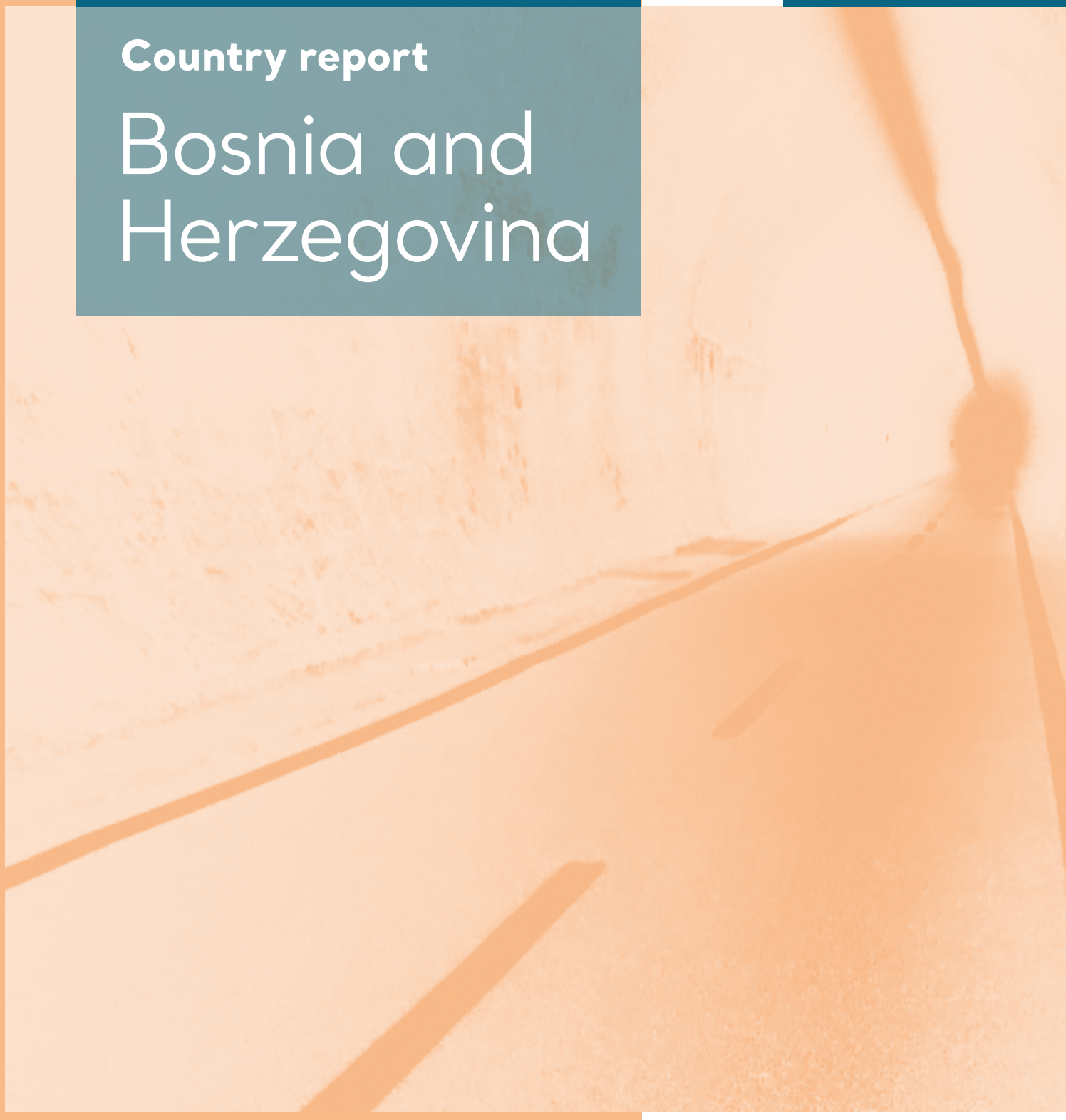
SEERMAP

South East Europe Electricity Roadmap

SOUTH EAST EUROPE ELECTRICITY ROADMAP

Country report

Bosnia and Herzegovina



SEERMAP: South East Europe Electricity Roadmap
Country report: Bosnia and Herzegovina 2017

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SEERMAP
South East Europe Electricity Roadmap

The South East Europe Electricity Roadmap (SEERMAP) project develops electricity sector scenarios until 2050. The project focuses on 9 countries in South East Europe: Albania, Bosnia and Herzegovina, Bulgaria, Greece, Kosovo*, former Yugoslav Republic of Macedonia, Montenegro, Romania and Serbia. The implications of different investment strategies in the electricity sector are assessed for affordability, energy security, sustainability and security of supply. In addition to analytical work, the project focuses on trainings, capacity building and enhancing dialogue and cooperation within the SEE region.

** This designation is without prejudice to positions on status, and it is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence.*

Further information about the project is available at: **www.seermap.rekk.hu**

Funding for the project was provided by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management and the European Climate Foundation.

European Climate Foundation

The project was carried out by a consortium of 5 partners, and involved 9 local partners as subcontractors. The consortium was led by the Regional Centre for Energy Policy Research (REKK).

The **Regional Centre for Energy Policy Research (REKK)** is a Budapest based think tank, and consortium leader of the SEERMAP project. The aim of REKK is to provide professional analysis and advice on networked energy markets that are both commercially and environmentally sustainable. REKK has performed comprehensive research, consulting and teaching activities in the fields of electricity, gas and carbon-dioxide markets since 2004, with analyses ranging from the impact assessments of regulatory measures to the preparation of individual companies' investment decisions.

The **Energy Economics Group (EEG),** part of the Institute of Energy Systems and Electrical Drives at the Technische Universität Wien (TU Wien), conducts research in the core areas of renewable energy, energy modelling, sustainable energy systems, and energy markets. EEG has managed and carried out many international as well as national research projects funded by the European Commission, national governments, public and private clients in several fields of research, especially focusing on renewable and new energy systems. EEG is based in Vienna and was originally founded as research institute at TU Wien.

The **Electricity Coordination Centre (EKC)** provides a full range of strategic business and technical consultancy and engineering leading models and methodologies in the area of electric power systems, transmission and distribution systems, power generation and electricity markets. EKC was founded in 1993 and provides consultant services from 1997 in the region of South-East Europe, Europe as well as in the regions of Middle East, Eastern Africa and Central Asia. EKC also organises educational and professional trainings.

