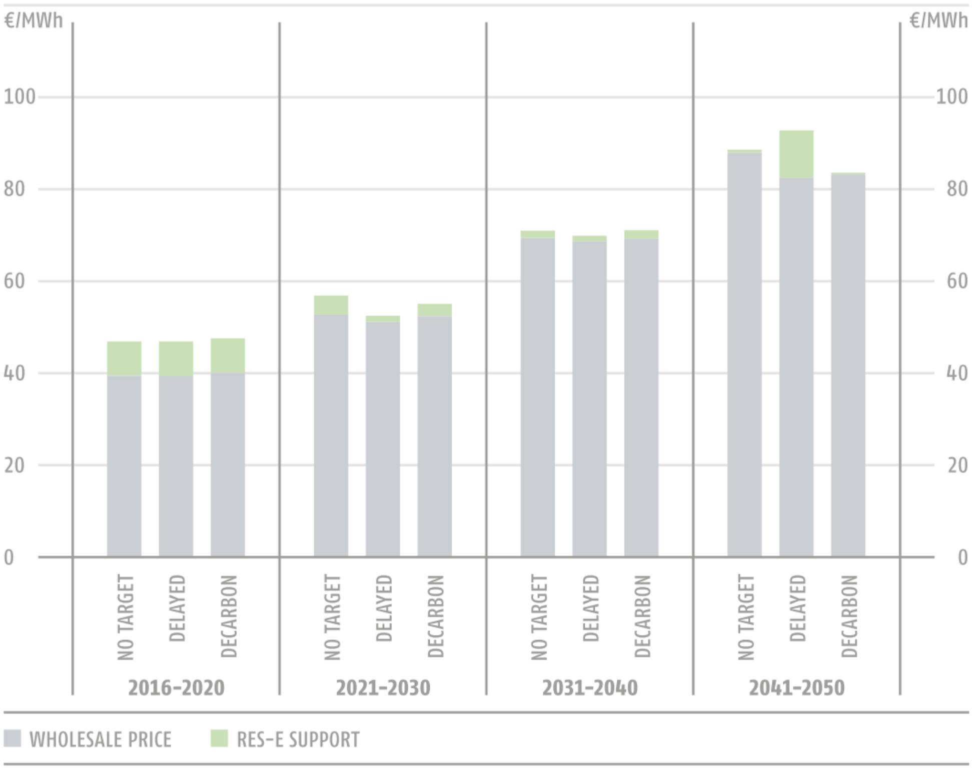
Source: SEERMAP Country Report Bulgaria

INSIGHTS FROM ROMANIA

The wholesale electricity prices are expected to increase over time in every scenario in Romania. However, by 2050 the lowest wholesale electricity price and RES support will be achieved in the 'decarbonisation' scenario.

RES support will gradually fall during the modelled period in the 'decarbonisation' scenario. The required RES support is quite low compared to the other countries: the maximum amount is around 7.5 EUR/MWh, which decreases to 0.2-0.6 EUR/MWh by 2040-50 under the 'decarbonisation' scenario of the SEERMAP model.

Figure 34 AVERAGE RES SUPPORT PER MWH OF TOTAL ELECTRICITY CONSUMPTION AND AVERAGE WHOLESALE PRICE IN ROMANIA, 2016-2050 (EUR/MWh)



Source: SEERMAP Country Report Romania

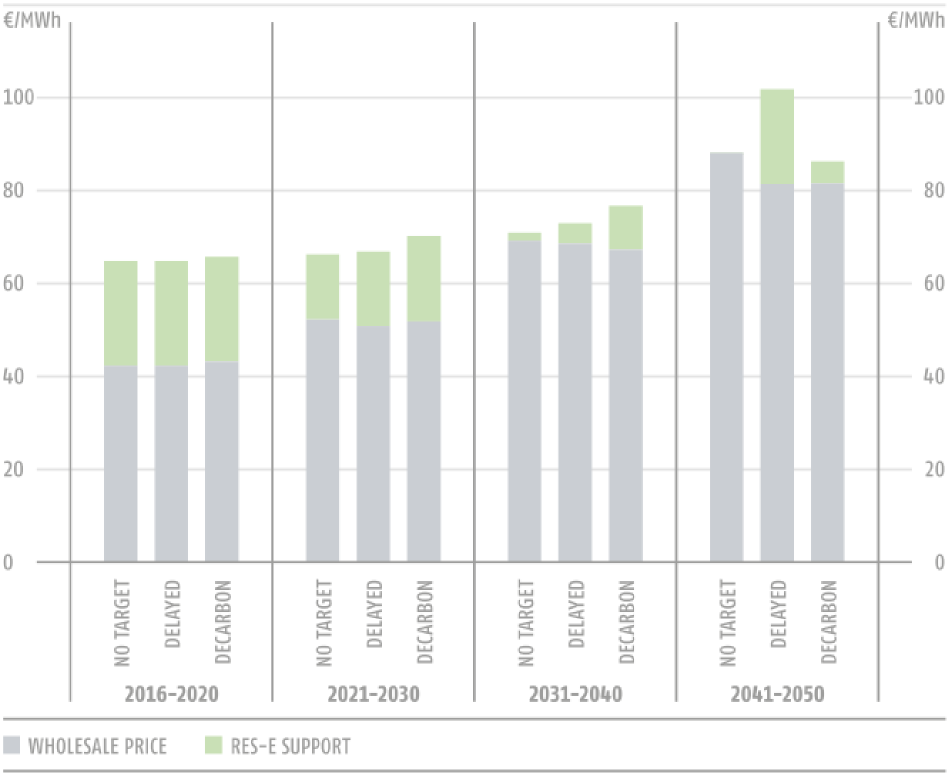
A significant share of the RES support for decarbonisation of the electricity sector can be covered by EU ETS revenues, thereby relieving the corresponding surcharge to consumers. Furthermore, due to RES support, private investments will have a positive effect on GDP growth by about 0.7% on average between 2017 and 2050 in the 'decarbonisation' scenario.

INSIGHTS FROM GREECE

RES support relative to the cost of electricity (the wholesale price plus RES support) in the 'decarbonisation' scenario is 25% in the period 2020-2025 but only 6% by 2045-2050. In this scenario the highest support needed is 22.6 EUR/MWh in the first years, decreasing to 4.7 EUR/MWh by 2050.

The results show that ETS revenues can cover a significant portion of the necessary support between 2021 and 2030, and most of the necessary support in the following decade, thereby relieving the burden on consumers.

Figure 35 AVERAGE RES SUPPORT PER MWh OF TOTAL ELECTRICITY CONSUMPTION AND AVERAGE WHOLESALE PRICE IN GREECE, 2016-2050 (EUR/MWh)



Source: SEERMAP Country Report Greece

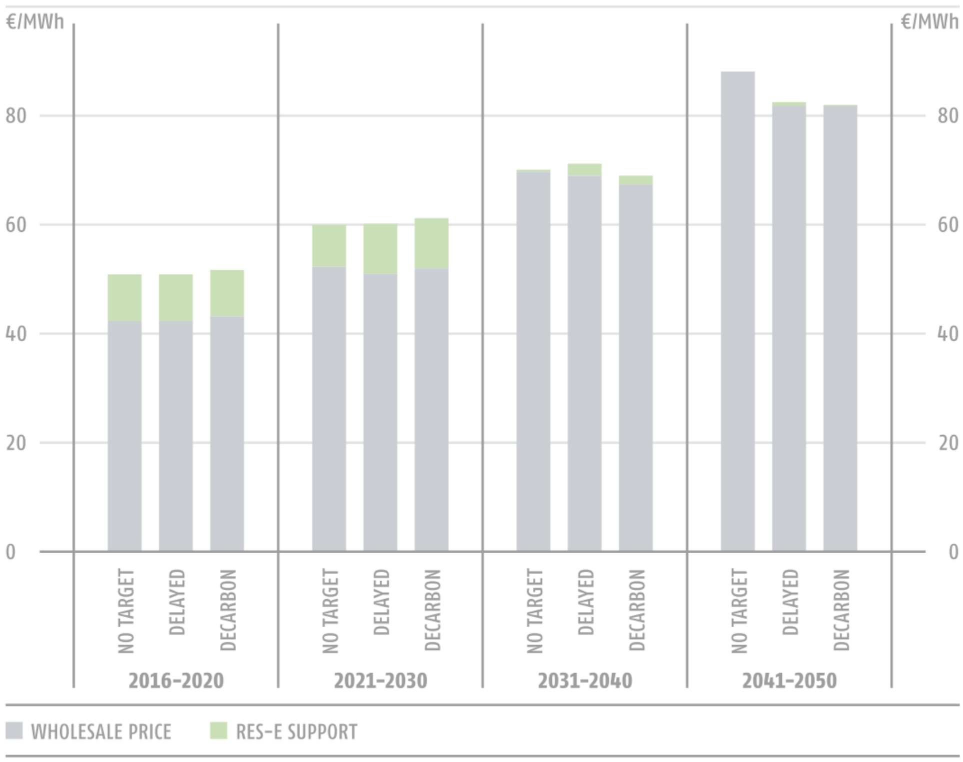
INSIGHTS FROM CROATIA

Croatia is facing increasing electricity wholesale prices in all scenarios. However, the wholesale prices are expected to be slightly higher in 'no target' scenario by 2050.

Despite the significant investment needs associated with the 'decarbonisation' scenario, SEERMAP analysis shows that the renewables support needed to incentivise these investments remains relatively low, initially at 8.5 EUR/MWh and temporarily rising to 10.5 EUR/MWh before steadily decreasing to 0.3 EUR/MWh towards the end of the modelled time horizon. The RES support relative to electricity cost (wholesale price plus RES support) is 16.8% at its highest level in the 'decarbonisation' scenario. Revenue from the auction of carbon allowances under the EU ETS is a potential source of financing for renewable investment. All scenarios have similar revenues, which may cover 25-30% of the RES support until 2030 and 100% after 2030.

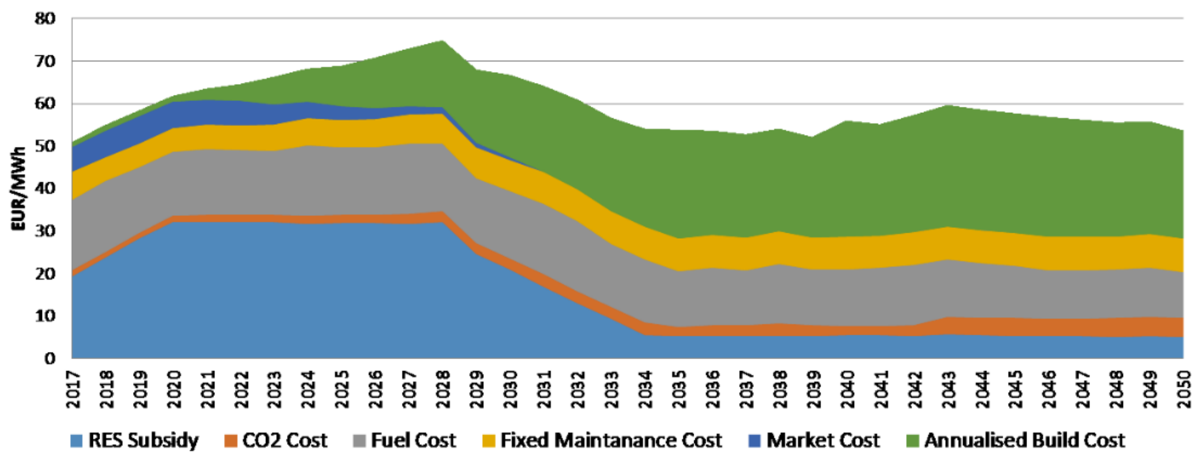
Rajšl & Tomšić (2017) created 3 different future energy scenarios (with total of 10 sub-scenarios) in their research on the electricity sector for the Croatian Low Carbon Development Strategy. The main scenarios are a reference scenario (NUR), a scenario with gradual transition (NU1) and one with strong transition (NU2). According to the results of the NU1a scenario, the levelised cost of electricity will grow until around 2028 and level out afterwards until 2050 under the NU1 scenario.

Figure 36 AVERAGE RES SUPPORT PER MWh OF TOTAL ELECTRICITY CONSUMPTION AND AVERAGE WHOLESALE PRICE IN CROATIA, 2016-2050 (EUR/MWh)



Source: SEERMAP Country Report Croatia

Figure 37 LEVELISED COST OF ELECTRICITY PRODUCTION IN CROATIA ACCORDING TO NU1A SCENARIO



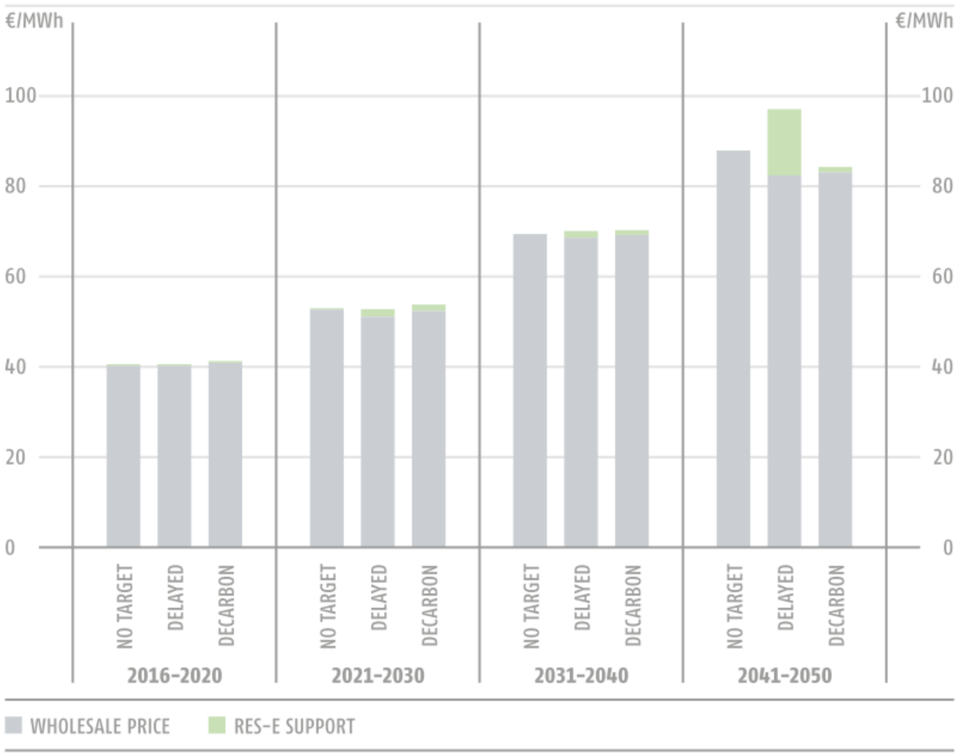
Source: Rajšl & Tomšić (2017)

Similar research was carried out by Pukšec et al. (2018) on possible energy transition scenarios for Croatia. According to their estimations, due to the high share of wind and solar power in the transition scenarios, the yearly total marginal cost of electricity production is expected to be 18.77 EUR/MWh by 2030. This constitutes an almost 60% decrease from prices in 2016 of 45.65 EUR/MWh.

INSIGHTS FROM NORTH MACEDONIA

The SEERMAP model results show that compared to a scenario with no emission reduction target, decarbonisation policies do not drive up wholesale electricity prices. The price of electricity follows a similar trajectory in all scenarios, only diverging after 2045 when prices for the ‘decarbonisation’ scenario are lower as a result of the low marginal cost of RES electricity production.

Figure 38 CUMULATIVE RES SUPPORT AND AUCTION REVENUES FOR 4 AND 10 YEAR PERIODS, 2016-2050 (MEUR)



Source: SEERMAP Country Report North Macedonia

Despite significant investment needs associated with the ‘decarbonisation’ scenario, the renewables support required to incentivise these investments remains low, starting at 0.4 EUR/MWh and staying below 2 EUR/MWh towards the end of the modelled time horizon. The RES support relative to electricity cost (wholesale price plus RES support) is only 2.6% at its highest level in the ‘decarbonisation’ scenario.

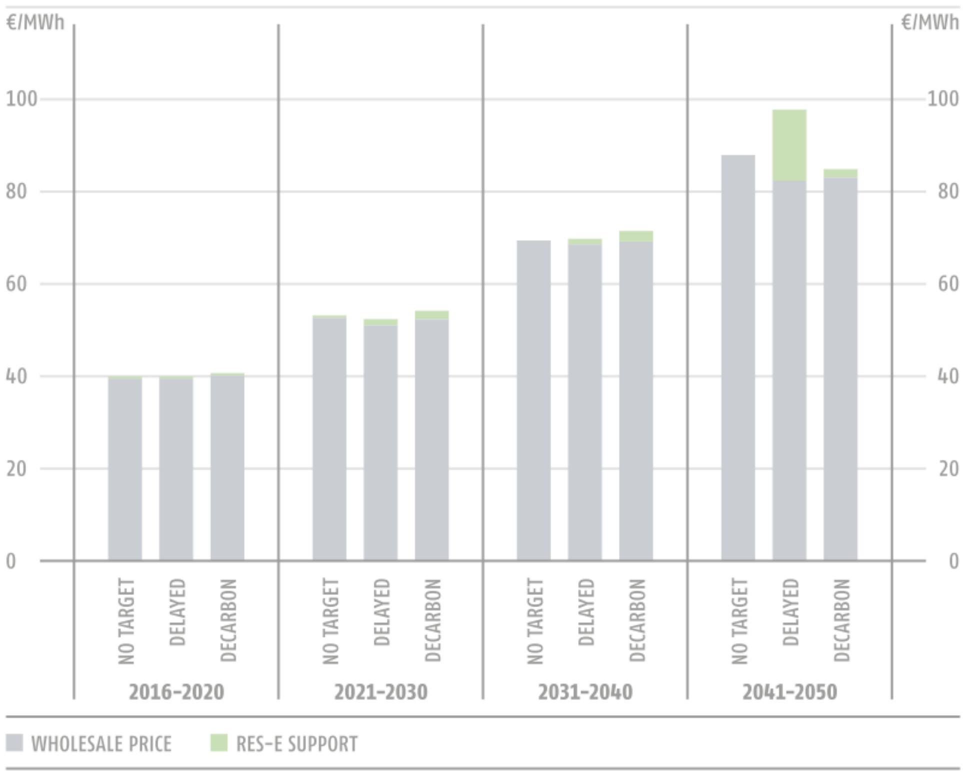
INSIGHTS FROM KOSOVO*

Similarly to other SEERMAP countries, the wholesale price of electricity follows almost the same trajectory under all scenarios. The average annual wholesale price increase in Kosovo* over the entire period is 2.9% in the ‘no target’, 2.2% in the ‘delayed’ and 2.3% in the ‘decarbonisation’ scenarios. The price of electricity only diverges after 2045 when prices are lower as a result of the low marginal cost of RES electricity production in the ‘decarbonisation’ and ‘delayed’ scenarios.

The renewables support needed to incentivise RES investments in the ‘decarbonisation’ scenario remains negligible (under 2 EUR/MWh) throughout the entire period.

In the ‘delayed’ scenario rapid deployment of additional capacities towards the end of the modelled period are needed to achieve 2050 decarbonisation targets, raising required support to an estimated 15.4 EUR/MWh on average over the last decade, equivalent to 16% of total electricity cost. These results show that it is not renewables per se which are expensive, but that delayed, unplanned action on renewables will significantly drive up costs.