The work of **OG Research** focuses on macroeconomic research and state of the art macroeconomic modelling, identification of key risks and prediction of macroeconomic variables in emerging and frontier markets, assessment of economic developments, and advice on modern macroeconomic modelling and monetary policy. The company was founded in 2006 and is based in Prague and Budapest.

The **Energy Regulators Regional Association (ERRA)** is a voluntary organisation comprised of independent energy regulatory bodies primarily from Europe, Asia, Africa, the Middle East and the United States of America. There are now 30 full and 6 associate members working together in ERRA. The Association's main objective is to increase exchange of information and experience among its members and to expand access to energy regulatory experience around the world.

Local partners in SEERMAP target countries

ENOVA (Bosnia and Herzegovina) is a multi-disciplinary consultancy with more than 15 years of experience in energy, environment and economic development sectors. The organization develops and implements projects and solutions of national and regional importance applying sound knowledge, stakeholder engagement and policy dialogue with the mission to contributing to sustainable development in South East Europe.

POLIS University (U_Polis, Albania) is young, yet ambitious institution, quality research-led university, supporting a focused range of core disciplines in the field of architecture, engineering, urban planning, design, environmental management and VET in Energy Efficiency.

The **Center for the Study of Democracy (CSD, Bulgaria)** is a European-based interdisciplinary non-partisan public policy research institute. CSD provides independent research and policy advocacy expertise in analysing regional and European energy policies, energy sector governance and the social and economic implications of major national and international energy projects.

FACETS (Greece) specialises in issues of energy, environment and climate, and their complex interdependence and interaction. Founded in 2006, it has carried out a wide range of projects including: environmental impact assessment, emissions trading, sustainability planning at regional/municipal level, assessment of weather and climate-change induced impacts and associated risks, forecasting energy production and demand, and RES and energy conservation development.

Institute for Development Policy (INDEP, Kosovo*) is a Prishtina based think tank established in 2011 with the mission of strengthening democratic governance and playing the role of public policy watchdog. INDEP is focused on researching about and providing policy recommendations on sustainable energy options, climate change and environment protection.

MACEF (Macedonia) is a multi-disciplinary NGO consultancy, providing intellectual, technical and project management support services in the energy and environmental fields nationally and worldwide. MACEF holds stake in the design of the energy policy and energy sector and energy resources development planning process, in the promotion of scientific achievements on efficient use of resources and develops strategies and implements action plans for EE in the local self-government unit and wider.

Institute for Entrepreneurship and Economic Development (IPER, Montenegro) is an economic thing tank with the mission to promote and implement the ideas of free market, entrepreneurship, private property in an open, responsible and democratic society in accordance with the rule of law in Montenegro. Core policy areas of IPER's research work include: Regional Policy and Regional Development, Social Policy, Economic Reforms, Business Environment and Job Creation and Energy Sector.

The **Energy Policy Group (EPG, Romania)** is a Bucharest-based independent, non-profit think-tank grounded in 2014, specializing in energy policy, markets, and strategy. EPG seeks to facilitate an informed dialogue between decision-makers, energy companies, and the broader public on the economic, social, and environmental impact of energy policies and regulations, as well as energy significant projects. To this purpose, EPG partners with reputed think-tanks, academic institutions, energy companies, and media platforms.

RES Foundation (Serbia) engages, facilitates and empowers efficient networks of relationships among key stakeholders in order to provide public goods and services for resilience. RES stands for public goods, sustainability and participatory policy making with focus on climate change and energy.

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1 | Executive summary

South East Europe is a diverse region with respect to energy policy and legislation, with a mix of EU member states, candidate and potential candidate countries. Despite this diversity, shared challenges and opportunities exist among the countries of the region. The electricity network of the South East Europe region is highly interconnected, energy policies are increasingly harmonised and the electricity market is increasingly integrated as a result of the EU accession process, the Energy Community Treaty and more recently the Energy Union initiative warranting a regional perspective on policy development.

A model-based assessment of different long term electricity investment strategies was carried out for the region within the scope of the SEERMAP project. The project builds on previous work in the region, in particular IRENA (2017), the DiaCore and BETTER EU research projects and the SLED project, as well as EU level analysis, in particular the EU Reference Scenario 2013 and 2016. The current assessment shows that alternative solutions exist to replace current generation capacity by 2050, with different implications for affordability, sustainability and security of supply.

In Bosnia and Herzegovina, more than 30% of current fossil fuel generation capacity is expected to be decommissioned by the end of 2030, reaching around 85% by 2050. This provides both a challenge for ensuring a policy framework which will incentivise investment in new generation and an opportunity to reshape the electricity sector over the long term following a broader economic strategy that is unconstrained by the current generation portfolio.

A set of five models covering the electricity and gas markets, the transmission network and macro-economic system were used to assess the impact of 3 core scenarios:

- The 'no target' scenario reflects the implementation of current energy policy (including implementation of renewable energy targets for 2020 and completion of all power plants listed in official planning documents) combined with a CO_2 price (applied from 2030 onwards for non-EU states), but no 2050 CO_2 target in the EU or Western Balkans;
- The 'decarbonisation' scenario reflects a long-term strategy to significantly reduce CO_2 emissions according to indicative EU emission reduction goals for the electricity sector as a whole by 2050, driven by the CO_2 price and strong, continuous RES support;
- The 'delayed' scenario envisages an initial implementation of current national investment plans followed by a change in policy from 2035 onwards that leads to the same emission reduction target by 2050 as the 'decarbonisation' scenario. The attainment of the target is driven by the CO_2 price and increased RES support from 2035 onwards.

The modelling work carried out under the SEERMAP project identifies the following key findings with respect to the different electricity strategy approaches that Bosnia and Herzegovina can take:

- Across all scenarios Bosnia and Herzegovina will experience a significant shift away from fossil fuel based electricity generation towards renewables. The share of renewable generation as a percentage of gross domestic consumption in 2050 reaches 66% in the 'no target' scenario, 103% in the 'delayed' scenario and 107% in the 'decarbonisation' scenario. Hydro and wind capacities will play the 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.

- Lignite based electricity generation contributes only 1-6% of the generation mix by 2050 in the modelled scenarios. This happens despite exogenous inclusion of new coal generation capacity in both the 'no target' and 'delayed' model scenarios following national investment plans envisaging a total capacity of 1700 MW. At the end of 2050 lignite capacity reaches 2000 MW in both the 'no target' and 'delayed' scenarios. Coal will not be able to compete on the market due to increasing carbon prices and decreasing renewable technology costs. The share of lignite based electricity generation drops gradually starting from 2030, when the EU ETS carbon price is expected to apply to Bosnia and Herzegovina.
- Natural gas is not projected to play any role in electricity generation over the modelled time horizon in any of the scenarios, due to higher natural gas prices compared to other countries in the SEERMAP region.
- Delayed action on renewables is feasible, but has two disadvantages compared with a long term planned effort. It results in stranded fossil fuel power generation assets, including currently planned power plants. Translated into a price increase equivalent over a 10 year period, the cost of stranded assets is significantly higher than the size of RES support needed for decarbonising the electricity sector. Furthermore, the increased effort required towards the end of the modelled period to meet the CO_2 emissions target requires a significant increase in RES support.
- Bosnia and Herzegovina is a net electricity exporter that increases its net exports significantly for a decade and a half from current levels in the 'no target' scenario. However, as lignite based electricity generation declines significantly, the country becomes a net importer by 2050. In contrast, the country is close to self-sufficient in the 'decarbonisation' scenario over the entire modelled time horizon, with net imports ranging within +/-10% over time.
- Compared to a scenario with no emission reduction target, decarbonising the electricity sector does not drive up wholesale electricity prices. The price trajectory follows a similar trend under all scenarios and only diverges after 2045, when prices fall in scenarios with high levels of RES in the electricity mix due to the low marginal cost of RES electricity production. Over the long term, prices rise the least in the 'decarbonisation' scenario.
- Under all scenarios the wholesale electricity price increases compared with current (albeit historically low) price levels. This occurs across the entire SEE region and the EU as a whole in all scenarios for the modelled time period. The drivers are the price of carbon and natural gas (which is relevant for the region but not Bosnia and Herzegovina itself), both of which increase significantly by 2050. While this leads to higher absolute end user prices, the macroeconomic analysis shows that household electricity expenditure relative to household income is expected to increase at a lower rate in all scenarios – the increase in household income will compensate for the increase in the price of electricity to some extent. Still, affordability issues may arise for some households in all scenarios. A benefit of higher wholesale prices is the positive signal it sends to investors in a sector currently beset by under investment.
- Decarbonisation will require significantly more investment in generation capacity, which is assumed to be financed by private actors who accept higher capital expenditure in exchange for low operating expenditure (plus RES support) in their investment decisions. From a societal point of view, the impact on GDP, employment and the fiscal

and external balance is more relevant. In Bosnia and Herzegovina, these indicators do not improve in the decarbonisation scenario like they do in some other countries.

- Decarbonisation will require continued RES support during the entire period. Despite the significant investment requirements associated with the 'decarbonisation' scenario, the renewables support needed to incentivise these investments remains at low levels, staying within the range of 0.1-2.1 EUR/MWh throughout the modelled time horizon. This is attributable to the relatively high cheap hydro potential and the increasing wholesale price for electricity which reduces the need for residual support.
- The network modelling results suggest that the planned transmission network developments (as in the ENTSO-E TNDP, 2016) would be sufficient for Bosnia and Herzegovina to meet projected trade and RES deployment. However, the distribution network – which was not modelled in the network assessment – might need significant development to support the integration of distributed RES generation.

A number of robust no regret policy recommendations can be provided across all scenarios:

- The high penetration of RES in all scenarios suggests policies should focus on enabling RES integration, including investment in transmission and distribution networks, demand side management, and storage (both hydro and small scale) through a combination of technical solutions and appropriate regulatory practices.
- RES potential can be maximised with de-risking policies lowering high cost of capital prevalent throughout the region. In Bosnia and Herzegovina this would pave the way for cost-efficient renewable energy investments.
- Co-benefits from investing in renewable electricity generation can strengthen the case for increased RES investment. Co-benefits, not assessed here, include health and environmental benefits from reduced emissions of air pollutants.
- An active, long-term and stable renewable energy support framework enables Bosnia and Herzegovina to avoid significant stranded costs in lignite based generation assets. The required RES support is not high, and can be covered by EU ETS revenues from 2030 onwards, thereby relieving the corresponding surcharge to consumers.
- Policymakers need to address the trade-offs which characterise fossil fuel investments. Lignite generation capacities are expected to be priced out of the market before the end of their lifetime in all scenarios resulting in stranded assets. These long term costs need to be weighed against any short term benefits that these power plants can provide.
- Irrespective of the scenario implemented, Bosnia and Herzegovina will have to address the increased financial burden of electricity bills for households. A long term policy to address energy poverty may need to be developed. The evolution of wholesale electricity prices is driven by regional and European level supply and demand, and policy makers cannot protect consumers from price impacts using domestic investment decisions in an integrated and competitive European electricity market.
- Regional level planning – including establishment of regional markets, increasing cross-border capacities and incentivising storage capacities with a regional significance – can improve system adequacy more efficiently than reliance on national production capacities.

This SEERMAP country report of includes detailed modelling outputs for Bosnia and Herzegovina and the two entities, the Federation of Bosnia and Herzegovina and Republika Srpska in its Annexes.

2 | Introduction

2.1 Policy context

Over the past decades EU energy policy has focused on a number of shifting priorities. Beginning in the 1990s, the EU started a process of market liberalisation in order to ensure that the energy market is competitive, providing cleaner and cheaper energy to consumers. Three so-called energy packages were adopted between 1996 and 2009 addressing market access, transparency, regulation, consumer protection, interconnection, and adequate levels of supply. The integration of the EU electricity market was linked to the goal of increasing competitiveness by opening up national electricity markets to competition from other EU countries. Market integration also contributes to energy security, which had always been a priority but gained renewed importance again during the first decade of the 2000s due to gas supply interruptions from the dominant supplier, Russia. Energy security policy addresses short and long term security of supply challenges and promotes the strengthening of solidarity between member states, completing the internal market, diversification of energy sources, and energy efficiency.

The Energy Community Treaty and related legal framework translates EU commitments on internal energy market rules and principles into commitments for the candidate and potential candidate countries. Other regional processes and initiatives, such as CESEC and the Western Balkan 6 initiative, also known as the Berlin Process, also have implications for regional energy policy and legislation, infrastructure and markets.