Figure 39 AVERAGE RES SUPPORT PER MWH OF TOTAL ELECTRICITY CONSUMPTION AND AVERAGE WHOLESALE PRICE, 2016-2050 (EUR/MWh)



*Source: SEERMAP Country Report Kosovo**

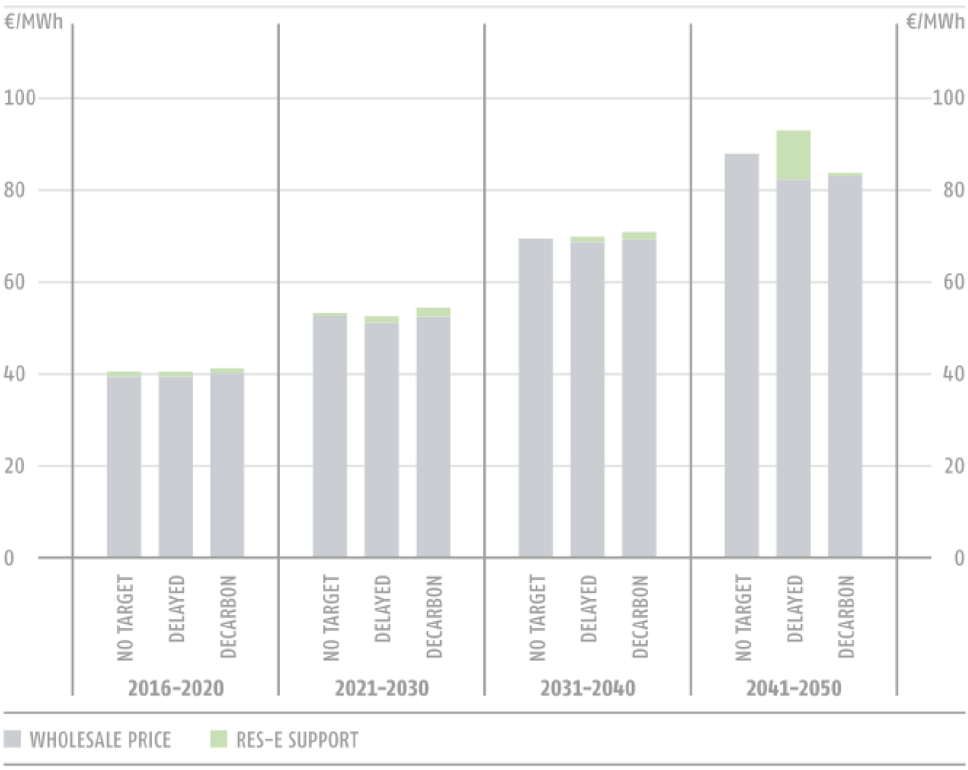
Kittner et al. (2016) defined six alternative energy scenarios for Kosovo* that meet electricity generation requirements at a lower cost than the base case by 2025. As "a 30 EUR/ton price on CO_2 increases costs of coal generation by at least 330 mEUR", Kittner et al. (2016) claim that building a new coal power plant is "the most expensive pathway to meet future electricity demand" of Kosovo*.

Germanwatch (Johnston et al., 2018) comes to the same conclusion. According to their calculations wind power is already competitive with new gas, coal and nuclear. In addition, solar power is competitive with new coal, nuclear and gas in areas of higher solar irradiance.

INSIGHTS FROM SERBIA

Decarbonisation of the electricity sector does not drive up wholesale electricity prices compared to a scenario where no emission reduction target is set. The price of electricity follows a similar trajectory under all scenarios and only diverges after 2045. After this year, prices are lower in scenarios with high levels of res in the electricity mix due to the low marginal cost of RES electricity production.

Figure 40 AVERAGE RES SUPPORT PER MWh OF TOTAL ELECTRICITY CONSUMPTION AND AVERAGE WHOLESALE PRICE, 2016-2050 (EUR/MWh)



Source: SEERMAP Country Report Serbia

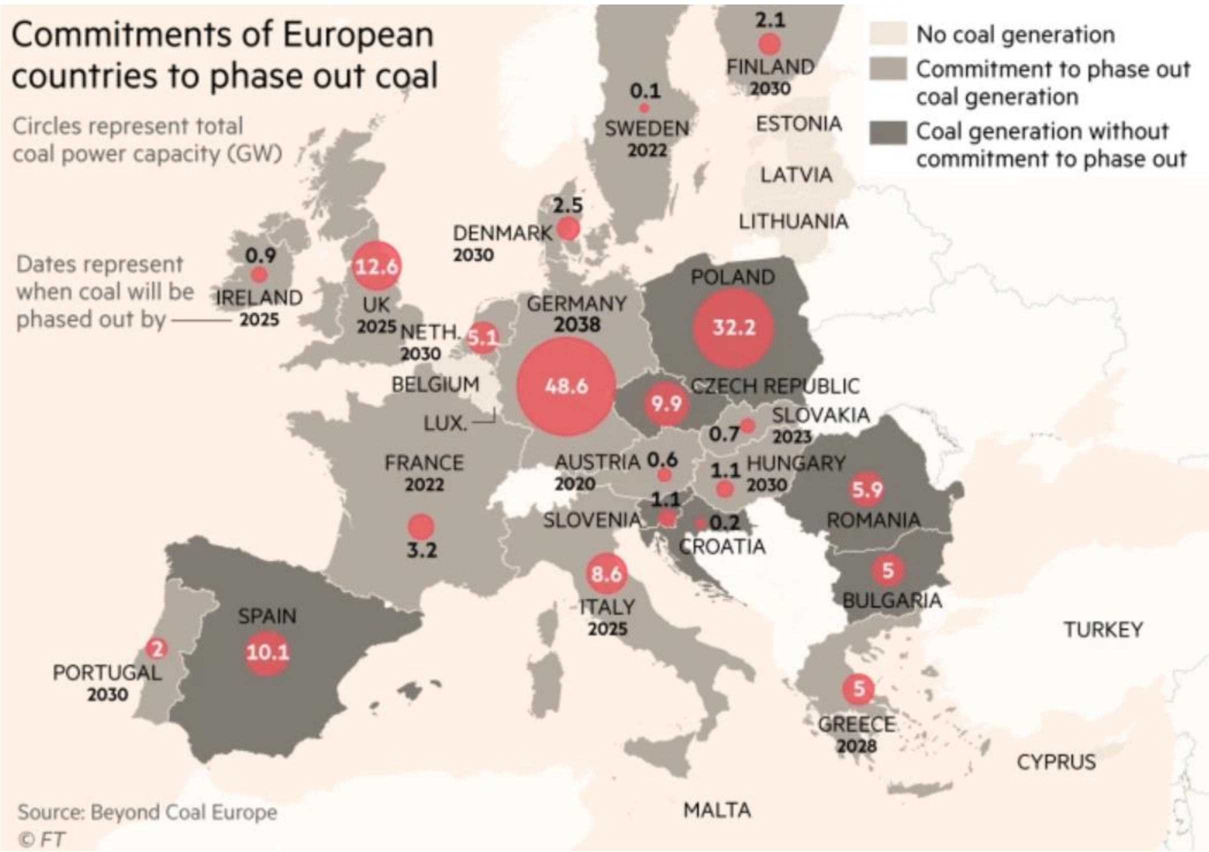
RES support falls over the period while investment in RES capacity increases. The broad decline in RES support is made possible mainly by the increasing wholesale price for electricity which reduces the need for residual support. The renewables support needed to incentivise RES investments in the 'decarbonisation' scenario remains negligible (under 2.1 EUR/MWh) throughout the entire period.

FACT: RES are only one of the causes of the inevitable coal phase-out. Security of supply can be maintained without coal.

The process of coal phase-out is already ongoing. This is in part due to decreasing profitability as a result of competition with RES, but mainly due to the high cost of carbon. Although the coal phase-out is underway, analysis shows that it is possible to operate an electricity system which consists mostly of RES capacities in a way that does not jeopardise security of supply.

Looking at global trends, one can see that coal phase out is already happening. Due to both climate and non-climate policy factors, several governments around the world have already committed to phasing out coal from the power sector. Momentum is also building in major coal-consuming economies. In large developing economies like China, India and South Africa, policies have been introduced recently or are being discussed to curb and/or reduce coal consumption over the coming decade (Johnston et al., 2018).

Figure 41 PLANNED COAL PHASE-OUT YEARS AND OPERATIONAL CAPACITY IN EUROPE



Source: Dempsey (2019)

Several EU countries have decided to phase-out coal until 2030 and in others this option is under discussion (Buck, Risteska, & Redl, 2018). Germany will phase out coal by 2038 with an assessment examining in 2032 whether a phase-out by 2035 is feasible (Agora Energiewende & Aurora Energy Research, 2019). In several cases, the decision to close coal power plants has been taken by the private sector due to decreasing profitability, such as in Hungary in the case of the Mátra power plant (Valaska, 2018).

The same process has been also begun in the SEE region, where between now and 2023, almost all coal and lignite plants “need investment to bring them in line with the countries’ commitments under the Energy Community Treaty or they must be closed” (CEE Bankwatch Network, 2017b). Therefore, irrespective of the penetration level of RES, the coal industry cannot be considered as a sector with bright future.

Renewables have an effect on the profitability of baseload power plants which is described by the missing money problem (Gallo, 2015; Reid, 2015). This is caused by two factors: renewables lower electricity prices and they also satisfy an increasing share of electricity demand, thus squeezing the profitability of coal power plants from two sides: the amount of electricity they can sell, and the price they receive for a unit of electricity sold. The lowered electricity prices are a result of the fact that renewables such as wind and solar produce electricity without marginal fuel costs. The increased role of renewables in satisfying demand results in existing baseload power plants having to be powered down because of large amount of renewable electricity production, lowering their utilisation rates and thus their profitability. In both cases, the result is missing revenue for the investors of conventional power plants to cover their investment and operating costs (Newbery, 2016).

In a new analysis carried out by REKK using the EEMM model, results show that an increase in the number of startups per generation unit is expected, with the utilization of baseload power plants becoming more flexible, i.e. coal power plants are no longer being used purely as base load plants. This is true for Europe as well as for the SEE region. There are two reasons behind the decrease in utilization of conventional power plants: on one hand, there is a significant increase in the share of variable RES in power generation, as wind and solar power has zero marginal cost and is therefore cheaper to operate whenever it is available. On the other hand, coal and lignite plants are becoming less economical. Fossil fuel costs, carbon prices and investment costs have increased, putting fossil-fuel based power plants at the end of the merit order curve. As a consequence, these plants have less operation hours. (REKK Foundation, 2019).

RES do undermine the economic basis of base load electricity generation. However, this does not negatively affect energy security. An energy system with high share of intermittent renewable energy capacities and without conventional power plants is feasible and able to satisfy energy demand and balance supply with adequate grid interconnections, storage, supply side flexibility and demand side response measures, as has been shown by numerous studies (Lund, 2014; Lund, Andersen, Østergaard, Mathiesen, & Connolly, 2012; Matek & Gawell, 2015; Ueckerdt & Kempener, 2015). There are also real life examples of electricity markets with high RES shares. In Germany, large RES capacities have been integrated into the electricity system without compromising security of supply, even in extreme situations such as a solar eclipse (Redl, 2018).

In addition, in order to enable countries to continue to use fossil fuel power plants to balance supply and demand while they transition to a clean energy system, the European Commission does allow capacity mechanism payments as a tool for ensuring security of supply without distortion of electricity markets. There are already existing precedents. (European Commission, 2018b; European Parlamentary Research Service EPRS, 2017).The Guidelines on State Aid for environmental protection and energy (EEAG) 2014-2020 adopted in July 2014 for the first time contain criteria for the Commission to apply when assessing capacity mechanisms. In addition, within the Clean Energy for All Europeans package, the Directive on wholesale electricity market design allows for capacity payments provided that certain conditions related to emissions and/or to the time power plants are allowed to operate are satisfied.

FACT: RES currently need support but will soon reach grid parity.

Renewable technologies are becoming more efficient and their costs are also decreasing. However, most technologies currently still need some level of support. They have to compete with well-established industries that benefit from existing infrastructure, expertise and policy and they also have to cope with numerous barriers which mean higher risks and costs. However, the RES support required to significantly increase the share of renewables is not high.

The SEERMAP modelling results show that despite falling costs which means that RES technologies are already at grid parity in some locations, support may still be needed in 2050 to incentivise new investment. This is partly due to a locational effect, as the best locations with highest potential are used first and costs of the subsequent RES capacities are therefore expected to increase over time.

It also has to be noted, that in many countries in the Western Balkan region, fossil fuel-based electricity production currently benefits from different forms of direct and indirect subsidies.

Regarding efficient policies for RES development, IRENA, IEA, & REN21 (2018) highlights the importance of going beyond direct economic incentives as a sole support form and urges countries to apply comprehensive integrating and enabling policies. These can be used to support the development not only of renewable technologies but also of the needed infrastructure, market environment and information for stakeholders.

Although globally some RES technologies have reached grid parity in some locations with technology costs continuing to fall, some support will still be needed in 2050 to stimulate new investment. This is because the best locations with highest potential are used first, and the levelised cost of electricity of new capacities therefore increases if more capacity is already installed.

INSIGHTS FROM NORTH MACEDONIA

The SEERMAP analysis has shown, that in order to decarbonise electricity production in North Macedonia by 2050 the renewables support required to incentivise these investments is low, starting at 0.4 EUR/MWh and rising to 2 EUR/MWh towards 2050. The RES support relative to electricity cost (wholesale price plus RES support) is only 2.6% at its highest level in the 'decarbonisation' scenario.

However, if investment in renewables is not well planned and deployment of these capacities begins later, the rapid deployment of additional capacities towards 2050 that are needed to achieve decarbonisation targets will require substantial support, estimated at around 26% of total electricity cost. The SEERMAP modelling results demonstrate the role of policy planning in keeping renewable support levels low.

B. Security of supply of high RES energy systems

MYTH B1: RES cannot ensure security of supply – baseload power plants are needed.

RES-based systems are unstable and inflexible due to intermittency; they can negatively influence security of supply and lead to system failure. A RES share higher than 30% (excluding hydro) is not technically feasible. Security of supply can only be achieved with baseload/coal/fossil power plants.

FACT: Baseload production is the basis of the current energy system, but it is not necessary and may even hinder the future energy system as it is inflexible, with obsolete units, stranded assets and high marginal costs.

Electricity production from some renewable resources such as storage hydro, biomass, biogas or geothermal can be regulated, while the other, so-called intermittent sources such as wind, solar and run-of-river hydro are intermittent. Studies, and increasingly also experience, have shown that energy systems with a high share of intermittent renewable energy are feasible. There are several ways of making sure that supply can meet demand. These include:

- Supply side flexibility;
- Electricity storage;
- Interconnectivity;
- Demand side response.

In addition to technological solutions, solutions in three other areas can help integrate intermittent RES:

- Business models;
- Market design;
- System operation.

A study by Tomić et al. (2017) showed, using the Dispa-SET model, that the Western Balkans can integrate up to 28.7% more RES than it was planned in the national energy strategies, without compromising the stability of the region's power system.

In an update to the SEERMAP project, REKK prepared a detailed analysis of security of supply by modelling energy demand and supply for all 8760 hours of the year. They found that "the number of hours with missing production will be very low in 2030. The scenario showed hours with missing production in Albania, Kosovo and North Macedonia. The missing production levels occur in one or two hours of the year, which indicate very low levels of load-shedding requirements. The typical security of supply standards in the EU range from three to six hours of loss of load expectation. The results of missing production levels and low cross-border correlation of vRES feed-in emphasize the importance of regional cooperation and the availability of sufficient interconnection capacity between countries. Increasing interconnection levels between the countries can eliminate the missing production hours entirely, because countries with this problem can rely on imported electricity from neighbouring power systems. (REKK Foundation, 2019). The factors which are responsible for enabling security of supply, according to the model results, are interconnectivity, a high share of hydro in the energy mix, and low correlation in wind availability both between countries within the region as well as between the SEE region and the rest of Europe.

Supply side flexibility

Supply side flexibility is often thought of as being provided by fossil fuel plants. However, not all renewable sources are intermittent, and some can provide flexibility on the supply side, such as biomass, biogas and pumped storage hydro. The extent to which fossil fuel plants are needed to provide flexibility is a question that has been assessed by a number of studies.

Baseload (mostly fossil) capacities are not necessary in an energy system, even with high RES penetration (Lund, 2014; Lund et al., 2012; Matek & Gawell, 2015; Ueckerdt & Kempener, 2015). In a flexible energy system (Lund, 2007), where all energy system actors are active, energy prosumers, smart solutions, electric cars, heat pumps, controllable CHP plants, demand side management, energy storage and transformation technologies all work together to integrate as much intermittent renewable energy as possible.

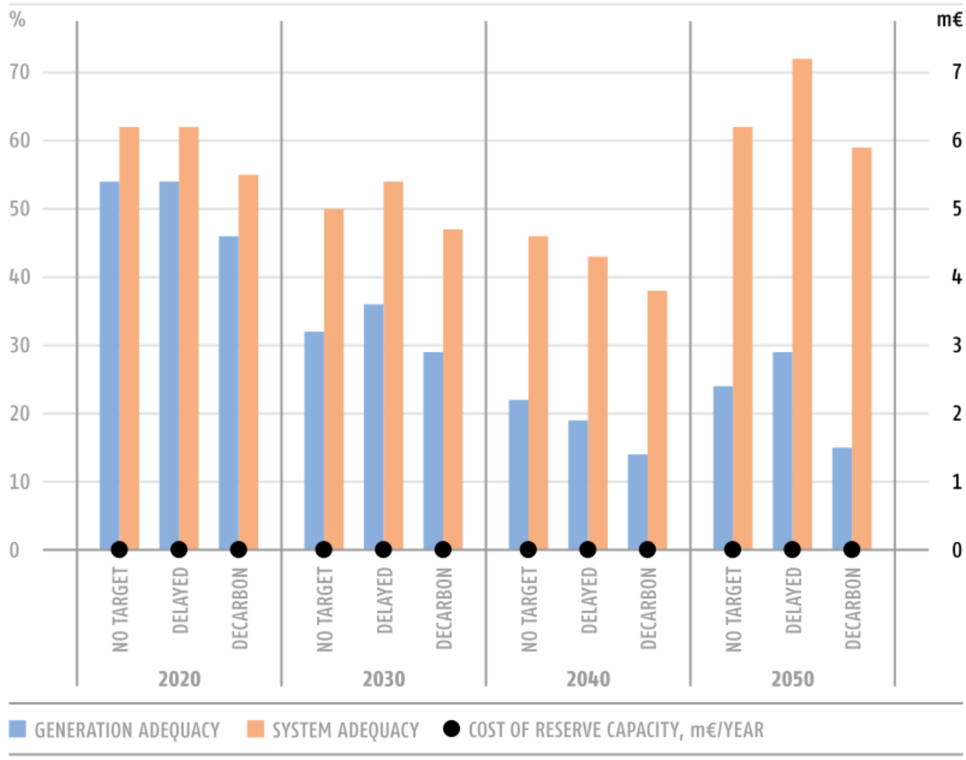
SEERMAP modelling has been very conservative with respect to the flexibility that can be achieved on the demand side. It was assumed that demand side management can shift only 3.5% of total daily demand from peak load to base load hours by 2050. The 3.5% assumption is a conservative estimate compared to other projections, e.g. McKinsey & Company (2010) which assumed demand side management will shift 2% of demand from peak hours in 2020 and 10% in 2050, or TECHNOFI (2013). No demand side measures were assumed to be implemented before 2035 and no storage capacity was assumed. Even with only limited demand side response, assuming only slightly higher interconnectedness between SEE countries than is currently the case, by relying on a mix of both intermittent and dispatchable RES, supply and demand can be balanced in an electricity system which by 2050 has an 83.2% RES share and only around 1% fossil fuel-based generation. In the 'decarbonisation' scenario demand and supply can be balanced even though only 294 MW fossil capacity remains in the system in contrast to 9723 MW renewable capacity by 2050.

In order to assess the validity of concerns about the impact of high RES shares on energy security, three security of supply indices were calculated for all countries and scenarios in the SEERMAP project: the generation capacity margin, the system adequacy margin, and the cost of reducing the generation adequacy gap to zero. Even with conservative assumptions relating to demand side measures, the generation adequacy indicator[2] remains favourable for the SEERMAP region as a whole, i.e. regional generation capacity is sufficient to satisfy regional demand in all hours of the year for all of the years modelled. The system adequacy[3] indicator for the region as a whole, which takes into account import possibilities as well as regional generation capacities, is even higher.

[2] Generation adequacy is the ability of generation to match load in the power system at all times. Generation adequacy analysis is important for energy consumers because it seeks to demonstrate whether the electricity supply is able to remain secure and available when needed (JRC 2016 - EUR 27944).
The generation adequacy margin is defined in SEERMAP model as the difference between available capacity and hourly load as a percentage of hourly load. If the resulting value is negative, the load cannot be satisfied with domestic generation capacities alone in a given hour and imports are needed. The generation adequacy margin was calculated for all of the 90 representative hours and the lowest value was used as the indicator. For this calculation, assumptions were made with respect to the maximum availability of different technologies. Fossil fuel power plants were assumed to be available 95% of the time, and hydro storage 100% of the time. For other RES technologies historical availability data was used. This is a simplified version of the methodology formerly used by ENTSO-E. (See e.g. ENTSO-E 2015, and previous SOAF reports)

[3] System adequacy means, that a country is able to fulfil all electricity needs for all hours in a year using its own electricity generation fleet as well as electricity imports.
The system adequacy margin is defined in SEERMAP model similarly to generation adequacy, but net transfer capacity available for imports is considered in addition to available domestic capacity. This is a simplified version of the methodology formerly used by ENTSO-E. (See e.g. ENTSO-E (2015a), and previous SOAF reports)

Figure 42 GENERATION AND SYSTEM ADEQUACY MARGIN FOR THE ENTIRE SEERMAP REGION, 2020-2050 (% OF LOAD)



Source: SEERMAP Regional Report South East Europe

However, the generation adequacy margin varies for individual countries, and is negative for some countries in some scenarios, in particular for Albania, Kosovo* and Serbia. This means that during certain time periods, these countries would need to import electricity to be able to satisfy domestic demand. This is in line with a broader EU approach which relies on cooperation and solidarity between member states – to which the countries of this region are also committed through their membership of the Energy Community.