Climate mitigation policy is inextricably linked to EU energy policy. Climate and energy were first addressed jointly via the so-called '2020 Climate and energy package' initially proposed by the European Commission in 2008. This was followed by the '2030 Climate and energy framework', and more recently by the new package of proposed rules for a consumer centred clean energy transition, referred to as the 'winter package' or 'Clean energy for all Europeans'. The EU has repeatedly stated that it is in line with the EU objective, in the context of necessary reductions according to the IPCC by developed countries as a group, to reduce its emissions by 80-95% by 2050 compared to 1990, in order to contribute to keeping global average temperature rise below 2°C compared with pre-industrial levels. The EU formally committed to this target in the 'INDC of the European Union and its 28 Member States'. The 2050 Low Carbon and Energy Roadmaps reflect this economy-wide target. The impact assessment of the Low Carbon Roadmap shows that the cost-effective sectoral distribution of the economy-wide emission reduction target translates into a 93-99% emission reduction target for the electricity sector (EC 2011a). The European Commission is in the process of updating the 2050 roadmap to match the objectives of the Paris Agreement, possibly reflecting a higher level of ambition than the roadmap published in 2011.

2.2 The SEERMAP project at a glance

The South East Europe Electricity Roadmap (SEERMAP) project develops electricity sector scenarios until 2050 for the South East Europe region. Geographically the SEERMAP project focuses on 9 countries in South East Europe: Albania, Bosnia and Herzegovina, Kosovo* (in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence), former Yugoslav Republic of Macedonia (Macedonia), Montenegro and

Serbia (WB6) and Bulgaria, Greece and Romania (EU3). The SEERMAP region consists of EU member states, as well as candidate and potential candidate countries. For non-member states some elements of EU energy policy are translated into obligations via the Energy Community Treaty, while member states must transpose and implement the full spectrum of commitments under the EU climate and energy acquis.

Despite the different legislative contexts, the countries in the region have a number of shared challenges. These include an aged electricity generation fleet in need of investment to ensure replacement capacity, consumers sensitive to high end user prices, and challenging fiscal conditions. At the same time, the region shares opportunity in the form of large potential for renewables, large potential of hydro generation which can be a valuable asset for system balancing, a high level of interconnectivity, and high fossil fuel reserves, in particular lignite, which is an important asset in securing electricity supply.

Taking into account the above policy and socio-economic context, and assuming that the candidate and potential candidate countries will eventually become member states, the SEERMAP project provides an assessment of what the joint processes of market liberalisation, market integration and decarbonisation mean for the electricity sector of the South East Europe region. The project looks at the implications of different investment strategies in the electricity sector for affordability, sustainability and security of supply.

The aim of the analysis is to show the challenges and opportunities ahead and the trade-offs between different policy goals. The project can also contribute to a better understanding of the benefits that regional cooperation can provide for all involved countries. Although ultimately energy policy decisions will need to be taken by national policy makers, these decisions must recognise the interdependence of investment and regulatory decisions of neighbouring countries. Rather than outline specific policy advise in such a complex and important topic, our aim is to support an informed dialogue at the national and regional level so that policymakers can work together to find optimal solutions.

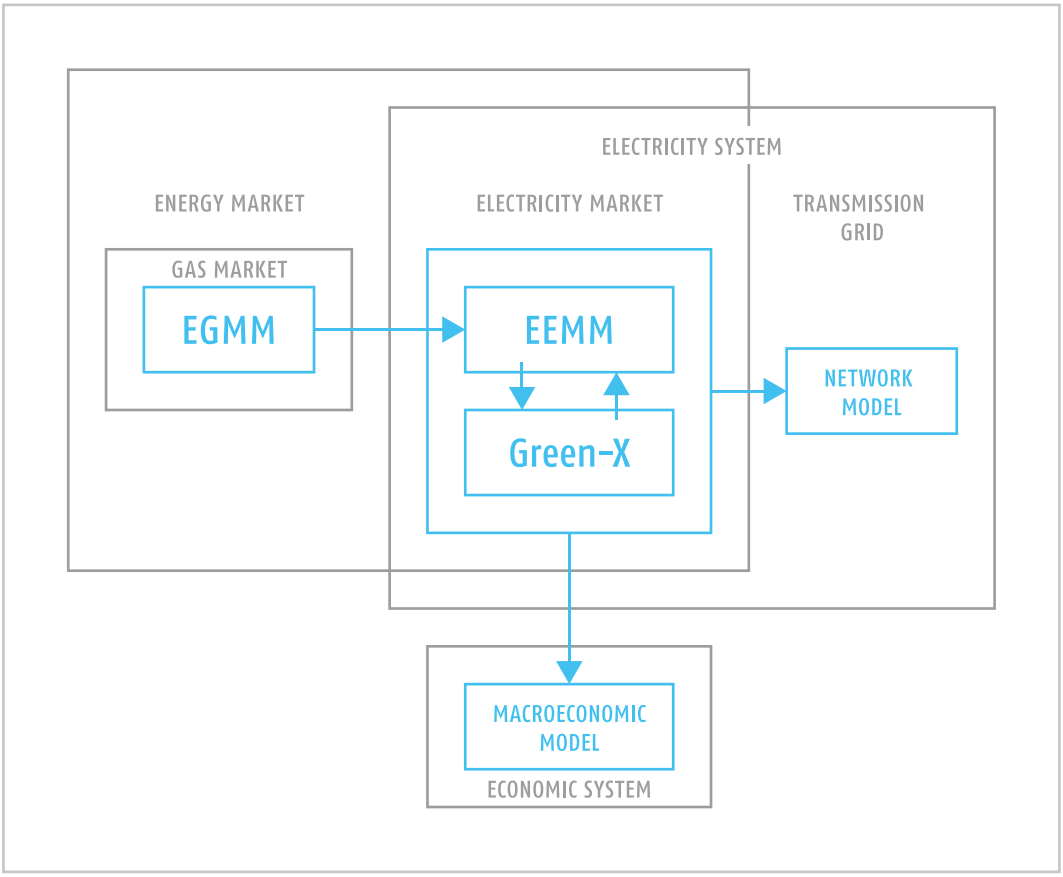
2.3 Scope of this report

This report summarises the contribution of the SEERMAP project to the ongoing policy debate on how to enhance the decarbonisation of the electricity sector in Bosnia and Herzegovina. We inform on the work undertaken, present key results gained and offer a summary of key findings and recommendations on the way forward. Please note that further information on the analysis conducted on other SEERMAP countries can be found in the individual SEERMAP country reports, and a Regional Report is also produced.

3 | Methodology

Electricity sector futures are explored using a set of five high resolution models incorporating the crucial factors which influence electricity policy and investment decisions. The European Electricity Market Model (EEMM) and the Green-X model together assess the

FIGURE 1
THE FIVE MODELS USED FOR THE ANALYSIS
A detailed description of the models is provided in a separate document ("Models used in SEERMAP")



impact of different scenario assumptions on power generation investment and dispatch decisions. The EEMM is a partial equilibrium microeconomic model. It assumes that the electricity market is fully liberalised and perfectly competitive. In the model, electricity generation as well as cross border capacities are allocated on a market basis without gaming or withholding capacity: the cheapest available generation will be used, and if imports are cheaper than producing electricity domestically demand will be satisfied with imports. Both production and trade are constrained by the available installed capacity and net transfer capacity (NTC) of cross border transmission networks respectively. Due to these capacity constraints, prices across borders are not always equalised. Investment in new generation capacity is either exogenous in the model (based on official policy documents), or endogenous. Endogenous investment is market-driven; power plant operators anticipate costs over the upcoming 10 years and make investment decisions based exclusively on profitability. If framework conditions (e.g. fuel prices, carbon price, available generation capacities) change beyond this timeframe then the utilisation of these capacities may change and profitability is not guaranteed.

The EEMM models 3400 power plant units in a total of 40 countries, including the EU, Western Balkans, and countries bordering the EU. Power flow is ensured by 104 interconnectors between the countries, where each country is treated as a single node. The fact that the model includes countries beyond the SEERMAP region incorporates the impact of EU market developments on the SEERMAP region.

The EEMM model has an hourly time step, modelling 90 representative hours with respect to load, covering all four seasons and all daily variations in electricity demand. The selection of these hours ensures that both peak and base load hours are represented,

and that the impact of volatility in the generation of intermittent RES technologies on wholesale price levels is captured by the model. The model is conservative with respect to technological developments and thus no significant technological breakthrough is assumed (e.g. battery storage, fusion, etc.).

The Green-X model complements the EEMM with a more detailed view of renewable electricity potential, policies and capacities. The model includes a detailed and harmonised methodology for calculating long-term renewable energy potential for each technology using GIS-based information, technology characteristics, as well as land use and power grid constraints. It considers the limits to scaling up renewables through a technology diffusion curve which accounts for non-market barriers to renewables but also assumes that the cost of these technologies decrease over time, in line with global deployment (learning curves). The model also considers the different cost of capital in each country and for each technology by using country and technology specific weighted average cost of capital (WACC) values.

An iteration of EEMM and Green-X model results ensures that wholesale electricity prices, profile based RES market values and capacities converge between the two models.

In addition to the two market models, three other models are used:

- the European Gas Market Model (EGMM) to provide gas prices for each country up to 2050 used as inputs for EEMM;
- the network model is used to assess whether and how the transmission grid needs to be developed due to generation capacity investments, including higher RES penetration;
- macroeconomic models for each country are used to assess the impact of the different scenarios on macroeconomic indicators such as GDP, employment, and the fiscal and external balances.

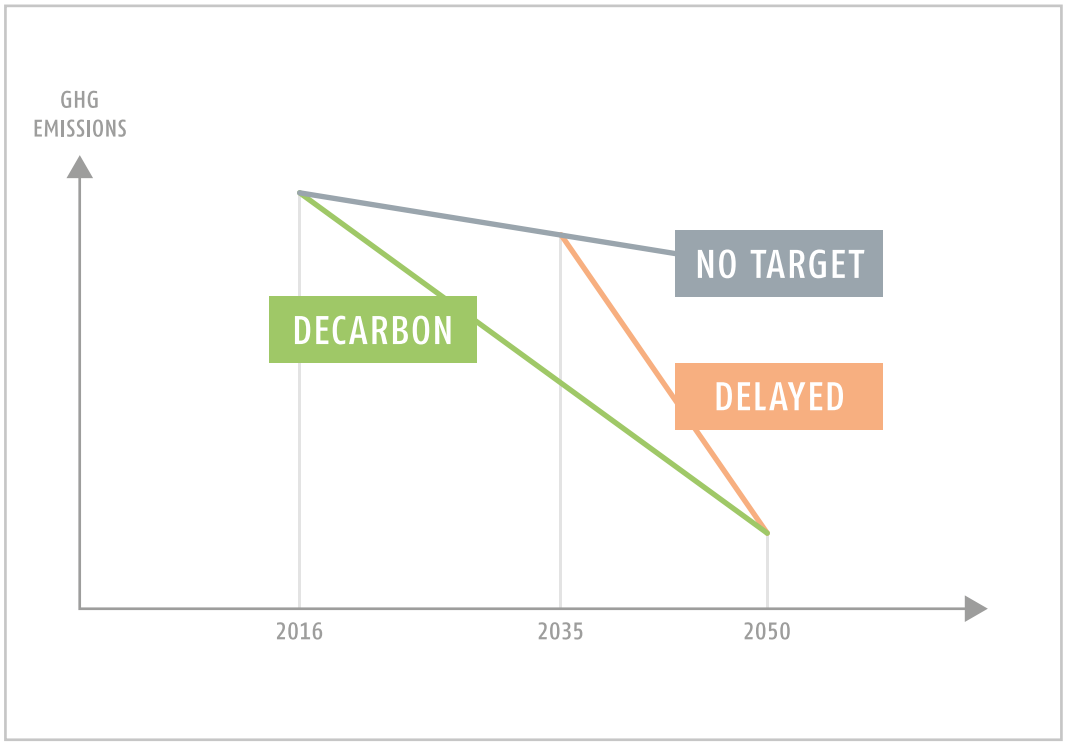
4 | Scenario descriptions and main assumptions

4.1 Scenarios

From a policy perspective, the main challenge in the SEE region in the coming years is to ensure sufficient replacement of aging power plants within increasingly liberalised markets, while at the same time ensuring affordability, security of supply and a significant reduction of greenhouse gas emissions. There are several potential long-term capacity development strategies which can ensure a functioning electricity system. The roadmap assesses 3 core scenarios:

- The 'no target' scenario reflects the implementation of current energy policy and no CO_2 target in the EU and Western Balkans for 2050;
- The 'decarbonisation' scenario reflects a continuous effort to reach significant reductions of CO_2 emissions, in line with long term indicative EU emission reduction goal of 93-99% emission reduction for the electricity sector as a whole by 2050;

FIGURE 2
THE CORE SCENARIOS



- The 'delayed' scenario involves an initial implementation of current investment plans 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.