At the country level, negative generation adequacy is linked to the two scenarios with decarbonisation targets. Increasing the generation adequacy margin to ensure that demand can be satisfied with domestic capacities at all times would require additional investment in new capacities and higher electricity prices, which underlines the importance of regional cooperation. Concerted efforts towards market integration and increasing the capacity of interconnections can reduce generation investment costs in scenarios with high shares of renewable generation. Additional positive effects of regionalisation include smoothing of electricity generated by intermittent RES capacities and also the decrease in the need for new investments in hydro power generation.

Natural gas is often considered a bridge fuel between the current fossil fuel-based economy and the future low carbon economy due to its lower emission factor and higher efficiency of gas combustion technologies relative to some other fossil fuel generation technologies, such as coal. Natural gas-fired generation is also said to provide the necessary flexibility in an electricity system with a high share of renewables. However, the 'bridging fuel' argument is often used to justify a higher role for natural gas than necessary.

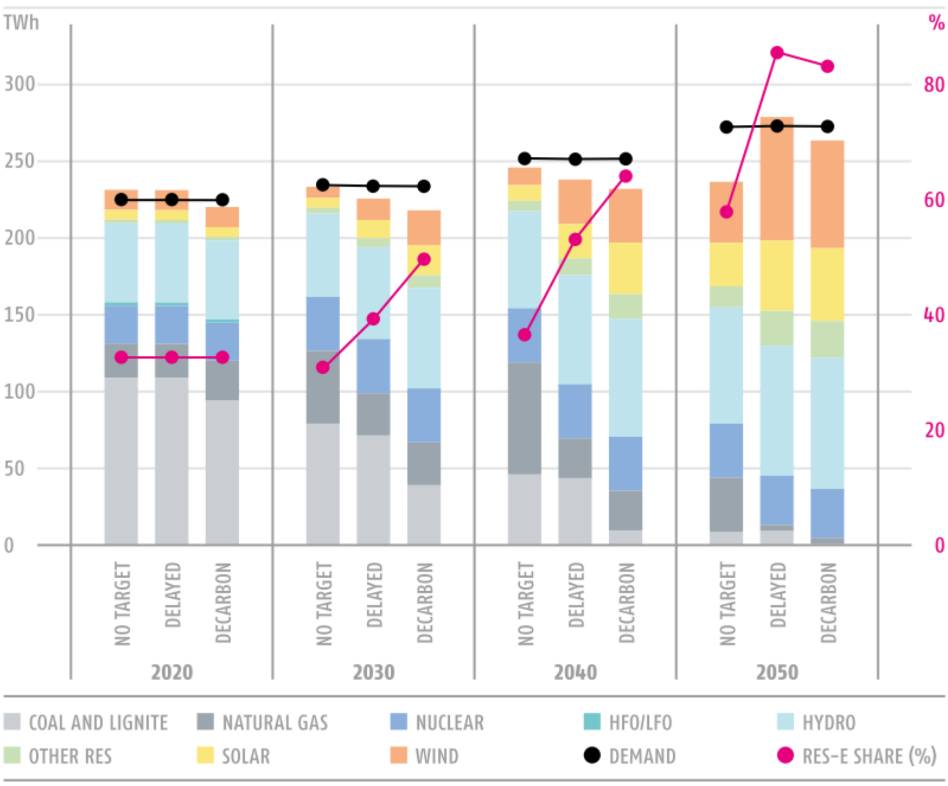
The SEERMAP results show that initially all scenarios foresee a rise in natural gas use for electricity generation. However, in the 'decarbonisation' scenario regional natural gas-based electricity generation plays only a very minor role towards the end of the modelled period, accounting for 1.5%

of generation in 2050. Under the 'no target' scenario, gas still provides 15% of regional electricity generation in 2050 with peak production expected around 2035.

Regarding capacities, this means 8500 MW installed natural gas capacity for 'no target' and 2200 MW capacity for 'decarbonisation' scenario by 2050 in the SEERMAP region. In the 'decarbonisation' scenario total gas capacity declines from 2020 onwards, with the rate of new capacity additions lower than the rate of outgoing capacity. Even without an increase in capacity, gas-based electricity generation is still sufficient to bridge the transition from fossil to renewable based electricity mix due to higher utilisation rates which peak between 2025 and 2035 in this scenario.

In most countries, natural gas does not play a bridging role in scenarios which are consistent with long-term EU decarbonisation targets. The only scenario where the share of natural gas is significant is in the 'no target' scenario, but this scenario is not in line with EU policy goals.

Figure 43 ELECTRICITY GENERATION AND DEMAND (TWh) AND RES SHARE (% OF DEMAND) IN THE SEERMAP REGION, 2020-2050



Source: SEERMAP Regional Report South East Europe

In all scenarios most gas-based electricity is produced in the EU countries covered by the SEERMAP project (Greece, Romania and Bulgaria), where gas infrastructure already exists. In these countries, the short-term uptick in gas-based electricity generation in a decarbonisation scenario can be achieved without a significant increase of natural gas capacities, as the generation increase is due in large part to higher utilisation rates. Two countries in the Western Balkans, Bosnia and Herzegovina and Montenegro, have no gas-based electricity generation in any of the scenarios. Since natural gas will play only a marginal role in the long-term and has a limited bridging role, the investment in gas distribution networks connecting to the Trans Adriatic (TAP) pipeline[4] should be reviewed in light of long-term decarbonisation targets.

The Energy Union Choices report confirms this result. Natural gas-based electricity generation will dramatically decline by 2030 even with large shares of coal retiring. Due to better grids and flexible demand, system balancing can be achieved with demand side response measures at a lower cost than with natural gas turbines, the role of natural gas in the generation mix therefore declines over time. According to the report, "this demonstrates that a phase-out of coal and reduction in nuclear capacities does not necessarily imply higher gas demand (and thus import dependency) for the power sector compared to today, as long as adequate policies and measures are put in place to facilitate the partial replacement of baseload generation by renewable power generation." (Energy Union Choices, 2017)

Although it has been shown by numerous studies that there is very little to no need for fossil fired electricity generation capacity to ensure supply side flexibility, some supply side flexibility is needed in all electricity systems. Such flexibility can be provided by dispatchable renewables such as biomass, biogas and storage hydro, and by electricity storage solutions.

However, high RES electricity systems cannot rely on supply side flexibility alone, and interconnectivity is a big part of the equation. The SEERMAP study showed that if countries would like to ensure that domestic generation capacity is adequate to satisfy demand in all hours of all years rather than relying on imports in certain high demand/low supply hours, then the additional cost of investing in the necessary balancing capacity can be prohibitively high in some countries.

Interconnectivity

There is a historically embedded belief in the SEE region that a country has to be self-sufficient to achieve energy security. Such thinking is pervasive in many parts of the world, and in the SEE region it is exacerbated by a historical legacy of distrust. However, energy security can also be achieved at a regional, rather than national level, by developing interconnections. This increases the security of supply by sharing benefits as well as risks (International Hydropower Association, 2017). Such thinking is also behind the EU concept of the Energy Union, which builds on the concept of solidarity and emphasises regional cooperation.

Cooperation is not only a high level concept but is also cheaper. A competitive electricity market, if unconstrained by cross-border network capacity, will result in trade flows which ensure economically optimal allocation of production across countries. Exporting electricity is only beneficial to a country if electricity can be produced at a lower cost in that country than in neighbouring countries. In this case, electricity producers can make a profit by producing electricity and exporting it to other countries. If this is not the case, and electricity imports are cheaper than domestic production, then importing electricity is the economically optimal solution, as it ensures a lower electricity price which is beneficial to consumers. Along the same logic, aiming for full self-sufficiency in electricity production can come at a significantly increased cost compared to a situation when the country is able to rely on cheaper imports.

A study of (Fraunhofer IWES, 2015) on flexibility challenges shows that geographical smoothing facilitated by strong electricity grids can reduce flexibility challenges in high-RES electricity systems. This requires regional level power system integration that relies on cross-border power flows. This

[4] In the modelled scenarios, they are assumed to be built between 2016 and 2021 and bring natural gas from the Shah Deniz II gas field to the region.

integrated power system also necessitates a mix of flexible resources for high reliability, accompanied by increased flexibility of the demand side in all countries and the adjustment of the operation of the existing conventional capacities.

Geographic smoothing across countries is made possible by a highly interconnected grid. The transmission grid in the SEE region is historically well-connected, especially within former Yugoslavia. In the future, additional network investments are expected to facilitate higher RES integration and cross-border electricity trade and to account for significant growth in peak load. Consequently, domestic high voltage transmission and distribution lines will need investments in the future in most of the SEE countries.

Concerning wind generation, the SEE regional pattern is relatively special and supportive of variable RES system integration: the correlation of wind speeds is weak within the region, in the range of 11%-46%; wind power generation peaks at different times in different countries of the SEE region. The analysis of the SEE regional pattern also shows that wind production would probably peak at different times than in the Northern European region, making smoothing of flexibility challenges easier. (REKK Foundation, 2019) This pattern of low correlation with wind availability elsewhere provides a good rationale for high interconnectivity with other regions, as it enables a higher utilisation of wind in the SEE region, as well as the possibility to import cheap wind generated electricity from other regions.

The SEERMAP network analysis covered a number of ENTSO-E impact categories, including contingency analysis[5], Total Transfer Capacity (TTC) and Net Transfer Capacity (NTC) assessment and network losses. Analysis of the network constraints anticipates contingencies in the SEE region. These problems can be solved by investments into the transmission network – e.g. by building additional lines or improving substations – where investment costs are estimated based on benchmark data for the region. In the 'delayed' scenario additional transmission network costs are 24 and 64 mEUR in 2030 and 2050, respectively. For the 'decarbonisation' scenario these values are 233 and 132 mEUR (not including the value for Greece). These costs are not significant compared to the overall investment costs in RES generation capacities, demonstrating that moderate investments in transmission line development will ensure that the network will not constrain a higher level of RES deployment projected for the region.

The SEERMAP regional report highlights that regional cooperation can significantly lower support costs and results in slightly lower investment needs for meeting RES targets. Regional cooperation requires interconnections. In parallel to implementing a regional support mechanism, issues such as differences in permitting, grid connection rules, financing, taxation, site restrictions, depreciation rules, etc. should be eliminated in order to avoid market distortions.

Fürsch et al. (2013) found that grid extensions due to high RES shares are cost-optimal solutions for the system. They claim that to reach a cost-optimal status of the European electricity network, further 228 000 km (76% extension) of network should be built by 2050. These connections will also be useful to transmit excess RES electricity production to regions where there is higher demand, therefore the need for storage capacities can be reduced.

According to a review conducted by Brown et al. (2018), additional grid costs tend to be around 10-15% of total system costs in European countries. A study for the European Commission of the European electricity system by 2030 examined the consequences for both the transmission and

[5] Contingency analysis is also called 'if-then' analysis; aimed at analysing static security of the power system by testing the impact of the failure of individual grid elements on the functioning of the grid and identifying the optimal response.

distribution grid of renewable energy penetration of up to 68% (KEMA, DNV GL-Energy, Imperial College, & NERA, 2014). For total annual system costs of 232 billion EUR/year, only 4 billion EUR/year is assigned to the costs of transmission grid investments and 18 billion EUR/year to the distribution grid. For 100% RES systems, the cost of grid expansion as a share of the total system costs vary between 10% and 15% in Germany depending on the application of smart solutions (Ackerman, Koch, Rothfuchs, Martens, & Brown, 2014 via (Brown et al., 2018).

Several studies of grid expansion and balancing costs in Germany and in Europe were analysed, and from this analysis, the following picture emerged: "grids and balancing costs reach approximately 5 EUR/MWh for rooftop solar PV, approximately 9 EUR/MWh for ground-mounted solar PV, approx. 13 EUR/MWh for wind onshore and approx. 37 EUR/MWh for offshore wind." (Agora Energiewende, 2015)

Increased electricity connection has advantages not only to countries which have difficulties in achieving their RES target, but to all countries. Increased interconnectivity allows for achieving higher shares of renewable energy in those countries which have a high intermittent renewable potential as geographic smoothing effects on the supply side and complementarities in electricity systems make balancing supply and demand easier and less costly on a European level. For example, Redl (2018) claims that investing more in interconnectivity rather than storage in flexible energy systems is cheaper.

A study of the European Climate Foundation found that a more interconnected European market would lead to increased system efficiencies that could help to achieve a total cost saving of EUR 426 billion by 2030 in the EU. A third of the saving potential comes from capital investment costs, two thirds comes from reduced operational costs as well as fuel costs. European market integration presents opportunities for countries of the SEE region. Power systems that are better interconnected make cost savings possible at lower capital investment needs for generation as well as from reduced operational costs connected to better system optimisation (Bergamaschi & Gaventa, 2014).

Storage

At the same time other studies such as Haller, Ludig, & Bauer (2012) show that emission reductions of up to 90% are feasible even without expanding transmission capacities. This study assumes a situation where the system is fragmented, therefore no significant long-distance electricity transmission is possible. In such a scenario self-sufficiency is achieved through investment in large diurnal storage capacities (especially in regions with PV) and curtailment of RES, and result in high variation between electricity prices in time and within the region (Haller et al., 2012). Energy storage can also provide advanced auxiliary services which can serve excellent power quality (Görtz, 2015).

Electricity storage is a highly relevant element of electricity systems with a high share of intermittent RES, however, relying on storage and curtailment without interconnectivity is more costly than taking advantage of import and export opportunities when needed to balance demand and supply.

Demand side management

In a flexible energy system (Lund, 2007), where all energy system players are active in integrating high shares of renewable energy, energy prosumers, smart solutions, electric cars, heat pumps, controllable CHP plants, demand side management, energy storage and transformation technologies all work together to utilize as much intermittent renewable energy production as possible and also to balance energy supply with demand. For achieving high reliability levels back-up options (e.g. use of flexible gas turbines to secure peak load cost-effectively, but hydropower or any other storage technology can also provide a back-up) as well as electricity to electricity storage (batteries, pumped hydro, etc.), flexible demand, electricity to other forms of energy storage (RES-based power to gas, hydrogen, heat, etc.) and regional integration are crucial(Fraunhofer IWES, 2015).

Dominković et al. (2016) clearly showed “that a 100% renewable energy system of the whole [SEE] region is possible”. According to their results, to achieve 100% renewable energy system, contribution from several sectors is needed to enable balancing of demand and supply at all times. These solutions include the integration of power and district heating sectors with the application of advanced CHPs and heat pumps coupled with thermal energy storage, use of solar thermal and heat pumps in buildings which cannot be connected to district heating systems, electrification of transport and use of vehicle to grid technology, electrification in industry, installation of storage solutions including pumped storage hydro where possible and CSP with storage, use of dispatchable RES such as waste incineration, and implementation of energy efficiency measures in all sectors (Dominković et al., 2016).

Regarding power quality[6], high penetration of e-car charging stations and intermittent renewable energy generators can cause degradation in power quality such as “frequency and voltage fluctuations, voltage drop, harmonic distortion and power factor reduction” (Farhoodnea, Mohamed, Shareef, & Zayandehroodi, 2013).

Non-technological solutions

A study by IRENA has shown that non-technological solutions are also available to ensure that electricity demand and supply are balanced at all times. (IRENA, 2019) The study presents the following solutions:

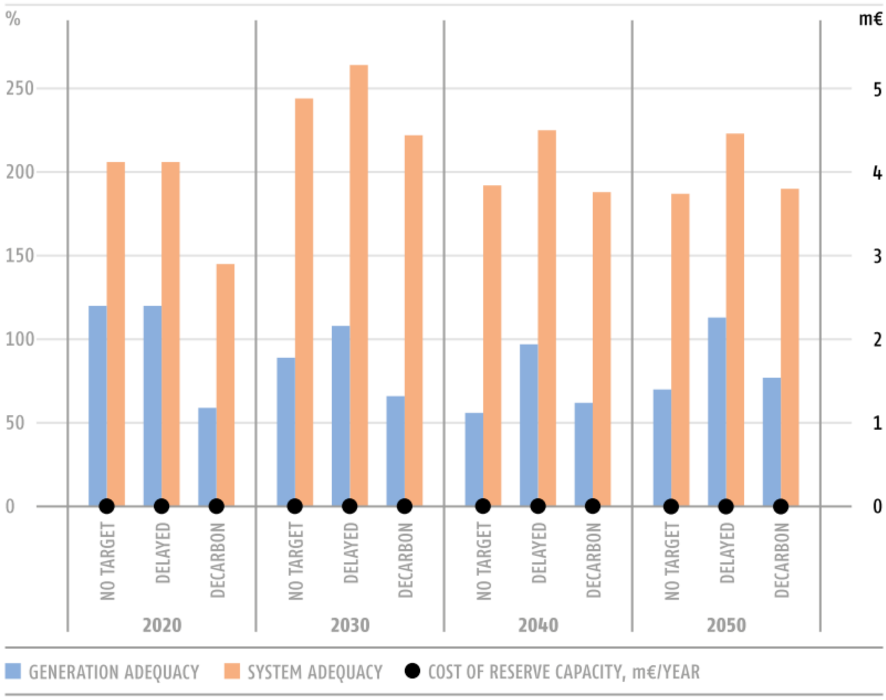
- “Business models: Innovative models that create the business case for new services, enhancing the system’s flexibility and incentivising further integration of renewable energy technologies;
- Market design: New market structures and changes in the regulatory framework to encourage flexibility and value services needed in a renewable-based power energy system, stimulating new business opportunities;
- System operation: Innovative ways of operating the electricity system, allowing the integration of higher shares of variable renewable power generation.” (IRENA, 2019)

INSIGHTS FROM BOSNIA AND HERZEGOVINA

A high RES share electricity mix is able to satisfy demand in Bosnia and Herzegovina in all hours of the year in all years until 2050 according to the ‘decarbonisation’ scenario model results, where only 300 MW existing coal power plant, the Stanari lignite-based power plant, will run by 2050 (with a utilisation rate of 7.6%).

[6] Defined as a steady supply voltage that stays within the prescribed range, steady a.c. frequency close to the rated value, and smooth voltage curve waveform (resembles a sine wave). In general, it is useful to consider power quality as the compatibility between what comes out of an electric outlet and the load that is plugged into it.

Figure 44 GENERATION AND SYSTEM ADEQUACY MARGIN FOR BOSNIA AND HERZEGOVINA, 2020-2050 (% OF LOAD)



Source: SEERMAP Country Report Bosnia and Herzegovina

For Bosnia and Herzegovina, the generation adequacy margin is positive throughout the modelling period for all scenarios, meaning domestic generation capacity is sufficient to satisfy demand in all hours of the year for all of the years modelled. The system adequacy margin is even higher.

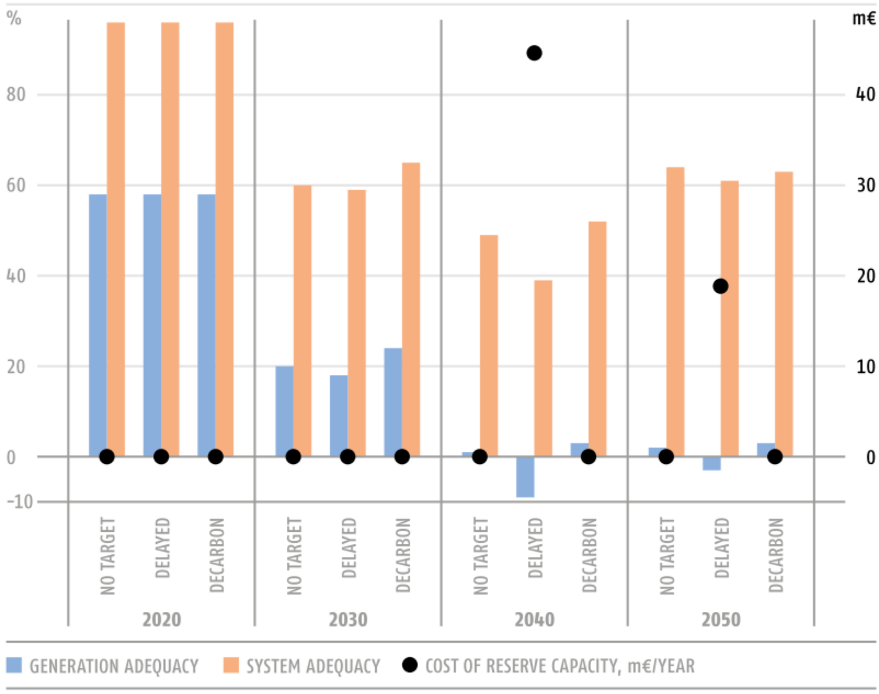
INSIGHTS FROM BULGARIA

For Bulgaria, the generation adequacy margin is positive in both the 'no target' and 'decarbonisation' scenarios over the entire modelled time period, although the value of the indicator nears zero after 2040. This means that domestic generation capacity will be enough to satisfy domestic demand during all hours of the year in both scenarios. Delayed action on renewables may endanger generation adequacy over the long term.