The modelling work does not take into account the impacts of the new Large Combustion Plant BREF (Commission Implementing Decision of 2017/1442), as it entered into force in July 2017.

The same emission reduction target of 94% was set for the EU28+WB6 region in the 'delayed' and 'decarbonisation' scenarios. This implies that the emission reductions will be higher in some countries and lower in others, depending on where emissions can be reduced most cost-efficiently.

The scenarios differ with respect to the mix of new technologies, included in the model in one of two ways: (i) the new power plants entered exogenously into the model based on policy documents, and (ii) the different levels and timing of RES support resulting in different endogenous RES investment decisions. The assumptions of the three core scenarios are the following:

- In the 'no target' scenario all currently planned fossil fuel power plants are entered into the model exogenously. Information on planned power plants is taken from official national strategies/plans and information received from the local partners involved in the project. We have assumed the continuation of current renewable support policies up to 2020 and the gradual phasing out of support between 2021 and 2025. The scenario assumes countries meet their 2020 renewable target but do not set a CO_2 emission reduction target for 2050. Although a CO_2 target is not imposed, producers face CO_2 prices in this scenario, as well as in the others.
- In the 'decarbonisation' scenario, only those planned investments which had a final investment decision in 2016 were considered, resulting in lower exogenous fossil fuel capacity. With a 94% CO_2 reduction target, RES support in the model was calculated endogenously to enable

countries to reach their decarbonisation target by 2050 with the necessary renewable investment. RES targets are not fulfilled nationally in the model, but are set at a regional level, with separate targets for the SEERMAP region and for the rest of the EU.

- The 'delayed' scenario considers that currently planned power plants are built according to national plans, similarly to the 'no target' scenario. It assumes the continuation of current RES support policies up to 2020 with a slight increase until 2035. This RES support is higher than in the 'no target' scenario, but lower than the 'decarbonisation' scenario. Support is increased from 2035 to reach the same CO_2 emission reduction target as the 'decarbonisation' scenario by 2050.

Due to the divergent generation capacities, the scenarios result in different generation mixes and corresponding levels of CO_2 emissions, but also in different investment needs, wholesale price levels, patterns of trade, and macroeconomic impacts.

4.2 Main assumptions

All scenarios share common framework assumptions to ensure the comparability of scenarios with respect to the impact of the different investment strategies over the next few decades. The common assumptions across all scenarios are described below.

Demand:

- Projected electricity demand is based – to the extent possible – on data from official national strategies. Where official projections do not exist for the entire period until 2050, electricity demand growth rates were extrapolated based on the EU Reference scenario for 2013 or 2016 (for non-MS and MS respectively). The PRIMES EU Reference scenarios assume low levels of energy efficiency and low levels of electrification of transport and space heating compared with a decarbonisation scenario. The average annual electricity growth rate for the SEERMAP region as a whole is 0.74% over the period 2015 and 2050. The annual demand growth rate for countries within the region is varies significantly, with the value for Greece as low as 0.2%, and for Bosnia and Herzegovina as high as 1.7%. Whereas the growth rate in all EU3 countries is below 0.7%, Macedonia is the only country in the WB6 where the growth rate is below 1% a year. For Bosnia and Herzegovina, electricity demand projections were based on domestic strategies with a 2025 outlook. From 2025, in the absence of national projections, the PRIMES EU Reference scenario growth rates were applied, resulting in an average annual growth rate of electricity demand close to 1.7% between 2016 and 2050. The PRIMES EU Reference scenarios anticipates lower levels of energy efficiency and electrification in transport and space heating compared with a decarbonisation scenario.
- Demand side management (DSM) measures are projected to shift 3.5% of total daily demand from peak load to base load hours by 2050, a conservative estimate compared to other projections from McKinsey (2010) or TECHNOFI (2013). DSM is not used in the modelled period until 2035.

Factors affecting the cost of investment and generation:

- Fossil fuel prices: Gas prices are derived from the EGMM model. The price of oil and coal were taken from IEA (2016) and EIA (2017) respectively. The price of coal is expected to increase by 15% from 2016 to 2050. In the same period gas prices increase by around 65%

and oil prices by 250% relative to historically low 2016 prices. Compared to 2012-2013 prices, the increase is only 15-20%.

- Cost of different technologies: Information on the investment cost of new generation technologies is taken from EIA (2017).
- Weighted average cost of capital (WACC): The WACC has a significant impact on the cost of investment, with a higher WACC implying a lower net present value and therefore a more limited scope for profitable investment. The WACCs used in the modelling are country-specific, these values are modified by technology-specific and policy instrument-specific risk factors. The country-specific WACC values in the region are assumed to be between 10 and 15% in 2016, decreasing to between 9.6 and 11.2% by 2050. The value is highest for Greece in 2016, and remains one of the highest by 2050. In contrast, the WACC values for the other two EU member states, Romania and Bulgaria, are on the lower end of the spectrum, as are the values for Kosovo* and Macedonia. The country-specific WACC for Bosnia and Herzegovina is projected to be 12% in 2015, falling to 10.9% by 2050.
- Carbon price: a price for carbon is applied for the entire modelling period for EU member states and from 2030 onwards in non-member states, under the assumption that all candidate and potential candidate countries will implement the EU Emissions Trading Scheme or a corresponding scheme by 2030. 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. This Reference Scenario reflects the impacts of the full implementation of existing legally binding 2020 targets and EU legislation, but does not result in the ambitious emission reduction targeted by the EU as a whole by 2050. The corresponding carbon price, although significantly higher than the current price, is therefore a medium level estimate compared with other estimates of EU ETS carbon prices by 2050. For example, the Impact Assessment of the Energy Roadmap 2050 projected carbon prices as high as 310 EUR under various scenarios by 2050 (EC 2011b). The EU ETS carbon price is determined by the marginal abatement cost of the most expensive abatement option, which means that the last reduction units required by the EU climate targets will be costly, resulting in steeply increasing carbon price in the post 2030 period.