However, the system adequacy margin is positive for all scenarios throughout the whole modelling period. The fact that the generation adequacy indicator is similar in the 'no target' and in the 'decarbonisation' scenario indicates that an increase in the RES share by 2050 of around 20% will not have a negative impact on security of supply. Measures which could be considered include demand side measures, increased network connections and storage solutions.

In all SEERMAP scenarios, Bulgaria will import electricity after 2035, in contrast to its present net exporter position. By 2050, net imports increase to more than 22% in the 'no target' scenario and around 14% of total consumption in the other two scenarios. This indicates that producing electricity in Bulgaria is more expensive than in other countries in the region. However, a decarbonisation policy has the benefit of reducing import dependency by 10% compared to the 'no target' scenario, implying that decarbonisation can help to reduce import dependency.

Figure 45 GENERATION AND SYSTEM ADEQUACY MARGIN FOR BULGARIA, 2020-2050 (% OF LOAD)

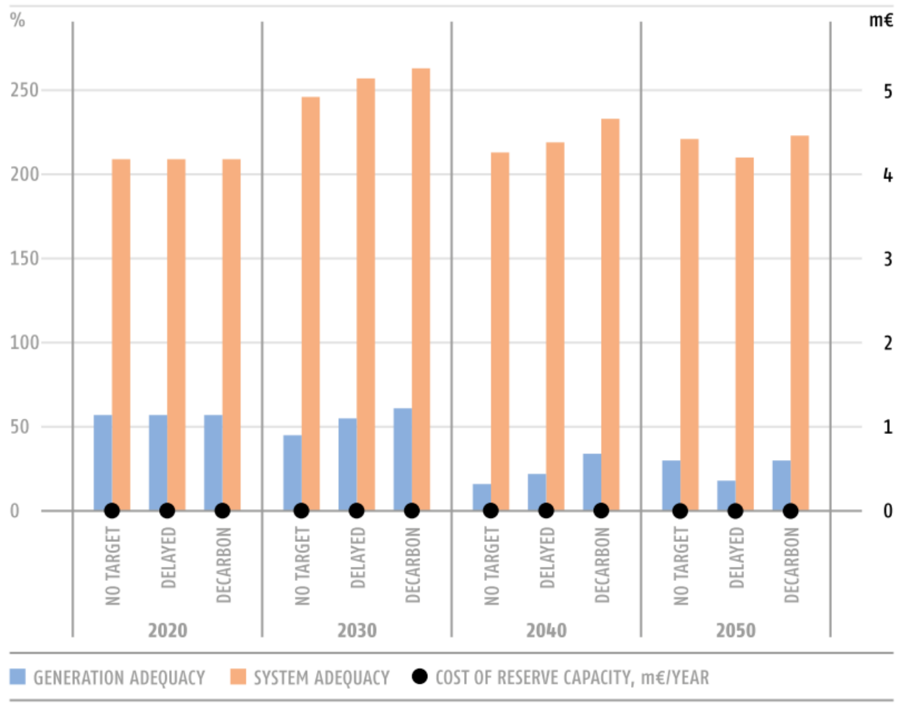


Source: SEERMAP Country Report Bulgaria

INSIGHTS FROM CROATIA

For Croatia, the SEERMAP results show that the generation adequacy margin is positive throughout the whole modelling period in all scenarios, i.e. domestic generation capacity is sufficient to satisfy domestic demand in all hours of the year for all of the years modelled even with a high share of renewables (84% in 'no target' and 101% in 'decarbonisation' scenario). The system adequacy margin is even higher.

Figure 46 GENERATION AND SYSTEM ADEQUACY MARGIN FOR CROATIA, 2020-2050 (% OF LOAD)



Source: SEERMAP Country Report Croatia

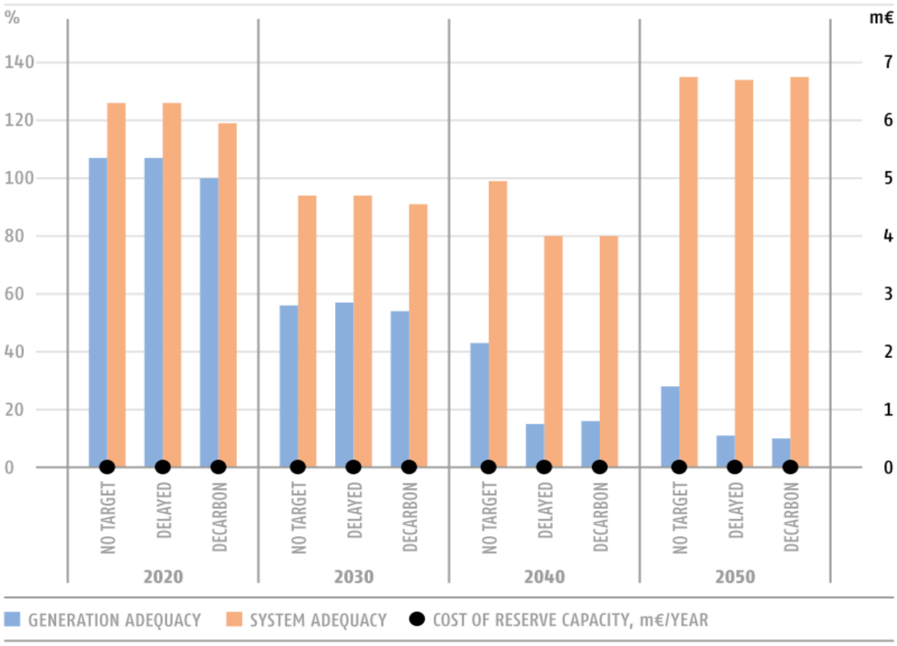
The results clearly show that RES integration should be the focus of energy policy in Croatia since RES shares will increase in every scenario, reaching a minimum of around 84% by 2050, while the security of supply will be not affected in a negative way.

INSIGHTS FROM GREECE

Greece's generation and system adequacy indicators remain favourable in all scenarios; installed generation capacity within the country enables Greece to satisfy domestic demand using domestic generation in all years in all hours of the day for the entire modelled period. This is true even under scenarios with an ambitious decarbonisation target and corresponding RES support schemes, with close to 100% renewable generation, mostly solar and wind, and some hydro by 2050.

According to the SEERMAP results, in contrast to its present net import position, Greece becomes self-sufficient in electricity generation in all three scenarios. Stronger and faster growth in RES generation compared to some neighbouring countries (e.g. Bulgaria and North Macedonia) allows for this market development.

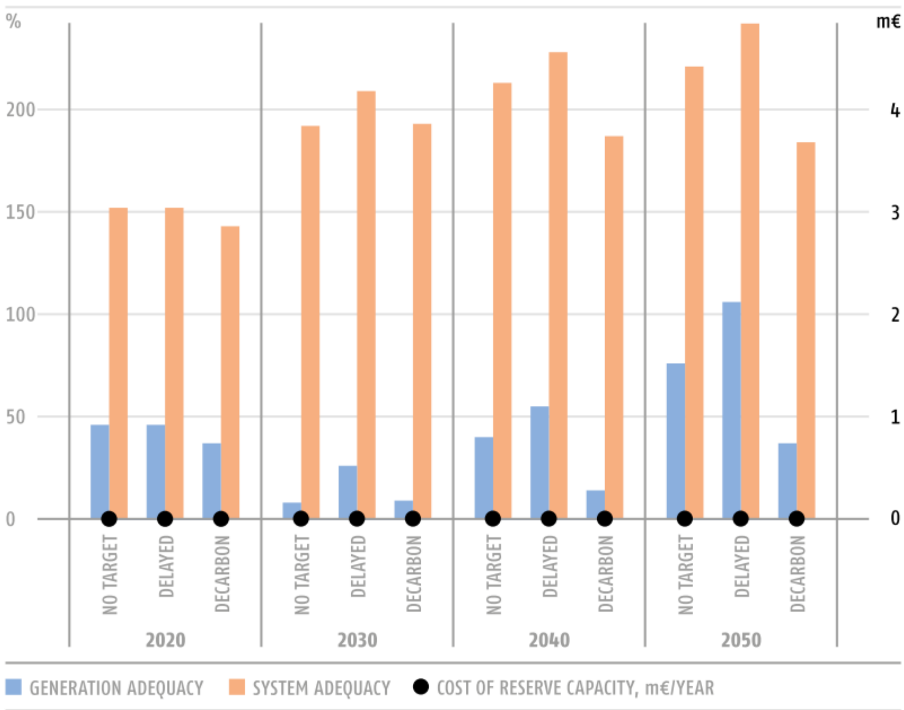
Figure 47 GENERATION AND SYSTEM ADEQUACY MARGIN FOR GREECE, 2020-2050 (% OF LOAD)



Source: SEERMAP Country Report Greece

INSIGHTS FROM NORTH MACEDONIA

Figure 48 GENERATION AND SYSTEM ADEQUACY MARGIN NORTH MACEDONIA, 2020-2050 (% OF LOAD)



Source: SEERMAP Country Report North Macedonia

The generation adequacy margin for North Macedonia is positive for all years for all scenarios, meaning the country has sufficient generation capacity to satisfy demand using only domestic capacity in all hours of all years even with RES share of 85-89%.

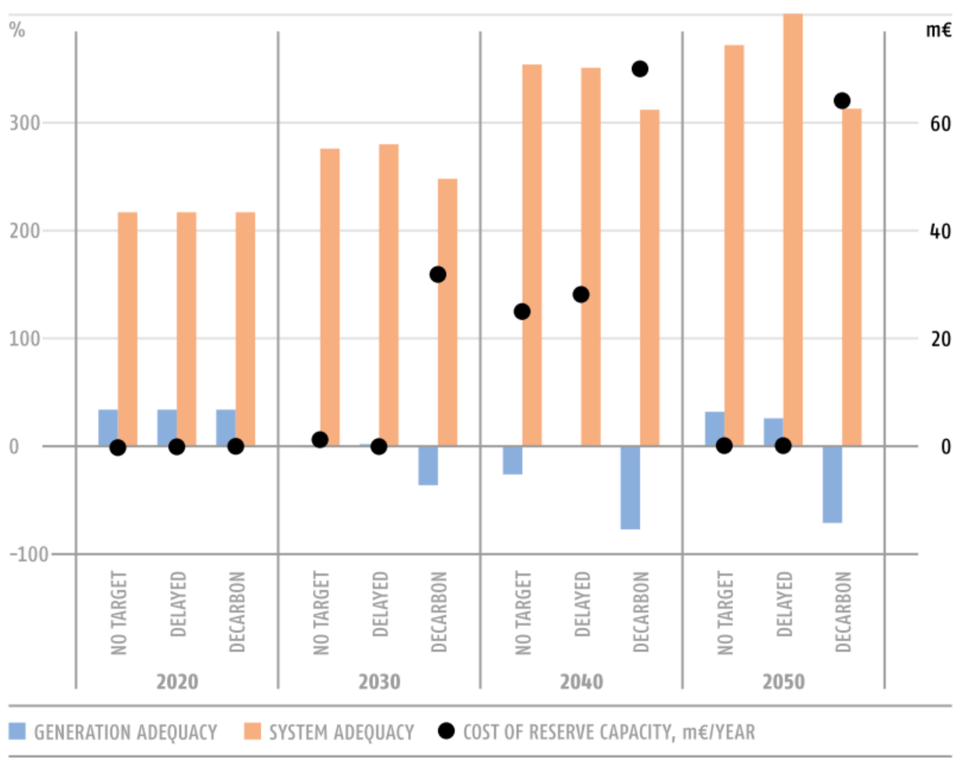
The transmission system of North Macedonia is well-connected with that of neighbouring countries but additional network investments in high voltage transmission lines and the distribution system are needed to accommodate greater RES deployment in the future. The network will have to cope with higher RES integration and cross-border electricity trade. Contrary to other countries in the region peak load is expected to decrease significantly from 1457 MW in 2016 (ENTSO-E DataBase) to 1160 MW in 2030 (SECI DataBase) and 1400 MW in 2050.

Overall, the network modelling does not show any congestion in the transmission network of North Macedonia provided that the planned TYNDP developments are realised in the future. This implies that no further investment in the transmission network beyond investment planned in the TYNDP will be required to accommodate a high share of renewables. This figure includes not only the transmission network costs, but those necessary for connecting facilities, as well as reinforcement of the national grid to facilitate the expected increase in RES generation. However, the SEERMAP network modelling did not take into account investment needs related to the development of the distribution network, which may be significant due to growth in solar generation capacity in particular – but will also help reduce distribution losses in general.

INSIGHTS FROM KOSOVO*

For Kosovo*, the generation adequacy margin turns negative in 2025 and remains so throughout the modelled period in the 'decarbonisation' scenario. In the other two scenarios the generation adequacy margin turns positive at the end of the period. The system adequacy margin, however, is positive for all hours of all years. This means that in some hours of the year Kosovo* will have to rely on imported electricity to satisfy its demand.

Figure 49 GENERATION AND SYSTEM ADEQUACY MARGIN KOSOVO, 2020-2050 (% OF LOAD)*



*Source: SEERMAP Country Report Kosovo**

Alternatively, relying on national capacity alone would imply an additional reserve capacity cost of 40 mEUR/year on average between 2025-2050, reaching 60-70 mEUR/year from 2040. This demonstrates that although ensuring that a country is able to satisfy demand at all times using exclusively domestic capacity may seem like an attractive option to policy makers for energy security reasons, it comes at a significant price. Ensuring high interconnectivity is more cost-optimal.

Kosovo's* transmission system is already well-connected with neighbouring countries but additional network investments in internal high voltage transmission lines and at the distribution level will be needed. The network will have to cope with higher RES integration and cross-border electricity trade and peak load that is expected to increase significantly from 1182 MW in 2016 (ENTSO-E DataBase) to 1630 MW in 2030 (SECI DataBase) and 2310 MW in 2050.

The contingency analysis of the network constraints anticipates contingencies that could be solved by investments of 72.5 mEUR by 2050 (in addition to ENTSO-E TYNDP 2016 recommendations).

According to the network analysis, transmission network losses are affected in different ways. On the one hand losses are reduced as renewables, especially PV, are connected mostly to the distribution network and as a result the distance between production and consumption decreases. On the other hand, high levels of electricity trade by 2050 in the summer season will increase transmission network losses.

Overall, some investment in the transmission network is necessary to accommodate new RES capacities in Kosovo's* electricity system, but the estimated cost of network investments remains below 173 mEUR for the period, in addition to the investments contained in ENTSO-E TYNDP (Entso-e, 2016). This number includes not only the transmission network costs, but those necessary for connecting facilities, as well as reinforcement of the national grid to facilitate the expected increase in RES generation. It does not include, however, investment needs related to the development of the distribution network, which may be significant due to the increase in solar generation capacity in particular but will also help reduce the massive distribution losses in Kosovo*.

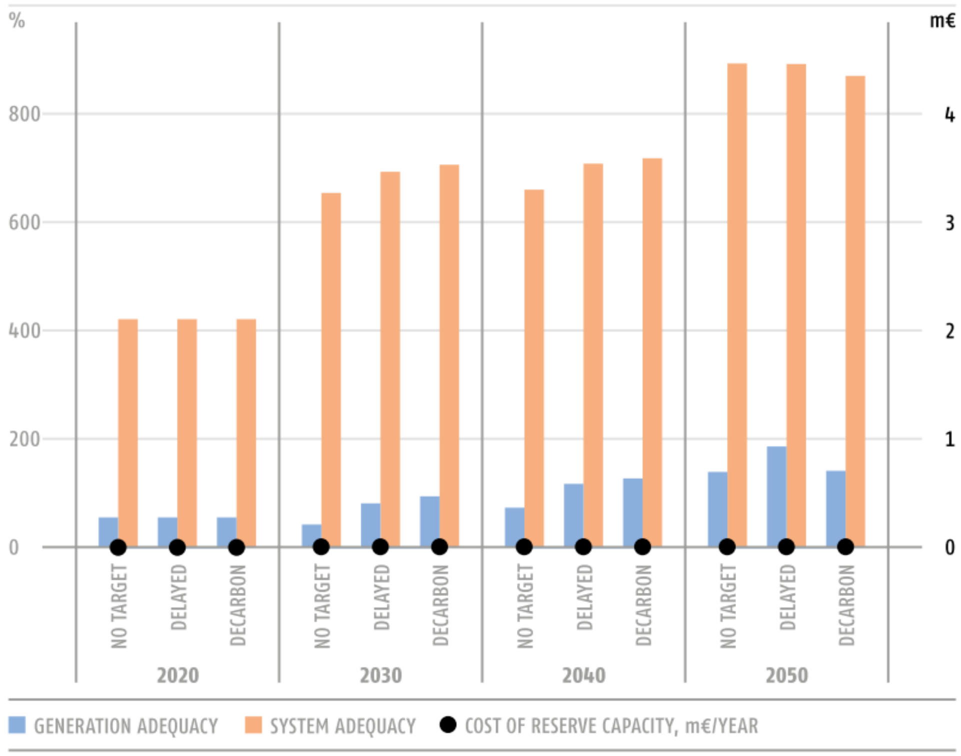
INSIGHTS FROM MONTENEGRO

According to the SEERMAP model results, Montenegro's generation and system adequacy indicators remain favourable; installed generation capacity within the country enables Montenegro to satisfy domestic demand using domestic generation in all seasons and hours of the day, throughout the modelled period even with above 100% RES share.

Montenegro's transmission system is already well-connected with neighbouring countries. In the future further new network investments are expected to be realised, in order to cope with higher RES integration and cross-border electricity trade. Peak load is expected to increase significantly, this will also have an impact on network development needs. For 2016 the recorded peak load on the transmission network of Montenegro was 576 MW (ENTSO-E DataBase), while the projected value for 2030 is 2039.6 MW (SECI DataBase) and 2489.5 MW for 2050. Internal high and medium voltage transmission lines, as well as the distribution level will need investment.

Analysis of the network constraints foresees several contingencies. Because of the projected tripping of the 110 kV overhead line connecting Bar and the Mozura Wind Power Plant, a new line needs to be built connecting the power plant with Ulcinj at a projected cost of 3.5 mEUR in the 'delayed' scenario. In the 'decarbonisation' scenario, an additional investment of 8 mEUR may become necessary for another line connecting Virpazar, Golubovci and Podgorica. A new substation for RES collection may become necessary at Brezna, incurring a cost of 20 mEUR. Furthermore, constraints on lines connecting the Perucica Hydro Power Plant to the grid may call for a new line between Vilusi and Herceg Novy at a cost of 5.5 mEUR.

Figure 50 GENERATION AND SYSTEM ADEQUACY MARGIN MONTENEGRO, 2020-2050 (% OF LOAD)



Source: SEERMAP Country Report Montenegro

A moderate amount of investment in the transmission network is necessary to accommodate new RES capacities in the Montenegrin electricity system in addition to ENTSO-E TYNDP (Entso-e, 2016). The estimated cost of network investments is over 30 mEUR for the modelling period until 2050. This figure includes not only the transmission network costs, but the necessary connecting facilities, as well as reinforcement of the national grid to facilitate the expected increase in RES generation. It does not include, however, investment needs related to the development of the distribution network, which may be significant due to the increase in solar generation capacity in particular. Increasing interconnections, including with Italy, will enable Montenegro to export surplus (renewable) energy and provide higher energy security for Montenegro. Interconnection with neighbouring countries will therefore help to support the planned wind capacity expansion: “the new 400 kV interconnection to Serbia to the planned pump storage plant Bistrica will also provide the country with additional balancing capacities for its planned wind expansion” (Tuerk et al., 2015). In general, increased interconnection will help Western Balkan countries to integrate their energy markets, diversify their energy sources and resolve their energy isolation.