Infrastructure:

- Cross-border capacities: Data for 2015 was available from ENTSO-E with future NTC values based on the ENTSO-E TYNDP 2016 (ENTSO-E 2016) and the 100% RES scenario of the E-Highway projection (ENTSO-E 2015b).
- New gas infrastructure: In accordance with the ENTSO-G TYNDP 2017 both the Transadriatic (TAP) and Transanatolian (TANAP) gas pipelines (see Annex 2) are built between 2016 and 2021, and the expansion of the Revithoussa and the establishment of the Krk LNG terminals are taken into account. No further gas transmission infrastructure development was assumed in the period to 2050.

Renewable energy sources and technologies:

- Long-term technical RES potential is estimated based on several factors including the efficiency of conversion technologies and GIS-based data on wind speed and solar irradiation, and is reduced by land use and power system constraints. It is also assumed that

the long term potential can only be achieved gradually, with renewable capacity increase restricted over the short term. A sensitivity analysis measured the reduced potential of the most contentious RES capacities, wind and hydro. The results of the sensitivity analysis are discussed in section 5.5.

- Capacity factors of RES technologies were based on historical data over the last 5 to 8 years depending on the technology.

Annex 2 contains detailed information on the assumptions.

5 | Results

When presenting the results of modelling we focus on Bosnia and Herzegovina as a whole. However, modelling results for the electricity system (discussed in sections 5.1-5.4) are available separately for the two entities, Federation of Bosnia and Herzegovina and Republika Srpska. These are presented, along with country level results, in Annex 1.

5.1 Main electricity system trends

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 model results show a significant shift from fossil fuel based electricity generation to renewables in all three scenarios. Coal and lignite generation contribute only 1-6% of the generation mix by 2050 in all scenarios despite exogenous new coal generation capacity added in both the 'no target' and 'delayed' scenarios following current national investment plans, with a total capacity of 1700 MW. At the end of 2050 lignite capacity reaches 2000 MW in both the 'no target' and 'delayed' scenarios.

Projected natural gas prices are high in Bosnia and Herzegovina compared to other countries in the SEERMAP region, and consequently natural gas generation capacity does not appear over the modelled time horizon in any of the three core scenarios. Apart from lignite based generation, renewable capacities are the only other source added over the whole modelled time period.

Renewables play an increasingly important role in all three scenarios as investments flow into hydro and wind capacities in Bosnia and Herzegovina. Even though small scale photovoltaic installations compete against end-user electricity prices, investment is lower than in other renewables such as wind technology that compete on the wholesale market. Wind capacity reaches around 2-4 GW depending on the scenario, whereas hydro capacity increases to 3.3-4.5 GW. The share of biomass in the capacity mix increases but remains negligible in all three scenarios.

The electricity generated in Bosnia and Herzegovina only reflects its generation capacity to a limited extent. Lignite generation peaks in 2025 in both the 'no target' and 'delayed' scenarios, while it drops continuously from current levels in the 'decarbonisation' scenario. The role of coal and lignite in electricity generation falls with increasing carbon prices and decreasing renewable technology costs. The share of lignite based electricity generation drops gradually starting from 2030, when the EU ETS carbon price is assumed to apply to Bosnia and Herzegovina, with an especially steep drop over the