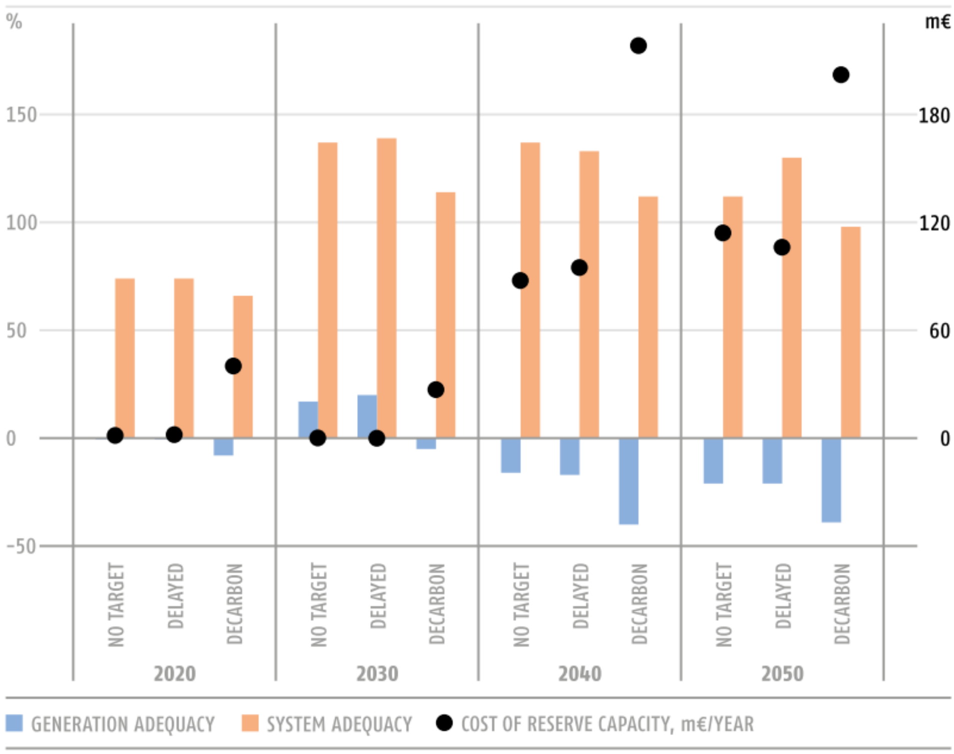
Increased interconnectivity may also have a downside in the specific case of Montenegro. The Montenegro-Italy undersea cable is indeed not necessarily advantageous in terms of its impact on energy poverty, as it is expected to result in an increase in wholesale electricity prices in Montenegro due to the significantly higher wholesale prices in Italy.

INSIGHTS FROM SERBIA

The ‘decarbonisation’ scenario of the SEERMAP study shows that it is feasible and possible to supply the Serbian power system without any fossil-based capacity by 2050, mainly with hydro, wind and solar capacities of total of more than 12 000 MW.

For Serbia, the generation adequacy margin is negative during the second half of the modelled time period for all scenarios and for the entire modelling period in the ‘decarbonisation’ scenario. This means domestic generation capacity is not sufficient to satisfy domestic demand in some hours of the year during this time period. However, the system adequacy margin is positive, indicating that demand can be satisfied during all hours if import potential is considered in addition to domestic capacities.

Figure 51 GENERATION AND SYSTEM ADEQUACY MARGIN SERBIA, 2020-2050 (% OF LOAD)



Source: SEERMAP Country Report Serbia

Alternatively, relying on national capacity alone would imply an additional reserve capacity cost of 219 mEUR/year in 2040 and 203 mEUR/year in 2050 in the ‘decarbonisation’ scenario, while it is about half in the other two scenarios. Although ensuring that a country is able to satisfy demand at all times using exclusively domestic capacity may seem like an attractive option to policy makers for energy security reasons, it comes at a significant price. Ensuring high interconnectivity is a more cost-optimal option. This demonstrates the importance of regional markets.

Batas Bjelić, Rajaković, Ćosić, & Duić (2013) created an hourly detailed energy system model of the existing Serbian energy system to prove that it is possible to integrate more than 500 MW wind capacity into the grid. They analysed critical excess electricity production (CEEP) which is “the sum of energy imbalances for the whole year”. As balancing tools, they list the following possible tools and solutions:

1) “Consumer load flexibility;
2) Increased flexibility from traditional generators:
    a) Reduced technical minimum,
    b) On/off cycling time reductions,
    c) Up/down load ramp increase;
3) Energy storage;
4) Regional market dispatch - interconnection imbalance;

5) Transmission upgrades;
6) The integration of the different sectors in the energy system (electricity, heat and transport);
7) Curtailment of wind production." (Batas Bjelić et al., 2013)

The results show that the existing system is able to integrate 1500 MW or 2500 MW of wind power to the system with less than 5% and 20% critical excess electricity production (CEEP) of wind power, respectively. It is worth mentioning that consumer load flexibility and demand side response (in domestic hot water production) was able to reduce CEEP by 0.3-0.61 TWh/year (Batas Bjelić et al., 2013).

INSIGHTS FROM ROMANIA

With a modest investment in the transmission network Romania can harness the benefits of increasing renewable penetration in the form of higher NTCs available for electricity trade and decreasing network losses.

Romania's transmission system is already well-connected with neighbouring countries. In the future additional network investments are expected to be realised to accommodate higher RES integration and cross-border electricity trade and to meet significant growth in peak load. The recorded peak load for Romania in 2016 was 8 752 MW (ENTSO-E DataBase), while it is projected to be 8 696 MW in 2030 (SECI DataBase) and 10 279 MW in 2050. The contingency analysis of the network constraints anticipates contingencies in the Eastern part of the country. The estimated level of investment needed in the Romanian transmission network system is 117 mEUR until 2050 in addition to investments contained in ENTSO-E TYNDP 2016. These upgrades would allow for the integration of new capacities, increase cross-border capacities available for trade, and at the same time reduce network losses.

C. Environmental sustainability of RES

MYTH C1: RES are not sustainable

RES (especially wind) pose a threat to ecosystems (e.g. birds). Renewables are as harmful to the environment as conventional energy.

FACT: **The environmental balance of RES is positive, but conflicts exist.**

Although RES raise some environmental sustainability issues, as do all physical investments, with careful planning and advanced solutions the negative environmental effects can be reduced. Deployment of renewable energy generally has net positive effects on the environment, such as reduced air pollution, reduced water pollution, climate mitigation or for example – in the case of terminating surface mining – increase in the landscape value.

A myth related to the sustainability of RES is related to the land area required for RES investment. Some believe that as RES occupies too much land, it is inherently unsustainable. This, however, has been shown to be untrue by a number of studies. Jacobson et al. (2017) estimated that achieving 100% renewable based energy systems in 139 countries in the world would require only 1.14% of the land area of these countries. This does not account for land gained from eliminating some of the currently existing energy infrastructure, such as open pit mining. From this share, only 0.22% is required by the generator units – mostly for utility scale PV – and further maximum 0.92% spacing area is required for onshore wind. However, the areas where wind turbines are sited remain available for other uses (e.g. agriculture).

In SEERMAP, the estimation of long-term technical RES potential took into consideration several factors including the efficiency of conversion technologies, power system constraints and GIS-based data on wind speed and solar irradiation. Calculation of physical potential also took into account land use constraints. Figure 52 shows the assumptions regarding the maximum land area that can be used for siting onshore wind installations for each surface type. The SEERMAP analysis shows that even if accounting for land use constraints, a very high share of onshore wind can be achieved in electricity production.

Figure 52 OPPORTUNITIES FOR ONSHORE WIND INSTALLATIONS TAKING INTO CONSIDERATION LAND USE RESTRICTIONS

Artifical surfaces	0%
Arable land	25.0%
Permanent crops	15.0%
Pastures	20.0%
Heterogeneous agricultural areas 1	10.0%
Heterogeneous agricultural areas 2	10.0%
Heterogeneous agricultural areas 3 (agro-forestry)	5.0%
Forests	5.0%
Natural grasslands, moors	22.5%
Sclerophyllous vegetation & Transitional woodland-shrub	22.5%
Beaches, dunes, sands	10.0%
Bare rocks	0.0%
Sparsely vegetated areas	30.0%
Burnt areas & glaciers	0.0%
Inland wetlands	5.0%
Maritime wetlands	5.0%
Inland waters	0%
Marine waters	0%

Source: Resch, Liebmann & Hiesl (2016)

In addition to land use constraints, the analysis also took into account other types of constraints which limit realisable renewables potential. Factors limiting economic potential include risks from policy and country risks, RES technology costs and learning rates. Finally, limits on technology diffusion from one year to the next were also considered (Resch et al., 2016).

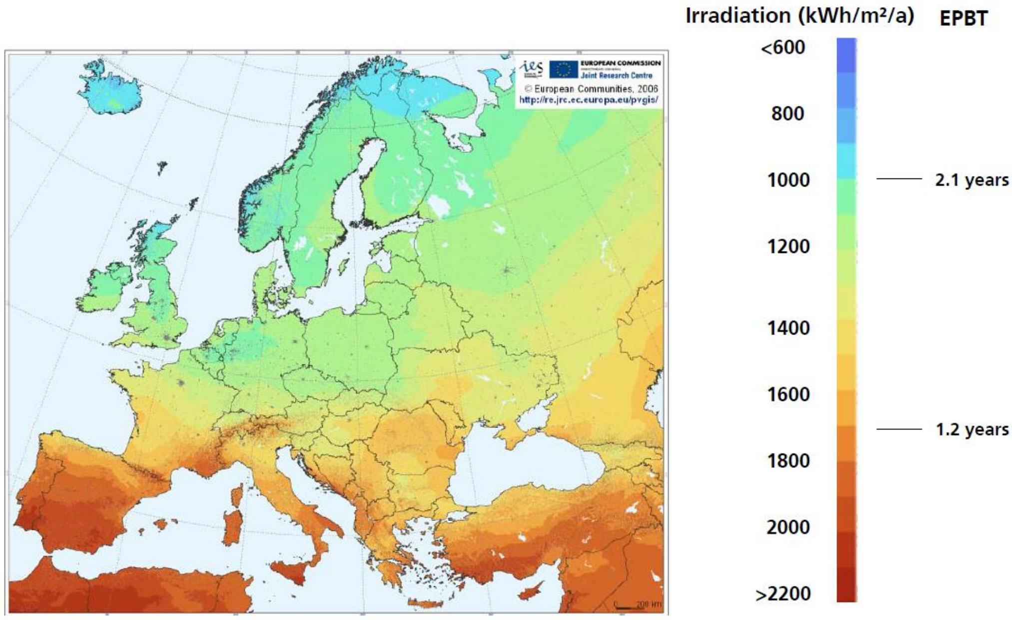
Another myth relates to the energy balance of RES investment, stating that the energy balance of the life cycle of RES investment is often negative. However, except for some extreme examples of unsustainable biofuel production, all renewable technologies have positive energy balances. Production processes are energy intensive for some technologies, such as for PVs, but still, their energy payback time is only 1-4 years compared with the further 26-29 years when they are producing clean electricity (Bhandari, Collier, Ellingson, & Apul, 2015).

Regarding wind turbines, a comprehensive life cycle assessment study considering manufacturing, transportation, installation, maintenance and end of life showed a 5.2-6.4 month energy payback time in case of 2 MW turbines (Haapala & Prempreeda, 2014). Without recycling, for a larger, 3.6 MW turbine the energy payback period is 10.76 months (125 m high version) and 9.69 months (90 m high version) (Wilhelmsson, 2012).

When looking at the energy return on investment (EROI) of different fuels, it is true that renewables have lower values except for hydro energy, which has an EROI above 100:1, while fossil fuels reach an EROI of between 8:1 and 80:1. According to data from the 2000's, bioethanol and biodiesel can have the lowest EROI, with values between 0.8:1 and 10:1 (Hall, Lambert, & Balogh, 2014). However, optimization of technology is ongoing and might lead to better EROI values (Hall et al., 2014).The report of Fraunhofer Institute reaffirms these findings: energy payback time has decreased significantly over the past years. The energy payback time depends on geographical conditions: in the Northern part of Europe, PV systems need roughly 2.5 years to balance the input energy, while in the

Southern part of the continent, it takes only around 1.5 years. If we take the example of a PV system installed in Sicily – where the energy payback time is around 1 year – and we assume a lifespan of 20 years, the system can produce 20 times the energy that was needed to produce it (Fraunhofer Institute for Solar Energy Systems & PSE GmbH, 2019).

Figure 53 ENERGY PAY-BACK TIME OF MULTICRYSTALLINE SILICON PV ROOFTOP SYSTEMS - GEOGRAPHICAL COMPARISON



Data: M.J. de Wild-Scholten 2013. Image: JRC European Commision. Graph: PSE 2014 (Modified scale with updated data from PSE and FraunhoferISE)

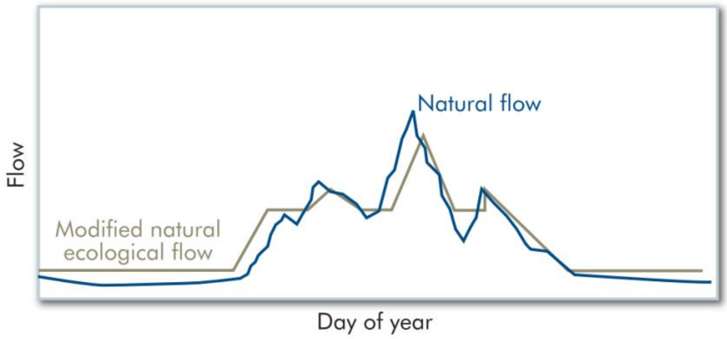
Source: Fraunhofer Institute for Solar Energy Systems & PSE GmbH (2019)

There are many concerns related to the effect of renewable technologies on ecosystems, especially in the case of wind and hydro.

For wind, planning and analysis related to the siting, technology and operation of wind farms is necessary in order to avoid negative ecological consequences. There is a significant amount of research which focuses on the effect of different types of wind turbines at various geographical locations on different species (AWWI, 2014; Hötker, Thomsen, & Jeromin, 2006; Kingsley & Whittam, 2005; Powlesland, 2009), and there are recommendations on how ecological damage can be avoided by choosing the appropriate type of wind turbine and location. Therefore, detailed local studies must be carried out to explore the potential conflict areas and to exclude them from the list of sites made available to wind investors. This way the environmental consequences of wind power plants can be reduced to a minimal level. In addition, operating choices can also reduce negative ecological impacts. For example, curtailing blade rotation at low wind speeds results in substantial reductions (50-87%) in fatality of bats and selective shutdown of high-fatality turbines may be an effective strategy for reducing fatalities of some raptor species (more than 50%). Bird monitoring and control systems, including “automatic real-time actions, such as warning and dissuasion of birds in collision risk”, are also effective solutions to reducing threats to birds (Barlovento, 2014).

Hydro energy, abundant in SEE, is more complicated from a sustainability perspective, and concerns related to the sustainability of hydro are not unfounded. Wetlands and river ecosystems are endangered habitats in general and they give home to rare and unique species. Dams and connecting infrastructure create modifications on upstream and downstream water regimes which degrade these ecosystems – in addition to other impacts such as displacement of human settlements and altering soils etc. “When natural flows are highly altered, populations of freshwater species can plummet or even be driven to extinction.” For these issues, integrated basin planning with a system level approach is needed which integrates hydro power with river basin management, flood control operations and floodplain management (Harrison, Opperman, & Richter, 2007). Hydro power plants can aim to adopt the natural flow patterns of a river by adjusting their operation to keep the original characteristics of the downstream flow as far as possible (Harrison et al., 2007).

Figure 54 A MODIFIED 'RUN-OF-RIVER' OPERATION COULD BE ADOPTED TO PROVIDE 'NATURAL-LIKE' FLOW PATTERNS DOWNSTREAM OF THE DAM CASCADE



Source: Harrison et al. (2007)

The issue is especially sensitive in the Balkan region which, for freshwater biodiversity, is a Mediterranean hotspot. The region contains a very high percentage of rivers in good or pristine condition: 80% of the 35 000 km of Balkan rivers are in this category. Unfortunately, this extraordinarily rich ecosystem is threatened by around 2800 hydropower projects of different sizes which are planned in the region (Weiss et al., 2018). According to CEE Bankwatch’s latest study on this topic (Gallop, Vejnović, & Pehchevski, 2019), at least 380 small hydropower projects were implemented in the region between 2009 and 2018, mainly driven by public support in the form of feed-in tariffs, that were originally aimed at boosting the investment in all types of renewable energies, but finally worked as an incentive for mostly hydro projects. Small hydropower plants (with capacity below 10 MW) raise several questions concerning sustainability, whereas their contribution to electricity generation was only 3.6% in 2018 in the Western Balkans. According to the study, environmental concerns coupled with perceived corruption and nepotism could lead to a situation where the population will be reluctant to back anything connected to energy transition.

Environmental unsustainability of hydro investment is not only an issue for the environment but also for investors. Examples of cases where nature protection organisations have taken companies to court exist in the region. This results in a delay or cancellation of planned investments, which result in costs to investors. In order to avoid such unforeseen costs, investors need to attribute high importance to environmental sustainability. For example, recently a group of NGOs (EcoAlbania, Riverwatch and EuroNatur) sent a complaint to the Energy Community against the Albanian Government over procedures for the Kalivac and Pocem hydropower projects. The three civil society organizations behind the campaign for the protection of the Vjosa River have raised concerns that the procedures for the two hydropower plants are not in line with Energy Community rules.

In addition to environmental sustainability, social impacts of hydro are also important. Water has many competing uses, e.g. in agriculture, industry or as tourist attractions, therefore investment in hydropower can cause economic losses to important economic sectors.

One way to limit the damage that RES investment – especially hydropower – does is to abide by rules aimed at ensuring the environmental sustainability of investment:

- Implementing relevant environmental legislation: The Bern Convention on the Conservation of European Wildlife and Natural Habitats and – for EU member states – the Birds Directive and the Habitats Directive are the legally binding instruments for species and habitats protection. To ensure that nature protection is respected throughout the planning of hydropower facilities, the EU has already started to push for the extension of environmental and nature protection as well as water management legislation – such as the Birds Directive, Habitats Directive, Water Framework Directive or the Environmental Impact Assessment Directive – to the whole of the Energy Community (Vejnović & Gallop, 2018). The EU has undertaken steps toward this: the Western Balkans Investment Framework, with funding from the EU, has recently drafted Principles for Sustainable Hydropower Development in the Western Balkans. This document stresses the importance of the fact that hydropower should be only one element amongst others in the renewable energy mix of the region (Western Balkans Investment Framework, 2018).
- Sustainability requirements related to financing: Being pressed by civic groups and aware of the growing sustainability issues connected to financing, the European Bank for Reconstruction and Development (EBRD) has developed a new Environmental and Social Policy coming into force on 1 January 2020, requiring projects to meet higher environmental standards than previously. In this document it has recognised – amongst others – the importance of sustainability in hydro projects. From 2020 onwards, all commercial banks serving as financial intermediaries to the EBRD will have to report back all high-risk projects – including all hydropower plants – for additional checking and analysis by the EBRD's team (Jovanović, 2019b).
- Ensuring transparency: The European Commissioner for enlargement negotiations and neighbourhood policy stressed in early 2019 the importance of nature conservation when planning HPPs and also the importance of engaging with stakeholders in the planning phase already. To this end, transparency must be ensured from the beginning (Spasić, 2019f).

Corruption in the energy sector in the SEE region – the whole of the energy sector, not only the renewable sector – is significant and combined with inadequate nature protection can lead to significant damage in protected areas. The conflict between nature protection and energy demand can never be fully resolved, as power generation will always have some effect on nature. Therefore, in addition to careful planning of new renewable capacities, the importance of energy efficiency and demand side management has to be emphasised as often as possible, as measures connected to these are crucial from the point of view of nature protection.

INSIGHTS FROM GREECE

In Greece, a large survey was carried out by WWF Greece first in 2008-2009 (Doutau, Kafkaletou-Diez, Cárcamo, Vasila, & Kret, 2011), then in 2009-2010 (WWF Greece, 2013) in Thrace, North-eastern Greece, an area of exceptional ornithological importance. The researchers estimated the mortality rate per turbine, and outlined a proposal for the delineation of exclusion and increased protection zones; and also areas suitable for the installation of wind farms in Thrace. Their methodology can serve as a blueprint to follow in other parts of Greece and in the SEE region. A good starting point can be the Map of Technically and Economically Exploitable Wind Capacity in Greece (CRES, 2012). Bird monitoring and control systems are already in operation there.

INSIGHTS FROM NORTH MACEDONIA

The sustainability of renewable capacities, such as in the case of hydro, depends on their scale and proper planning. On one hand, several conflicts arise between hydro and nature protection, on the other hand, due to climate change precipitation, the viability of these investments will also decrease in the coming decades making hydropower generation less efficient (UNDP, 2011).

In the past decade, it has been observed that hydropower production of the country was in the range of 600 to 1650 GWh per year, which shows a high variation depending on precipitation. As negative effects of climate change become more severe, further decrease in precipitations is expected, resulting in more uncertainty from the point of view of economic viability and security of supply (UNDP, 2011). According to Vejnović (2017) Environmental Impact Assessment is not implemented in an adequate manner in North Macedonia, resulting in environmental permits which are easier to obtain than under EU legislation. This results in hydropower plants which are often built in regions of high biodiversity value. Residual flow requirements (10%) are too low and do not take into consideration seasonal fluctuation of precipitation. This has a negative effect on the area's ecology. New analysis of all water resources in the country should be conducted before new projects are approved. All small and large HPP investments are currently approved on the basis of a study carried out in the 1970's in North Macedonia.

INSIGHTS FROM SERBIA

According to the analysis of a team of the Faculty of Forestry at the University of Belgrade, Serbian authorities did not take into consideration sustainability issues properly when issuing construction permits for small hydropower plants (SHPPs). Instead of constructing SHPPs that would all together produce only around 2% of electricity currently consumed in Serbia annually, the efficiency of existing hydropower plants – producing around 10-12% in some cases – should be improved, as currently they are working with energy losses of 16%-17% (whereas the EU considers power losses of around 5% to be acceptable). The team analysed 46 existing SHPPs and found several deficiencies: non-functioning fish-passages, pipelines put in place where this was not allowed, or SHPPs not releasing enough (if any) water to secure the prescribed minimum flow (also called environmental flow). Legislation for the issuance of construction permits, and environmental inspections should be stricter to protect the environment and the interests of the many compared to that of the few (Spasić, 2019d).

Another team of experts at the Academy of Engineering Sciences of Serbia came to similar conclusions about SHPPs – especially those with long penstock – when analysing energy, environmental, and social problems related to them. They also highlight that the legislation incentivising the construction of SHPPs in Serbia was not satisfyingly thought through. The share of the potential that lies in SHPPs is small, so their contribution to the country's renewable target is negligible compared to their negative ecological and social effects. In several cases, energy used for their construction is higher than the energy they produce during their whole lifetime. Some SHPP construction permits have even been issued in nature conservation areas, where the negative social and economic effects on local populations living from tourism are considerable. Experts have warned that a negative public attitude towards SHPPs can spill over into negative attitudes towards hydro power in general, which should be avoided as carefully planned hydro power could represent an important part of Serbia's renewable energy portfolio (Balkan Green Energy News, 2019a).

FACT: There are a growing number of RES technologies which can be sited in cities such as rooftop solar and small-scale wind.

PV systems can be located both in urban and rural areas. Using rooftop instead of ground mounted photovoltaics reduces the effect of the energy industry on the landscape, saves energy by shortening the distance between producers and consumers, and can help climate mitigation by providing shade.

Heating with biomass is also available in cities, however, it is recommended that biomass is utilised in modern CHPs rather than individual heating due to sustainability and air quality issues that it may pose.

Ambient heat (shallow geothermal) can be utilised in residential houses and offices with heat pumps; solar collectors and panels on any suitable rooftops, supermarkets, or above parking lots.

Furthermore, a new generation of small-scale rooftop wind generators can be effectively used on taller buildings, especially on standardised apartment blocks which are common in some parts of the Western Balkans.

Figure 55 WIND GENERATOR ON AN APARTEMENT BLOCK IN PÉCS, HUNGARY

Source: Németh (2017)

There is a trade-off between energy efficiency and renewable energies; policy-makers must decide on which one to focus on when pursuing low carbon paths.

FACT: **Energy efficiency and RES are mutually reinforcing.**

Energy efficiency and renewable development are not alternatives; both are necessary for a cost-efficient, secure and sustainable energy system (Eurelectric, 2009). A report of IEA-IRENA (2017) claims that it is possible to globally reduce energy-related CO_2 emissions by 70% by 2050. However, it cannot be done with renewables only: they "can account for about half of those reductions, with another 45% coming from increased energy efficiency and electrification." Maximising the synergy between the two crucial objectives can drastically reduce energy-related carbon emissions – highlights IRENA (2017b). "Renewable energy and energy efficiency work in synergy. When pursued together, they can bring faster reduction in energy intensity and lower energy costs (…). Crucially, improved efficiency reduces total energy demand, allowing the share of renewables in the energy mix to grow faster."

The Energy Roadmap 2050, the official long-term technology-neutral framework of the European Union, has come to the same conclusion when targeting 80-95% emission reduction by 2050 compared to 1990. Its two main strategies are energy efficiency, where "the prime focus should remain", and renewable energy, "the second major prerequisite for a more sustainable and secure energy system" (European Commission, 2012).

The Fifth Assessment Report of the IPCC also highlights that switching to low-carbon energy carriers alone would not ensure a successful energy transformation pathway. "Transformations of the energy system rely on a combination of three high-level strategies: (1) decarbonisation of energy supply, (2) an associated switch to low-carbon energy carriers such as decarbonised electricity, hydrogen, or biofuels in the end-use sectors, and (3) reductions in energy demand" (Clarke & Jiang, 2015).

An example for the positive consequences of applying energy efficiency measures together with RES deployment is shown by the study of the World Bank (Jorgensen & Timislina, 2016), modelling different energy scenarios in Romania. The results show in the baseline scenario that without energy efficiency measures, emissions decrease only by 2% by 2050 (compared to 2005) and energy supply costs in total EUR 336 billion between 2015-2050. With demand side energy efficiency measures 16% emission reduction can be achieved over the same period with a total cost of EUR 323 billion. In other words, demand side energy efficiency costs 19 billion but by reducing total fuel costs and preventing need of new capacities it saves EUR 29 billion. "Thus, improving energy efficiency across the board in all economic sectors but especially in the residential sector and district heating offers the most effective and also viable means for containing the growth of energy demand" (Jorgensen & Timislina, 2016)

D. Social impacts of RES

MYTH D1: RES cause losses in employment and GDP

The transition from coal induces loss of employment that cannot be compensated for. RES cannot sustain jobs that exist in the conventional energy sector.

FACT: RES and energy efficiency can provide more jobs per energy produced than coal.

The energy transition requires the transformation of today's global energy system from the current centralised mainly fossil and nuclear based power generation to a decentralised interconnected network that enables a massive use of renewable resources. This necessarily involves radical changes in production patterns, consumer behaviour, policy approach and in the general way of thinking regarding energy (Loorbach & Verbong, 2012; Markard, Raven, & Truffer, 2012). Since global economic development is so intertwined with energy production and consumption, this change requires fundamental adjustments in multiple sectors at different scales – from individual to societal.

This process can shift some actors to new situations where they can gain benefits or lose their former status and will result in benefits and losses which will accrue to different groups of winners and losers at different times. Some actors who are winners of the current fossil fuel-based regime may lose out, but other actors will gain from an increase in the share of renewables (and connected technologies). However, broad experience to date shows that in a well-legislated system society as a whole will benefit over the long term.

Just transition is a key concept regarding the issue of winners and losers of the energy transition. Just transition focuses on supporting the most exposed and sensitive groups such as mine workers; however, it should not be forgotten that companies, owners and investors are also affected in the fossil sector. Benn, Bodnar, Mitchell, & Waller (2018) claim that the write-offs – or stranded asset costs which arise when coal power plants have to be shut down before the end of their lifetime – can have crucial consequences to the unit owners, therefore they should prepare in time. "Proactive planning for the end of the coal era can preserve shareholder value and avoid financial shocks to equity and debt holders alike".

The shift in the energy system will take place over time, currently operating thermal power plants will not all cease operations in the short term. Thus, the losses resulting from the energy transition will not materialize at once and with plans for just transition via adequate political, economic and societal preparations they can be reduced and compensated for by gains from the renewable energy sector.

The main messages relating to the job impacts of the transition to a low carbon energy system are the following:

1. Job losses resulting from a transition to a low carbon energy system are generally overestimated, as the ongoing increase in labour productivity means that there are fewer and fewer coal sector jobs even without a change in coal output;
2. However, even if numbers are lower than claimed by many, job losses in the coal sector are real and the shutting down of coal mines can cause unemployment and economic downturn in regions currently reliant on the coal industry;

3. A just transition is needed, whereby focus is placed on supporting coal workers in entering new jobs and strengthening the local economy;
4. Overall, renewable energy and energy efficiency already create more jobs than coal.

There is already a decline in coal sector jobs

A new report of the European Commission's Joint Research Centre (JRC) describes a decline in the number of coal-based jobs in the EU (Alves Dias et al., 2018). According to the estimations, approximately 237 000 jobs are provided currently by the coal sector, of which 185 000 in coal mining, while further indirect workplaces are estimated to be 215 000. Between 2020 and 2030, approximately two thirds of the existing coal-fired power capacity will close. "Coal mines are already closing down due to a lack of competitiveness": 27 mines closed between 2014-2017 in the EU, and further mines are expected to close threatening 109 000 mining jobs (Alves Dias et al., 2018).

At the same time, studies on jobs in the coal sector found that in the cases of new nuclear power plants and mines, the future number of jobs are overestimated (Ciută & Gallop, 2018; Tagliapietra, 2017). In reality, due to efficiency and productivity gains, the current level of employment in coal cannot be sustained, and the number of jobs has already started to decline for example in Serbia and Montenegro. The labour productivity levels in lignite mining are in average 3-4 times lower in the countries of this region than in Germany, as such, further rationalisations and employment reductions in these countries will be required over the long-term. This means that even without any renewable deployment, the number of jobs in the coal sector is expected to decline significantly (Ciută & Gallop, 2018).

Figure 56 LIGNITE MINE PRODUCTIVITY, 2015, EU COUNTRIES

Country	Tonnes lignite 2015	Employees lignite 2015	Tonnes/worker 2015
Bulgaria	35,900,000	11,765	3,051
Czech Republic	38,100,000	7,869	4,842
Germany	178,100,000	15,428	11,544
Greece	45,400,000	4,919	9,230
Hungary	9,300,000	1,655	5,619
Poland	63,100,000	9,574	6,591
Romania	24,000,000	10,600	2,264
Slovakia	1,800,000	2,190	822
Slovenia	3,200,000	1,274	2,512
Total	398,900,000	65,274	6,111

Source: Ciută & Gallop (2018)

According to employment data, Greece has the highest productivity level in lignite mining, the electricity generation per worker is relatively low compared to other countries in the region. The authors claim that the sector keeps workers in the production chain to maintain an "artificially high level" of employment to be able to show that "it is a major source of job creation and maintenance". (Ciută & Gallop, 2018).

Furthermore, an important challenge is still ahead: compliance with the new LCP BREF limits. Apart from the new Stanari power plant – which fulfils the requirements contained in the BREF documents – there are 36 existing coal-fired power plants in Bosnia and Herzegovina, Kosovo*, Macedonia, Montenegro and Serbia with more than 8000 MW capacity (Ciută & Gallop 2018). They will have to carry out expensive investments or close within the next few years.

Alves Dias et al. (2018) points out that in some coal regions, due to a one-sided economy, other sectors are not well-developed. Consequently, coal regions' GDP/capita is lower than their respective national averages.

However, some regions will be negatively impacted by power plant and mine closures

Nevertheless, in spite of the negative trends in the coal industry, this situation includes opportunities and new development paths for future regional development as well. Alves Dias et al. (2018) points out that with the closing of units in the coal industry there is an opportunity to develop new businesses and jobs built on the industrial heritage of the regions in question. Strategic planning which focuses on supporting coal workers is needed to take advantage of this opportunity, to increase the quality of the local environment and strengthen the local economy by investments in competitive fields, in a way that allows the energy sector to "remain a driver for regional development. Conversion into wind or solar parks, for example, could provide re-employment opportunities for coal workers after an adjustment of skills, since electrical and mechanical skills, experience of working under difficult conditions and sophisticated safety experience are highly valued in the wind and solar energy industries." The same is true in the case of geothermal or hydro connected to ex-mining sites (Alves Dias et al., 2018). However, proper planning and implementation is key here as well: according to Sartor (2018), thinking and planning at the earliest time possible is of utmost importance for ensuring a successful transition. Time, anticipation and experience is needed to achieve a just transition via development of well-designed re-education programmes and reach a satisfying level of local economic resilience.

A just transition is needed

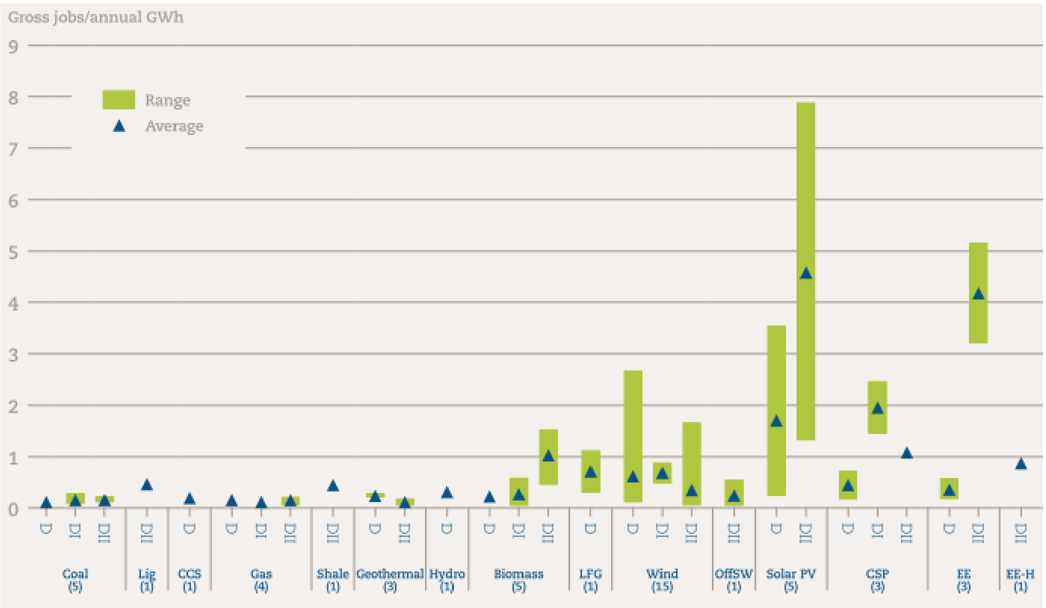
The concept of 'just transition' was developed to ensure that no one is left behind when the shift to a low carbon economy is realised. In addition to energy poverty, the impacts of the energy transition on the coal and mining industries and communities are the most relevant issues for a just transition in South East Europe. It requires well developed social and economic plans for people and communities affected by a coal phase out. Most newly created jobs must be comparable to those that disappear in terms of wages and the level of qualification required. Bird & Lawton (2009) emphasise focusing on keeping jobs in vulnerable industries especially where organisations are not able to provide the needed steps in a low carbon transition such as compensation and retraining. They highlight the importance of creating 'decent' jobs "which pay a living wage, provide decent working conditions, are accessible to people with a range of skills and offer clear career progression opportunities" (Bird & Lawton, 2009).

The European Union has recognised the importance of addressing job losses and general economic decline in coal regions, and has launched a Platform for Coal Regions in Transition (European Commission, 2017). "The Commission is already supporting the transition in coal and carbon-intensive regions through its Cohesion policy. […] In parallel, the Commission is working on a pilot basis with a small number of regions in Member States on planning and accelerating the process of economic diversification and technological transition through technical assistance, information exchange and tailored bilateral dialogue on relevant EU funds, programmes and financing tools." The president of the incoming Commission, Ursula von der Leyen, has proposed the creation of a Just Transition Fund. This would complement funding available from the European Globalisation Adjustment Fund; the rules governing its scope were changed in 2009 allowing it to support the transition when employment is terminated as well as before the termination, as a result of a transition to a low carbon economy. (Tagliapietra, 2017)

Renewables will provide new jobs

The growing renewable energy sector is able to provide more jobs than the coal sector. According to the study of Biofuels & Electricity (2011), technologies utilising RES "are more labour-intensive than fossil fuel technologies", where photovoltaics provide the highest job-years/GWh over the technology lifetime. This is especially true if photovoltaics are installed as rooftop systems, where three times more jobs are created than is the case for ground-mounted systems (EY & Solar Power Europe, 2017). Compared to fossil fuels, where in general 0.15 jobs are created per GWh produced, the average in the RES sector is 0.65 jobs/GWh, and including energy efficiency it jumps to 0.80 workplaces/GWh (Blyth et al., 2014b).

Figure 57 GROSS JOBS CREATED BY UTILISING DIFFERENT ENERGY SOURCES AND ENERGY EFFICIENCY (LEGEND STANDS FOR DIRECT (D), INDIRECT (DI) AND INDUCED (DII) JOBS.)



Source : Blyth et al. (2014a)

According to IRENA, jobs in solar energy now outnumber jobs in coal mining and the oil and gas industry added together; furthermore, the renewable energy sector employs more women than the oil, gas, and coal sector (IRENA, 2017a). Today the renewable sector employs about 1.2 million people in Europe, which would increase substantially if EU targets for 2030 were met (IRENA, 2018). EY & Solar Power Europe (2017) estimates that the number of full-time equivalent jobs in solar industry of 81 000 increases to 175 000 between 2016 and 2021 in the EU-28, while more than doubles the gross value added to 9 500 mEUR.

Recent reports in OECD countries come to the same conclusion: renewable technologies and energy efficiency create more jobs than the fossil industry (Blyth et al., 2014b). An analysis which reviewed the results of 84 research papers from OECD countries found that on average, renewables create more gross jobs per year and significantly more short-term jobs during the construction period than conventional energy sources.

Jacobson et al. (2017) analysed a scenario for 139 countries where mainly wind, water and solar energy sources will supply all electricity demand while electrifying demand sectors. The results show that this scenario would create 52 million new jobs while only 27.7 million job losses would be expected, resulting in 24.3 million net new long-term, full-time jobs. These scenarios would also help to reach the target of limiting the increase in global average temperature to 1.5°C, and they would almost eliminate deaths from air pollution.

Biomass is also an attractive option from the employment perspective. "Biomass cogeneration is increasingly used in the EU. Then there is the social impact of shutting down coal power plants and mines, and the use of biomass can help as it requires a larger workforce for forestation, logging, and transportation." (Spasić, 2019e)

According to preliminary calculations, the Briska Gora solar power plant in Montenegro, that should start producing electricity at the end of 2021, with an installed capacity of 250 MW, should create 226 permanent jobs after completion of the construction and up to 1000 temporary jobs during the construction period. Local companies are estimated to get contracts for around EUR 20 million (Jovanović, 2019a).

Although it is likely that the totality of people formerly employed in the fossil fuel sector will not find a job in the RES sector, no matter how good the planning, training and education are, leaving the coal industry by itself can lead to a better position on the labour market from a certain perspective: human capital is more valuable when healthy. Research shows that working in coal mines or even just living in coal mining regions results in more respiratory and chronic heart disease (Sapire, 2012).

INSIGHTS FROM GREECE

Almost 5000 people were working in the lignite industry in Greece in 2015, while a further 2500 people had jobs which were indirectly linked to the lignite sector (EURACOAL, 2018a).

The estimated number of people directly employed by the wind sector was 1800 in 2007, when the installed capacity was 871 MW according to EWEA. At the end of 2017, the installed capacity grew to 2651 MW (Wind Europe, 2018) and based on SEERMAP results this will increase to 4376 MW by 2050 according to 'no target' or 10 485 MW according to the 'decarbonisation' scenario. This means, that in the 'decarbonisation' scenario, the wind industry alone could provide more jobs by 2035 than the lignite sector today.

Furthermore, 16 000-18 500 MW of PV is expected by 2050 in Greece according to 'no target' and 'decarbonisation' scenario. In 2016 the solar PV industry employed 2008 people in Greece (Ernst and Young and Solar Power Europe, 2017). Assuming that employment per installed MW remains constant and taking into account the projected increase in installed solar capacity based on the SEERMAP 'decarbonisation' scenario, employment levels in the solar PV sector alone could reach the current level of employment of the lignite sector by 2025. According to Ernst and Young and Solar Power Europe (2017), the total jobs per year are expected to be 10 094 in Greece by 2021 in the PV sector.

However, Greece has to pay special attention to the transition. As Alves Dias et al. (2018) highlight: "Regions with highest unemployment rates (for example in Greece and Spain) are likely to be more sensitive to additional jobs losses. It is expected that the region Dytiki Makedonia with 31.5% of unemployed population in 2016, will face the highest social impact if an additional 3.5% of active population becomes unemployed due to the decommissioning of power plants and mines. In this region, the GDP/capita is already 25% lower than the national average."

INSIGHTS FROM SERBIA

Around 28 thousand people were working directly or indirectly in the lignite industry in Serbia in 2015, mostly in lignite mining or related jobs (EURACOAL, 2018b). This level of employment is higher than in most other countries in South East Europe, and the trends are also different as the level of lignite mining is not decreasing but expanding and new mines are planned to open. However, the labour productivity of Drmno (4427 t lignite/worker in 2017) and Kolubara (2950 t lignite/worker in 2017) mines are still below the EU average (6111 t lignite/worker/year), which means that approximately 600 employees from Drmno and 5260 from Kolubara would have to leave their workplaces if EU average productivity levels were achieved. (Ciută & Gallop, 2018)

Figure 58 EMPLOYMENT IN COAL INDUSTRY IN SERBIA

Employment		**2015**
Direct in hard coal mining	thousand	1.600
Direct in lignite mining	thousand	12.360
Other lignite-related*	thousand	14.050

Source: EURACOAL (2018c)

A report of UNEP (2013) provides an overview of Serbia's transition to a green economy based on modelling for 2030. The simulations show that there is potential for 5000-8000 jobs in the energy demand sectors by 2030, with approximately 2000-3000 job potential in the residential, commercial and industrial sectors and the remaining jobs in the transportation sector. However, due to lack of green job statistics in Serbia, these numbers are rough estimates. (UNEP, 2013)

On the supply side, estimates show that approximately 1500-2600 additional jobs could be generated if relevant policies were implemented and assuming domestic production of renewable generation units. "If solar panels and wind turbines, among others, are imported and only installed domestically, the potential new job creation would be confined to a small percentage of the full potential, and employment creation in 2030 would be estimated to average 1 500 to 1 600 jobs" (UNEP, 2013).

MYTH D2: RES cause corruption

All RES projects are corrupt. RES program are aimed entirely at making selected people richer. Local communities will gain nothing from high RES penetration, only large companies will profit. The RES sector is highly corrupted

FACT: Corruption is not a characteristic of RES projects but of the broader institutional and legislative systems or decision-making processes.

A study by Gennaioli & Tavoni (2016) measuring the correlation between renewable energy support and corruption in the Italian wind energy industry found that corruption increases in high wind potential areas, especially after the introduction of favourable support policies, such as green certificates. Furthermore, the expansion of the wind sector is positively correlated with the extent of criminal activity, with both the level of wind and the functioning of social and political institutions playing a crucial role in the increase of corruption. The overall conclusion of the study is that if socio-political institutions don't function correctly, even well-designed policies can have a negative impact and act as perverse incentives. Thus, countries characterised by poorly functioning institutions and large renewable potential need to pay special attention to avoiding corruption linked to RES. It has to be underlined that the authors state that complicated regulation and major public expenditure are factors that can encourage corruption, and that the RES sector is one sector amongst several that can be plagued by potential corruption.

Moreover, research shows that corruption is also prominent in relation to the traditional fossil energy sector, which is characterised by larger projects and lower transparency. Transparency International (2018) identifies the oil and gas sector as one of the major corruption areas, with benefits accruing to a small elite group.

Practices in the fossil-based energy sector imply several abuses of the system by a small group, making society pay more for energy production. According to an opinion article in The World Bank website Serbian tax payers pay the salary of a coal mine, Resavica through subsidies, at the same time the mine is forced by law to sell its coal to certain privileged traders for an exorbitantly low price, instead of directly selling the coal to the power plants. Then traders coal at the market price with a more than 100% mark-up, with the price difference paid by Serbian citizens (Verheijen, 2016).

A study published in July 2018 points out that the dissatisfactory state of the rule of law is a general phenomenon in the Western Balkans, and that this creates space for corruption in all sectors at all levels (Marović, 2018), not only in relation to renewables. There are also examples of state capture such as in the case of the (now suspended) South Stream gas pipeline, where North Macedonia, Serbia and Bulgaria was also affected and "encountered similar governance issues and difficulties in managing gas agreements with Gazprom and meeting EU rules on transparency and third party access" (SELDI, 2016).

Therefore, the solution is not to avoid investment in renewable energy technologies, but to strengthen the rule of law, take effective steps against corruption via detailed financial reporting, tracking revenues, making governments accountable for their budget and publishing results of findings (Transparency International, 2018b). According to SELDI (2016b), "the corporate mismanagement of state-owned energy enterprises, the dependence and incompetence of energy regulators, and inconsistencies in energy policies" are the main obstacles of development of transparent and robust energy governance, while this improvement would provide substantial steps towards anti-corruption and integration to the EU. They recommend implementing the following actions:

- increasing transparency and access to energy data;
- improving corporate governance of state-owned energy enterprises by introducing compulsory corporate governance standards;
- reducing the political leadership's direct involvement in the operational management of energy enterprises;
- introducing international accounting standards in the reporting of state-owned energy enterprises (IFRS) (SELDI, 2016).

SELDI paid particular attention to procurement practices in the Bulgarian energy sector, where "one in four public procurement contracts relates to the energy sector, which renders it one of the biggest spenders of taxpayer money. However, 38% of all procedures for the awarding of public procurement contracts in the energy sector for 2012 were non-competitive" (SELDI, 2014). All in all, according to SELDI's estimates, Bulgaria is the most corrupt country in the region based on the corruption of political leaders.

In summary, where the benefits of a high RES penetration accrue is largely dependent on legislation and institutions. RES development can potentially provide numerous benefits for local communities, for example through community energy projects. This can be maximised when the control (decisions, or influence over decisions) and the benefits (income, jobs, professional knowledge etc.) of the RES project are local. As Walker et al. claim (Walker & Devine-Wright, 2008; Walker, Hunter, Devine-Wright, Evans, & Fay, 2007; Walker & Simcock, 2012), this has to be ensured through proper legislation. For that, the Community Energy Strategy of the United Kingdom (Department of Energy & Climate Change, 2014), the toolkits of Centre for Sustainable Energy (2009), Rae & Bradley (2012) and Community Power (2013) can provide useful guides.

MYTH D3: RES are forced on countries by the EU

The EU dictates the targets which should be unconditionally respected. The deployment of RES seen from the policy level perspective is perceived as a matter of an obligation deriving from the EU perspective and integration process.

FACT: RES are part of the solution for tackling climate change and ensure better life quality by providing economic, environmental and health benefits.

The EU targets related to the development of renewable energy production, energy efficiency and interconnections ensure competitiveness, more economic opportunities, better life quality and healthier environment for the whole region over the long-term. Furthermore, only the targets are set by the EU: the countries can decide on which technologies to incentivise, support schemes used and strategies to reach the targets.

These targets are not easy to achieve. However, technologies are there, support in know-how and also funding can be provided; and all existing examples and research show that these efforts and investments are beneficial over the long term.

All SEERMAP scenarios show that fossil fuels will become uneconomical and renewable energy sources will not only be better for the climate but also for the national economy and for public health. The rapid positive change in air quality can save tens of thousands of lives per year and also billions of Euros.

It has been shown that a transition to renewable energy has multiple co-benefits. A shift to a low carbon energy system can address multiple challenges faced by the current energy system, such as rapid depletion of resources, air pollution, greenhouse gas emissions, energy poverty and nuclear risks (Markard et al., 2012). Some of these co-benefits would materialise as immediate short-term gains, such as health benefits from improved air quality.

It is true that some of the co-benefits materialise only on the medium-term or the long-term, but they are manifold: according to Nabiyeva (2018) the transition to renewables can not only have positive health and environmental effects, but also lead to growing energy security by diversification of energy sources, to economic growth and the creation of many jobs and also to democratization via decentralization of the energy system, fostering of regional cooperation and also by encouraging stronger sense of participation amongst citizens if energy cooperatives are introduced. Winners of the transition to renewables may include farmers, local sustainable energy communities, workers in the renewable energy industry and related industries and services etc.

INSIGHTS FROM MONTENEGRO

Renewable energy technologies contribute to economic competitiveness, more economic opportunities, better life quality and healthier environment for the whole region. Montenegro's renewable potential is high, which can ensure a 125-165% RES-share by 2050 under the different SEERMAP scenarios and also significant electricity exports over the long-term.

If a renewables-based strategy is chosen, long term planned action offers clear advantages:

- The 'decarbonisation' scenario demonstrates that it is technically possible and financially viable to reach 100% of decarbonisation for Montenegro with its abundant RES resources by 2030;
- Long term planned support for RES does not drive wholesale prices up relative to other scenarios with less ambitious RES policies, but on the contrary, it reduces them after 2045;

- Decarbonisation does not jeopardise Montenegro's position as a net electricity exporter, installed generating capacity within the country enables Montenegro to satisfy domestic demand using domestic generation in all seasons and hours of the day, with higher a share of net exports than in the 'no target' scenario;
- The macroeconomic analysis shows that household electricity expenditure relative to household income is expected to increase over time, but the increase is smallest in the 'decarbonisation' scenario;
- Long term planned support for RES reduces the cost of stranded investments from 2.7 EUR/MWh in the 'no target' scenario to zero.

INSIGHTS FROM KOSOVO*

Kosovo* has a favourable renewable energy potential, which could potentially ensure 85% RES share in electricity consumption by 2050. Utilising renewable energy sources will be the cheapest possible solution over the long term as the price of fossil fuels and CO_2 allowances increase and the cost of RES technologies declines.

If a renewables-based strategy is chosen, long term planned action offers clear advantages:

- Stranded cost is a magnitude higher in the scenario where delayed action is taken, compared to the 'decarbonisation' scenario (8.1 EUR/MWh versus 0.1 EUR/MWh).
- The renewables support needed to incentivise investment is considerable in the scenario with delayed action on renewables, estimated at 15.4 EUR/MWh support level (16% of total electricity generation cost) over the last ten years, because towards the end of the modelled period rapid deployment of additional capacities is required.
- The price of electricity is lower over the long term in a system with a high RES share as a result of the low marginal cost of RES electricity production.

References

Ackerman, T., Koch, M., Rothfuchs, H., Martens, N., & Brown, T. (2014). *Verteilnetzstudie Rheinland-Pfalz*.

Agora Energiewende. (2015). *The Integration Costs of Wind and Solar Power. An Overview of the Debate on the Effects of Adding Wind and Solar Photovoltaic into Power Systems.*

Agora Energiewende. (2019). *Climate (Un)ambition in South East Europe. A Critical Assessment of the Draft National Energy and Climate Plans*. Berlin. Retrieved from https://www.agora-energiewende.de/fileadmin2/Projekte/2019/Climate_Un-ambition_SEE/162_Climate_Un-ambition_SEE_WEB.pdf

Agora Energiewende and Sandbag. (2019). *The European Power Sector in 2018. Up to date analysis on the enrgy transition.*

Agora Energiewende, & Aurora Energy Research. (2019). *The German Coal Commission. A Roadmap for a Just Transition from Coal to Renewables.*

Alves Dias, P., Kanellopoulos, K., Medarac, H., Kapetaki, Z., Miranda-Barbosa, E., Shortall, R., … Tzimas, E. (2018). *EU coal regions : opportunities and challenges ahead*. Luxembourg: Publications Office of the European Union. https://doi.org/10.2760/064809

AWWI. (2014). *Wind turbine interactions with wildlife and their habitats: a summary of research results and priority questions*. Washington, DC: American Wind Wildlife Institute (AWWI).

Balkan Green Energy News. (2018). Energy Community finds distortions of state aid rules regarding Kosova e Re power plant. Retrieved from https://balkangreenenergynews.com/energy-community-finds-distortions-of-state-aid-rules-regarding-kosova-e-re-power-plant/

Balkan Green Energy News. (2019a). Academy of Engineering Sciences of Serbia on SHPP: Mistakes, Consequences, Solutions.

Balkan Green Energy News. (2019b). Future of renewables in Croatia.

Barlovento. (2014). *DTBird®: Bird Monitoring and Control in Wind Farms*.

Batas Bjelić, I., Rajaković, N., Ćosić, B., & Duić, N. (2013). Increasing wind power penetration into the existing Serbian energy system. *Energy*, *57*, 30–37. https://doi.org/10.1016/j.energy.2013.03.043

Benn, A., Bodnar, P., Mitchell, J., & Waller, J. (2018). *Managing the Coal Capital Transition: Collaborative Opportunities for Asset Owners, Policymakers, and Environmental Advocates*. Retrieved from http://www.rmi.org/insight/ managing-coal-capital-transition/

Bennett, V. (2018). EBRD puts decarbonisation at centre of new energy sector strategy.

Bergamaschi, L., & Gaventa, J. (2014). *New Policy Frameworks for Electricity Infrastructure Cooperation in South East Europe*. *Policy briefing*. London: Third Generation Environmentalism Ltd (E3G).

Bhandari, K. P., Collier, J. M., Ellingson, R. J., & Apul, D. S. (2015). Energy payback time (EPBT) and energy return on energy invested (EROI) of solar photovoltaic systems: A systematic review and meta-analysis. *Renewable and Sustainable Energy Reviews*, *47*, 133–141. https://doi.org/http://dx.doi.org/10.1016/j.rser.2015.02.057

Bird, J., & Lawton, K. (2009). *The Future’ s Green: Jobs and the UK low-carbon transition*. *October*.

London: Institute for Public Policy Research (IPPR).

Blyth, W., Gross, R., Speirs, J., Sorrell, S., Nicholls, J., Dorgan, A., & Hughes, N. (2014a). *Low carbon jobs : The evidence for net job creation from policy support for energy efficiency and renewable energy*. UKERC Technology & Policy Assessment Function.

Blyth, W., Gross, R., Speirs, J., Sorrell, S., Nicholls, J., Dorgan, A., & Hughes, N. (2014b). *Low carbon jobs:The evidence for net job creation from policy support for energy efficiency and renewable energy*. UKERC Technology & Policy Assessment Function.

Brown, T. W., Bischof-Niemz, T., Blok, K., Breyer, C., Lund, H., & Mathiesen, B. V. (2018). Response to 'Burden of proof: A comprehensive review of the feasibility of 100% renewable-electricity systems.' *Renewable and Sustainable Energy Reviews*, *92*(May), 834–847. https://doi.org/10.1016/j.rser.2018.04.113

Buck, M., Risteska, S., & Redl, C. (2018). *A Clean-Energy Transition in Southeast Europe: Challenges, Options and Policy Priorities*. Berlin.

Burki, T. K. (2018). The long road to recovery from conflict in Serbia. *The Lancet Respiratory Medicine*, *6*(6), 413–414. https://doi.org/10.1016/S2213-2600(18)30205-4

Capros, P., Paroussos, L., Fragkos, P., Tsani, S., Boitier, B., Wagner, F., … Bollen, J. (2014). European decarbonisation pathways under alternative technological and policy choices: A multi-model analysis. *Energy Strategy Reviews*, *2*(3–4), 231–245. https://doi.org/10.1016/j.esr.2013.12.007

Carbon Tracker. (2018). EU carbon prices could double by 2021 and quadruple by 2030. Retrieved from https://www.carbontracker.org/eu-carbon-prices-could-double-by-2021-and-quadruple-by-2030/

Carbon Tracker. (2019). *Apocalypse now*. Retrieved from https://www.carbontracker.org/reports/apocoalypse-now/

CEE Bankwatch Network. (2017a). Carbon costs for planned coal power plants in the Western Balkans and the risk of stranded assets. *Briefing Paper*, 17.

CEE Bankwatch Network. (2017b). *Planned coal power plants in the Western Balkans versus EU pollution standards*. Praha.

CEE Bankwatch Network. (2019). Energy Community opens infringement procedure against Bosnia-Herzegovina over illegal Tuzla 7 state aid.

Centre for Sustainable Energy. (2009). *Delivering community benefitsfrom wind energy development:A Toolkit*.

Ciută, I., & Gallop, P. (2018). *The great coal jobs fraud*. CEE Bankwatch Network.

Clarke, L., & Jiang, K. (2015). Assessing Transformation Pathways. In Intergovernmental Panel on Climate Change (Ed.), *Climate Change 2014: Mitigation of Climate Change: Working Group III Contribution to the IPCC Fifth Assessment Report* (pp. 413–510). Cambridge: Cambridge University Press. https://doi.org/DOI: 10.1017/CBO9781107415416.012

Climact, & ECF. (2018). *Net Zero by 2050: From whether to how - Zero emission Pathways to the Europe we want*.

Community Power. (2013). *The Benefits of an Energy Revolution*. communitypower.eu: Community Power Project.

Ćosić, B., Krajačić, G., & Duić, N. (2012). A 100% renewable energy system in the year 2050: The case of Macedonia. *Energy*, *48*(1), 80–87. https://doi.org/10.1016/j.energy.2012.06.078

Ćosić, B., Markovska, N., Krajačić, G., Taseska, V., & Duić, N. (2012). Environmental and economic aspects of higher RES penetration into Macedonian power system. *Applied Thermal Engineering*, *43*, 158–162. https://doi.org/10.1016/j.applthermaleng.2011.10.042

Couture, T. D., Jacobs, D., & Appleman, N. (2018). *Low Cost Renewables*.

CRES. (2012). Maps of Technicaly and Economicaly Exploitable Wind Capacity in Greece.

Dempsey, H. (2019). European coal plants forecast to lose €6.6bn in 2019.

Department of Energy & Climate Change. (2014). Community Energy Strategy:Full Report. London.

DNV GL-Energy. (2016). *Fact-based scenario to meet commitments under the LCP BREF* (Hard coal/lignite fired power plants in EU28, 16–1213, R ed.). Arnhem.

Dominković, D. F., Bačeković, I., Ćosić, B., Krajačić, G., Pukšec, T., Duić, N., & Markovska, N. (2016). Zero carbon energy system of South East Europe in 2050. *Applied Energy*, *184*, 1517–1528. https://doi.org/0.1016/j.apenergy.2016.03.046

Doutau, B., Kafkaletou-Diez, A., Cárcamo, B., Vasila, kis D., & Kret, E. (2011). *Impact assessment of wind farms on birds of prey in Thrace. Annual Report August 2009 - August 2010. Technical Report.* Greece, Athens: WWF.

Dryzek, J. S., Norgaard, R. B., & Schlosberg, D. (2011). *The Oxford handbook of climate change and society*. Oxford: Oxford University Press.

Duić, N. (2015). Is the success of clean energy guaranteed? *Clean Technologies and Environmental Policy*, *17*(8), 2093–2100. https://doi.org/10.1007/s10098-015-0969-y

Ecofys. (2017). *Mapping the cost of capital for wind and solar energy in South Eastern European Member States*. Utrecht: ECOFYS Netherlands B.V.

Energy Union Choices. (2017). *Cleaner, Smarter, Cheaper: responding to opportunities in Europe's changing energy system*. Brussels. Retrieved from https://www.energyunionchoices.eu/cleanersmartercheaper/Cleaner, Smarter, Cheaper_Web.pdf

Entso-e. (2016). Res Directive Review: Entso-E Views on Res Support Schemes, (October). Retrieved from https://www.entsoe.eu/Documents/Publications/Position papers and reports/RES support schemes_Oct 16.pdf

Ernst and Young and Solar Power Europe. (2017). Solar PV Jobs & Value Added in Europe, (November), 40.

EURACOAL. (2018a). *Country profile: Greece*.

EURACOAL. (2018b). *Country profile: Serbia*.

EURACOAL. (2018c). *Country profile: Serbia*. Retrieved from https://euracoal.eu/info/country-profiles/serbia/

Eurelectric. (2009). *Power Choices: Pathways to Carbon-Neutral Electricity in Europe by 2050* (Full Repor). Brussels. Retrieved from www.eurelectric.org/PowerChoices2050/

European commission. (2018). In-depth analysis in support of the Commission Communication COM (2018) 773 "A Clean Planet for all A European long-term strategic vision for a prosperous , modern , competitive and climate neutral economy." Brussels.

European Commission. (2012). Energy Roadmap 2050. Luxembourg: Publications Office of the

European Union.

European Commission. (2017). *No region left behind: launch of the Platform for Coal Regions in Transition*. Strasbourg: European Commission - Press release. Retrieved from http://europa.eu/rapid/press-release_IP-17-5165_en.htm

European Commission. (2018a). Revision for phase 4 (2021-2030). Retrieved from https://ec.europa.eu/clima/policies/ets/revision_en

European Commission. (2018b). *State aid: Commission approves six electricity capacity mechanisms to ensure security of supply in Belgium, France, Germany, Greece, Italy and Poland - Factsheet* (press release). Retrieved from http://europa.eu

European Parlamentary Research Service EPRS. (2017). Capacity mechanisms for electricity, (May).

EY, & Solar Power Europe. (2017). *Solar PV Jobs & Value Added in Europe*. EY. Retrieved from https://www.ey.com/Publication/vwLUAssets/EY-solar-pv-jobs-and-value-added-in-europe/$FILE/EY-solar-pv-jobs-and-value-added-in-europe.pdf

Farhoodnea, M., Mohamed, A., Shareef, H., & Zayandehroodi, H. (2013). Power Quality Impact of Renewable Energy based Generators and Electric Vehicles on Distribution Systems. *Procedia Technology*, *11*, 11–17. https://doi.org/https://doi.org/10.1016/j.protcy.2013.12.156

Fraunhofer Institute for Solar Energy Systems, & PSE GmbH. (2019). *Photovoltaics Report*.

Fraunhofer IWES. (2015). *The European Power System in 2030: Flexibility Challenges and Integration Benefits. An Analysis with a Focus on the Pentalateral Energy Forum Region* (Analysis). Berlin.

Fürsch, M., Hagspiel, S., Jägemann, C., Nagl, S., Lindenberger, D., & Tröster, E. (2013). The role of grid extensions in a cost-efficient transformation of the European electricity system until 2050. *Applied Energy*, *104*, 642–652. https://doi.org/10.1016/j.apenergy.2012.11.050

Gallo, G. (2015). Electricity Market Manipulation: How Behavioral Modeling Can Help Market Design, (December), 31. Retrieved from http://www.nrel.gov/docs/fy16osti/65416.pdf

Gallop, P., Vejnović, I., & Pehchevski, D. (2019). *Western Balkans hydropower. Who pays, who profits ?*

Gennaioli, C., & Tavoni, M. (2016). Clean or dirty energy: evidence of corruption in the renewable energy sector. *Public Choice*, *166*(3–4), 261–290. https://doi.org/10.1007/s11127-016-0322-y

Görtz, S. (2015). Battery energy storage for intermittent renewable electricity production. A review and demonstration of energy storageapplications permitting higher penetration of renewables. *Examensarbete För Civilingenjörsexamen i Energiteknik*, 82. Retrieved from https://www.diva-portal.org/smash/get/diva2:818683/FULLTEXT01.pdf

Haapala, K. R., & Prempreeda, P. (2014). Comparative life cycle assessment of 2.0 MW wind turbines. *Int. J. Sustainable Manufacturing*, *3*(2), 170–185. https://doi.org/10.1504/IJSM.2014.062496

Hall, C. A. S., Lambert, J. G., & Balogh, S. B. (2014). EROI of different fuels and the implications for society. *Energy Policy*, *64*, 141–152. https://doi.org/10.1016/j.enpol.2013.05.049

Haller, M., Ludig, S., & Bauer, N. (2012). Decarbonization scenarios for the EU and MENA power system: Considering spatial distribution and short term dynamics of renewable generation. *Energy Policy*, *47*, 282–290. https://doi.org/10.1016/j.enpol.2012.04.069

Harrison, D. L., Opperman, J. J., & Richter, B. D. (2007). Can hydro power be sustainable? *International Water Power and Dam Construction*, *59*(10), 22–25.

HEAL, CAN Europe, Sandbag, CEE Bankwatch Network, & Europe Beyond Coal. (2019). *Chronic coal pollution - EU action on the Western Balkans will improve health and economies across Europe.*

Hötker, H., Thomsen, K.-M., & Jeromin, H. (2006). *Impacts on biodiversity ofexploitation of renewable energy sources: the example of birds and bats - facts,gaps in knowledge, demands for further research, and ornithological guidelinesfor the development of renewable energy exploitation*. Bergenhusen: Michael-Otto-Institut imNABU.

IEA-IRENA. (2017). *Perspectives for the energy transition: Investment needs for a low-carbon energy system*.

IEA. (2017). *World Energy Outlook 2017*. https://doi.org/10.1016/0301-4215(73)90024-4

International Hydropower Association. (2017). Hydropower in the Balkans. Retrieved from https://www.hydropower.org/blog/can-these-unlock-hydro-potential-in-the-balkans

IRENA. (2011). *Renewable Energy Jobs: Status, Prospects & Policies*. *Working Paper*. International Renewable Energy Agency (IRENA). https://doi.org/24/03/2015

IRENA. (2016). *Renewable Energy Benefits: Measuring the Economics*. Abu Dhabi.

IRENA. (2017a). Renewable Energy and Jobs – Annual Review 2016.

IRENA. (2017b). *Synergies Between Renewable Energy and Energy Efficiency* (Working pa). Abu Dhabi. Retrieved from http://www.irena.org/remap

IRENA. (2018). *Renewable Energy Prospects for the European Union*. *Remap 2030*. European Union and IRENA.

IRENA. (2019). *Innovation Landscape for a Renewable-Powereed Future: Solutions To Integrate Variable Renewables*. Abu Dhabi: International Renewable Energy Agency. Retrieved from https://irena.org/-/media/Files/IRENA/Agency/Publication/2019/Feb/IRENA_Innovation_Landscape_2019_report.pdf

IRENA, IEA, & REN21. (2018). *Renewable Energy Policies in a Time of Transition*. IRENA, OECD/IEA and REN21. https://doi.org/ISBN 978-92-9260-061-7

IRENA, Joanneum Research, & University of Ljubljana. (2017). *Cost-Competitive Renewable Power Generation: Potential across South East Europe*. Abu Dhabi. Retrieved from http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/IRENA_Cost-competitive_power_potential_SEE_2017.pdf

Jacobson, M. Z., Delucchi, M. A., Bauer, Z. A. F., Goodman, S. C., Chapman, W. E., Cameron, M. A., … Yachanin, A. S. (2017a). 100% Clean and Renewable Wind, Water, and Sunlight All-Sector Energy Roadmaps for 139 Countries of the World. *Joule*, *1*(1), 108–121. https://doi.org/10.1016/j.joule.2017.07.005

Jacobson, M. Z., Delucchi, M. A., Bauer, Z. A. F., Goodman, S. C., Chapman, W. E., Cameron, M. A., … Yachanin, A. S. (2017b). 100% Clean and Renewable Wind, Water, and Sunlight All-Sector Energy Roadmaps for 139 Countries of the World. *Joule*, *1*(1), 108–121. https://doi.org/10.1016/j.joule.2017.07.005

Johnston, A., Buck, M., Goldammer, K., Heffron, R., Hiersemenzel, P., Kittel, M., … Wynn, G. (2018). *Phasing in Renewables -- Towards a prosperous and sustainable energy future in Kosovo : challenges and possible solutions*. Bonn/Berlin. Retrieved from www.germanwatch.org/en/15497

Jones, D., Huscher, J., Myllyvirta, L., Gierens, R., Flisowska, J., Gutmann, K., … Azau, S. (2016). *Europe's dark cloud - How coal-burning countries are making their neighbours sick*. Brussels.

Jorgensen, E., & Timislina, G. (2016). *Development of Low-Carbon Energy Supply System in Romania*. World Bank Group.

Jørgensen, J. (2007). *Samsø a Renewable Energy Island - 10 years of Development and Evaluation*.

Jovanović, S. (2019a). Construction on 250 MW Briska Gora solar power plant to begin in 2020.

Jovanović, S. (2019b). EBRD tightens environmental, disclosure standards for all hydropower projects.

Jovičić, B. (2019). IRENA: SEE region yet to realise full potential of energy transition.

KEMA, DNV GL-Energy, Imperial College, & NERA. (2014). Integration of Renewable Energy in Europe, (June), 236. https://doi.org/10.4018/978-1-4666-8398-3.ch022

Kingsley, A., & Whittam, B. (2005). *Wind Turbines and Birds: A Background Review for Environmental Assessment*. Environment Canada / Canadian Wildlife Service.

Kittner, N., Dimco, H., Azemi, V., Tairyan, E., & Kammen, D. M. (2016). An analytic framework to assess future electricity options in Kosovo. *Environmental Research Letters*, *11*(10). https://doi.org/10.1088/1748-9326/11/10/104013

Kopač, J. (2018). *Towards clean , secure and affordable energy systems in Southeast Europe* (presentation). Wien.

Kovacevic, A. (2011). *Fossil Fuel Subsidies in the Western Balkans*.

Lalas, D., & Gakis, N. (2017). *A Comparison of Some Available Modelling Results for the Greek Electricity Sector to 2050*. Athens: FACE3TS.

Loorbach, D., & Verbong, G. (2012). *Governing the Energy Transition. Reality, Illusion or Necessity*. Routledge.

Lund, H. (2007). Renewable energy strategies for sustainable development. *Energy*, *32*(6), 912–919. https://doi.org/10.1016/j.energy.2006.10.017

Lund, H. (2014). *Renewable energy systems : a smart energy systems approach to the choice and modeling of 100% renewable solutions* (2.). Oxford: Academic Press.

Lund, H., Andersen, A. N., Østergaard, P. A., Mathiesen, B. V., & Connolly, D. (2012). From electricity smart grids to smart energy systems – A market operation based approach and understanding. *Energy*, *42*(1), 96–102. https://doi.org/10.1016/j.energy.2012.04.003

Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy*, *41*(6), 955–967. https://doi.org/10.1016/j.respol.2012.02.013

Markets Insider. (2018). CO2 European Emission Allowances. Retrieved from https://markets.businessinsider.com/commodities/co2-emissionsrechte

Marović, J. (2018). *Western Balkans and the Rule of Law: How to solve a catch-22?* Retrieved from https://idscs.org.mk/wp-content/uploads/2018/07/Rule-of-Law-2.pdf

Matek, B., & Gawell, K. (2015). The Benefits of Baseload Renewables: A Misunderstood Energy Technology. *The Electricity Journal*, *28*(2), 101–112. https://doi.org/https://doi.org/10.1016/j.tej.2015.02.001

McKinsey & Company. (2010). *Transformation of Europe's power system until 2050*. *McKinsey & Company*. Retrieved from https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/epng/pdfs/transformation_of_europes_power_system.ashx

Nabiyeva, K. (2018). *Energy Transition in South East and Eastern Europe, South Caucasus and Central Asia*.

Németh, K. (2017). Szélturbina pörög a kertvárosi panel tetején! Retrieved from https://www.pecsma.hu/abszolut-pecs/szelkereket-allitottak-egy-kertvarosi-panel-tetejen/

Newbery, D. (2016). Missing money and missing markets: Reliability, capacity auctions and interconnectors. *Energy Policy*, *94*(February 2015), 401–410. https://doi.org/10.1016/j.enpol.2015.10.028

NewClimate Institute. (2019). Unlocking Low Cost Renewables in South East Europe Case Studies on De-risking Onshore Wind Investment.

Noothout, P., Jager, D. De, Tesnière, L., Rooijen, S. van, Karypidis, N., Brückmann, R., … Resch, G. (2016). *The impact of risks in renewable energy investments and the role of smart policies - DiaCore project final report* (DiaCore).

Öko-Institut. (2017). *Renewables versus fossil fuels – comparing the costs of electricity systems*. Berlin. Retrieved from https://www.agora-energiewende.de/fileadmin/Projekte/2016/Stromwelten_2050/Agora_Gesamtkosten-Stromwelten-EN_WEB.pdf

Pleßmann, G., & Blechinger, P. (2017). Outlook on South-East European power system until 2050: Least-cost decarbonization pathway meeting EU mitigation targets. *Energy*, *137*(C), 1041–1053. https://doi.org/10.1016/j.energy.2017.03.076

Powlesland, R. G. (2009). *Impacts of wind farms on birds: a review*. Wellington: New Zealand Department of Conservation.

Pukšec, T., Krajačić, G., Pavičević, M., Pfeifer, A., Doračić, B., & Novosel, T. (2018). *Hrvatska energetska tranzicija 2018* (Thank you for the translation for Tomislav Pukšec.). Rujan.

Radović, F. (2019). Air quality in Serbia unsatisfactory, implementation of measures goes hand in hand with economic recovery.

Rae, C., & Bradley, F. (2012). Energy autonomy in sustainable communities—A review of key issues. *Renewable and Sustainable Energy Reviews*, *16*(9), 6497–6506. https://doi.org/10.1016/j.rser.2012.08.002

Rajšl, I., & Tomšić, Ž. (2017a). *Croatian Power System Model for Low Carbon Development Strategy*. Presentation.

Rajšl, I., & Tomšić, Ž. (2017b). Croatian Power System Model for Low Carbon Development Strategy. In *8th Energy Planning and Modeling of Energy System, Belgrade, October 23-24* (p. 50). Zagreb.

Redl, C. (2018). *A word on flexibility: The German Energiewende in practice: how the electricity market manages flexibility challenges when the shares of wind and PV are high*. Berlin: Agora Energiewende.

Reid, G. (2015). Renewables and the missing money problem. https://doi.org/10.15713/ins.mmj.3

REKK Foundation. (2019). *The Southeast European power system in 2030*.

REN21, & UNECE. (2017). *Renewable Energy Status Report 2017*. Paris. Retrieved from https://staging.unece.org/fileadmin/DAM/energy/se/pp/renew/Renewable_energy_report_2017_web.pdf

Resch, G., Liebmann, L., & Hiesl, A. (2016). RES in SEERMAP - … some key inputs to the analysis, 23. Retrieved from https://rekk.hu/downloads/events/2016_SEERMAP_intro_RES_Resch.pdf

Roinioti, A., Koroneos, C., & Wangensteen, I. (2012). Modeling the Greek energy system: Scenarios of clean energy use and their implications. *Energy Policy*, *50*, 711–722. https://doi.org/10.1016/j.enpol.2012.08.017

Romanian Ministry of Energy. (2018). *Romanian Energy Strategy 2016-2030, with an Outlook to 2050* (Executive Summary (English)). Retrieved from https://www.solarthermalworld.org/sites/gstec/files/news/file/2016-12-30/romanian-energy-strategy-2016-2030-executive-summary3.pdf

Sáfián, F. (2014). The Synergies of Community Ownership, Renewable Energy Production and Locality – The Cases of Güssing and Samsø. *Geographical Locality Studies*, *2*(1), 386–410.

Sandbag. (2019a). Europe's great coal collapse of 2019. Retrieved from https://sandbag.org.uk/wp-content/uploads/2019/07/2019-EU-Coal-Report-FIN_1.2.pdf

Sandbag. (2019b). *The cash cow has stopped giving: Are Germany's lignite plants now worthless?*

Sapire, R. (2012). Engulfed in a Toxic Cloud: The Effects of Coal Mining On Human Health. *Harvard College Global Health Review*. Retrieved from https://www.hcs.harvard.edu/hghr/print/spring-2011/coal-mining/

Sartor, O. (2018). *Implementing coal transitions: Insights from case studies of major coal-consuming economies* (A Summary Report of the Coal Transitions project). France.

SELDI. (2014). *Anti-Corruption Reloaded: Assessment of Southeast Europe* (Revised). (O. Shentov, R. Stefanov, & B. Todorov, Eds.). Sofia: Center for the Study of Democracy.

SELDI. (2016). *Energy Governance and State Capture Risks in Southeast Europe - Regional Assessment Report*. Sofia: Center for the Study of Democracy.

Spasić, V. (2019a). BiH, Kosovo*, Serbia pay EUR 444 million in coal subsidies, EUR 147 million for renewables – report.

Spasić, V. (2019b). EIB to ditch fossil fuel projects from 2021.

Spasić, V. (2019c). EU said to be considering carbon tax for Western Balkans.

Spasić, V. (2019d). Investors alone have benefits from small hydropower plants – citizens, state and municipalities have none.

Spasić, V. (2019e). Montenegro leading energy transition in region.

Spasić, V. (2019f). Western Balkan countries once again commit to clean energy development, as EU warns them about hydropower.

Spasić, V. (2019g). Wpd Adria plans EUR 1.5 billion investment in 1.2 GW wind farms in BiH, Croatia.

Szabó, L., Mezősi, A., Pató, Z., Kelemen, Á., Beöthy, Á., Kácsor, E., … Todorović, D. (2017). *SEERMAP: South East Europe Electricity Roadmap - South East Europe Regional report 2017*.

Tagliapietra, S. (2017). *Beyond Coal: Facilitating the Transition in Europe* (Policy brief). Brussels: Bruegel.

Taseska, V., Markovska, N., Causevski, A., Bosevski, T., & Pop-Jordanov, J. (2011). Greenhouse gases

(GHG) emissions reduction in a power system predominantly based on lignite. *Energy*, *36*(4), 2266–2270. https://doi.org/10.1016/j.energy.2010.04.010

TECHNOFI. (2013). *E-Highway 2050. Selection and characterization of the most impacting demand-side technologies*. Paris.

Temperton, I., Buck, M., Graf, A., & Brückmann, R. (2018). *Reducing the cost of financing renewables in Europe - Report of a multi-stakeholder dialogue on the proposed EU Renewable Energy Cost Reduction Facility*. Berlin: Agora Energiewende. Retrieved from https://www.agora-energiewende.de/fileadmin2/Projekte/2016/De-Risking/Agora_RES_CRF-Dialogue_WEB.pdf

Tigas, K., Giannakidis, G., Mantzaris, J., Lalas, D., Sakellaridis, N., Nakos, C., … Alexandridis, A. T. (2015). Wide scale penetration of renewable electricity in the Greek energy system in view of the European decarbonization targets for 2050. *Renewable and Sustainable Energy Reviews*, *42*, 158–169. https://doi.org/10.1016/j.rser.2014.10.007

Tomić, I., Pavičević, M., Quoilin, S., Zucker, A., Krajačić, G., Pukšec, T., … ***. (2017). Applying the Dispa-SET model on the seven countries from the South East Europe. In *8th Energy Planning and Modeling of Energy Systems, Belgrade, 24.10.2017* (p. 27).

Transparency International. (2018a). Corruption by topic: oil and gas. Retrieved from https://www.transparency.org/topic/detail/oil_and_gas

Transparency International. (2018b). Corruption by topic: oil and gas.

Tuerk, A., Frieden, D., Steiner, D., Fruhmann, C., Kordic, Z., Pasicko, R., … Totschnig, G. (2015). *Bringing Europe and Third countries closer together through renewable Energies: Case study report on prospects for RES cooperation with the West Balkans using the cooperation mechanisms* (BETTER D4 .3 project report). Retrieved from http://better-project.net/sites/default/files/D4.3 Case study report on prospects for RES cooperation with the West Balkans using the cooperation mechanisms_0.pdf

Turković, M. (2019). Barrier analysis and derisking RES in Serbia: Study Results.

Ueckerdt, F., & Kempener, R. (2015). *From baseload to peak:Renewables provide a reliable solution*. IRENA.

UNDP. (2011). *Assessing The Economic Impact of Climate Change*.

UNEP. (2013). *Green Economy Scoping Study: Serbia*.

Valaska, J. (2018). Az Európai Unió kibocsátás-kereskedelmi rendszerének (ETS) reformja. *REKK PiacMonitoring Klub*, (2018. október 8.), 10.

van der Burg, L., Trilling, M., & Gençsü, I. (2019). *Fossil fuel subsidies in draft EU National Energy and Climate Plans. Shortcomings and final call for action*.

Vejnović, I. (2017). *Broken rivers*. Retrieved from https://bankwatch.org/wp-content/uploads/2017/12/broken-rivers.pdf

Vejnović, I., & Gallop, P. (2018). *Financing for hydropower in protected areas in Southeast Europe: 2018 update*. Retrieved from https://bankwatch.org/wp-content/uploads/2018/03/Financing-hydropower-southeast-Europe-web-2018-update.pdf

Verheijen, T. (2016). Two “Robberies” of Serbian Tax Payers. Retrieved from http://www.worldbank.org/en/news/opinion/2016/06/16/two-robberies-of-serbian-tax-payers

Voogt, M. (2018). *Using carbon pricing to support coal transition on the Western Balkan*.

Walker, G., & Devine-Wright, P. (2008). Community renewable energy: What should it mean? *Energy Policy*, *36*(2), 497–500. https://doi.org/10.1016/j.enpol.2007.10.019

Walker, G., Hunter, S., Devine-Wright, P., Evans, B., & Fay, H. (2007). Harnessing Community Energies: Explaining and Evaluating Community-Based Localism in Renewable Energy Policy in the UK. *Global Environmental Politics*, *7*(2), 64–82. https://doi.org/10.1162/glep.2007.7.2.64

Walker, G., & Simcock, N. (2012). Community Energy Systems. In M. E. Susan J. Smith Lorna Fox O'Mahony, Ong Seow Eng, Susan & H. L. Wachter (Eds.), *International Encyclopedia of Housing and Home* (Vol. 1, pp. 194–198). Oxford: Elsevier.

Weiss, S., Apostolou, A., Đug, S., Marčić, Z., Mušović, M., Oikonomou, A., … Zabric, D. (2018). *Endangered Fish Species in Balkan Rivers: their distributions and threats from hydropower development*. Retrieved from https://balkanrivers.net/sites/default/files/Fish_Study_web.pdf

Western Balkans Investment Framework. (2018). Principles for Sustainable Hydropower Development in the Western Balkans. Retrieved from https://www.wbif.eu/content/stream//Sites/website/library/Draft-Principles-for-Sustainable-Hydropower-in-the-WB.pdf

Wilhelmsson, L. (2012). Investigation of the Energy Payback of the Mervento 3 . 6-118 Wind Turbine.

Wind Europe. (2018). *Wind in power 2017*.

WWF, & NOA. (2017). *Long Term Plan for the Greek Energy System*. Athens.

WWFGreece. (2013). *Wind farms in Thrace: Updating the proposalfor propersite selection.* Dadia-Athens.

Wynn, G., & Azemi, V. (2018). IEEFA Update: Kosovo's Latest Coal-Plant Plan Would Violate EU Standards for Market Competition. Retrieved from http://ieefa.org/ieefa-update-kosovos-latest-coal-plant-plan-violate-eu-standards-market-competition/

Wynn, G., & Coghe, P. (2017). *Europe's Coal-Fired Power Plants: Rough Times Ahead Analysis of the Impact of a New Round of Pollution Controls*. Retrieved from http://ieefa.org/wp-content/uploads/2017/05/Europe-Coal-Fired-Plants_Rough-Times-Ahead_May-2017.pdf