FIGURE 3
INSTALLED CAPACITY IN THE 3 CORE SCENARIOS UNTIL 2050 (GW) IN BOSNIA AND HERZEGOVINA, 2020-2050

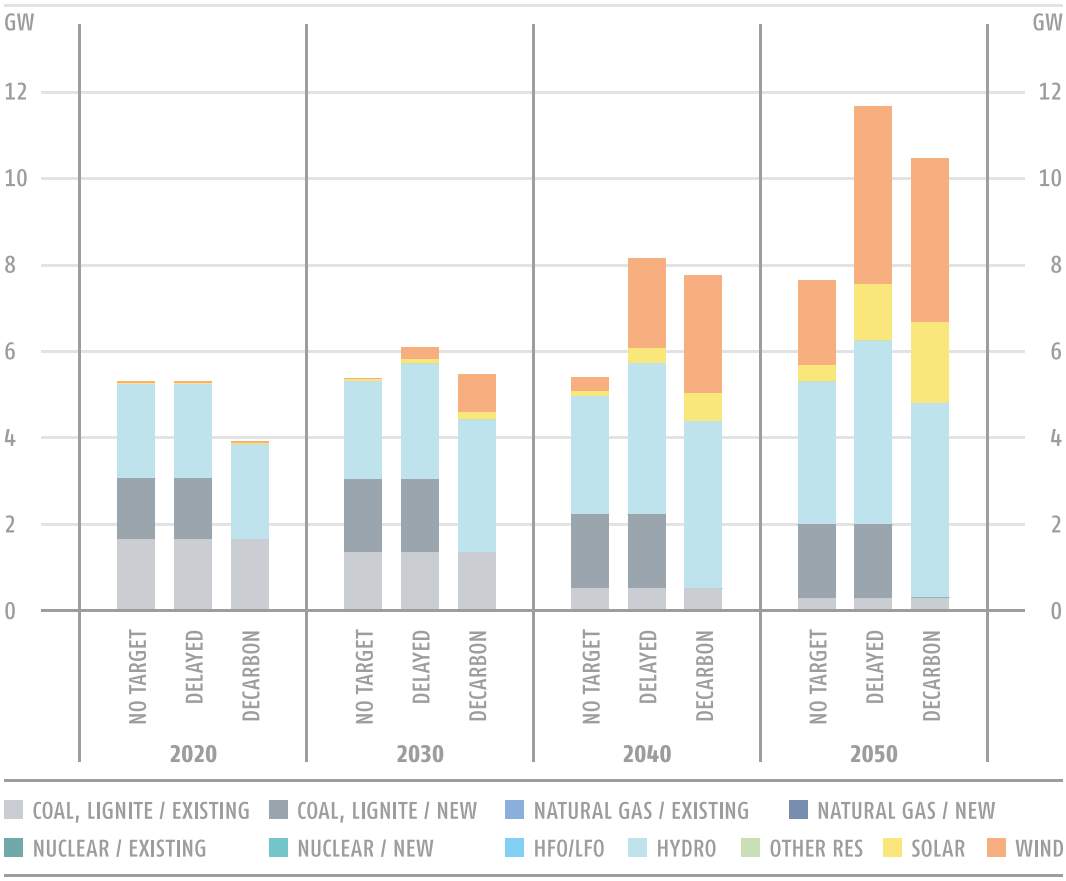


FIGURE 4
ELECTRICITY GENERATION AND DEMAND (TWH) AND RES SHARE (% OF DEMAND) IN BOSNIA AND HERZEGOVINA, 2020-2050

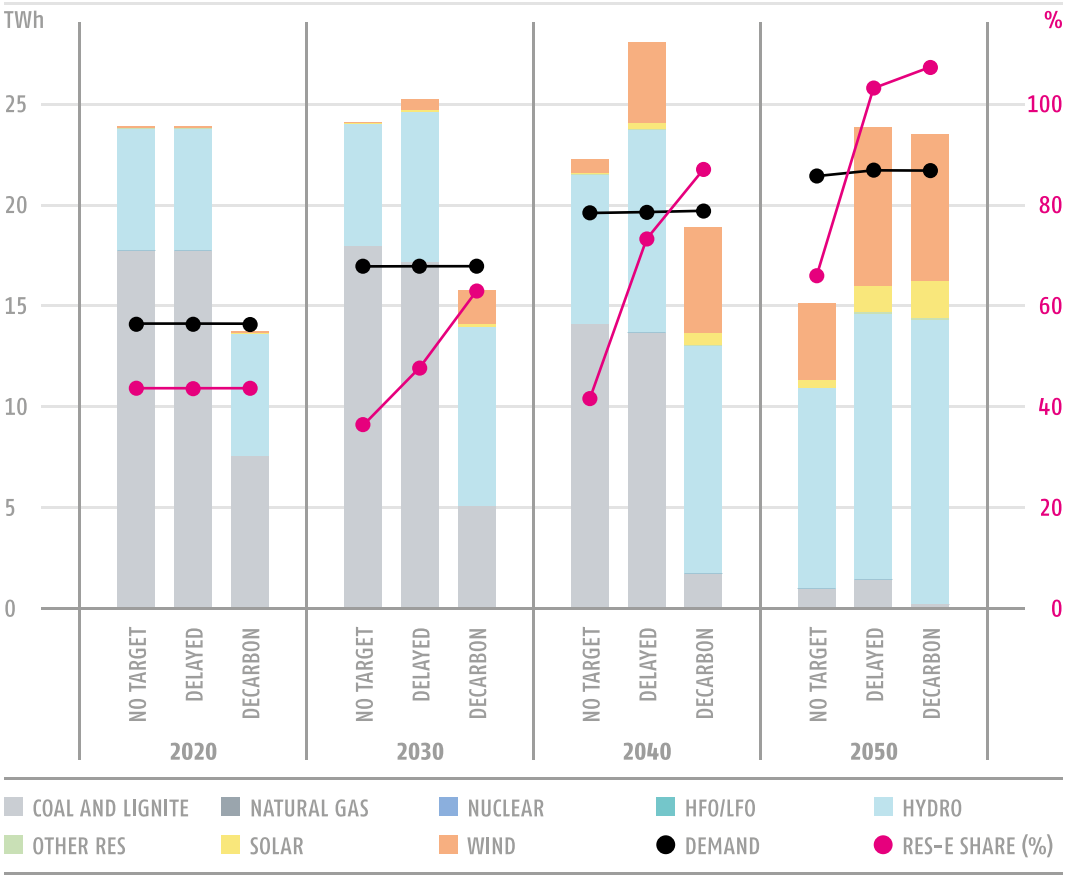
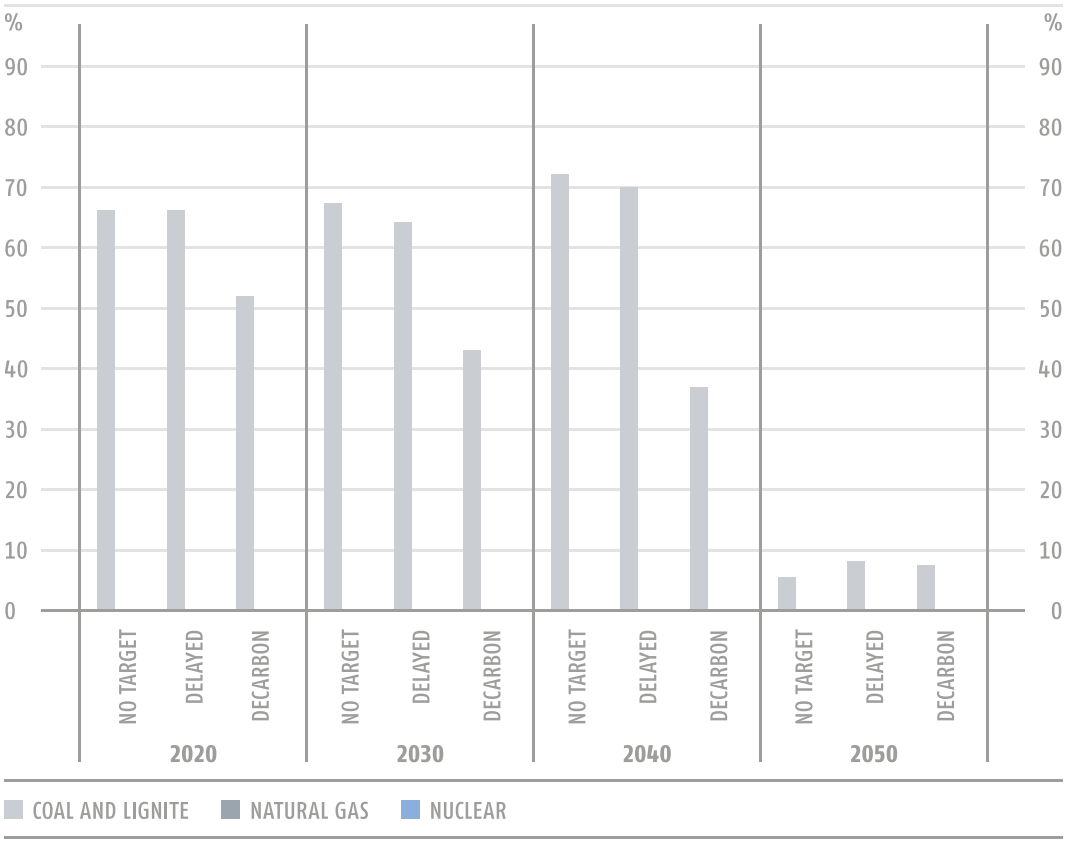


FIGURE 5
UTILISATION RATES OF CONVENTIONAL GENERATION IN BOSNIA AND HERZEGOVINA, 2020-2050 (%)



last 5-10 years of the modelled time period when the carbon price becomes so high that utilisation of lignite becomes uneconomical.

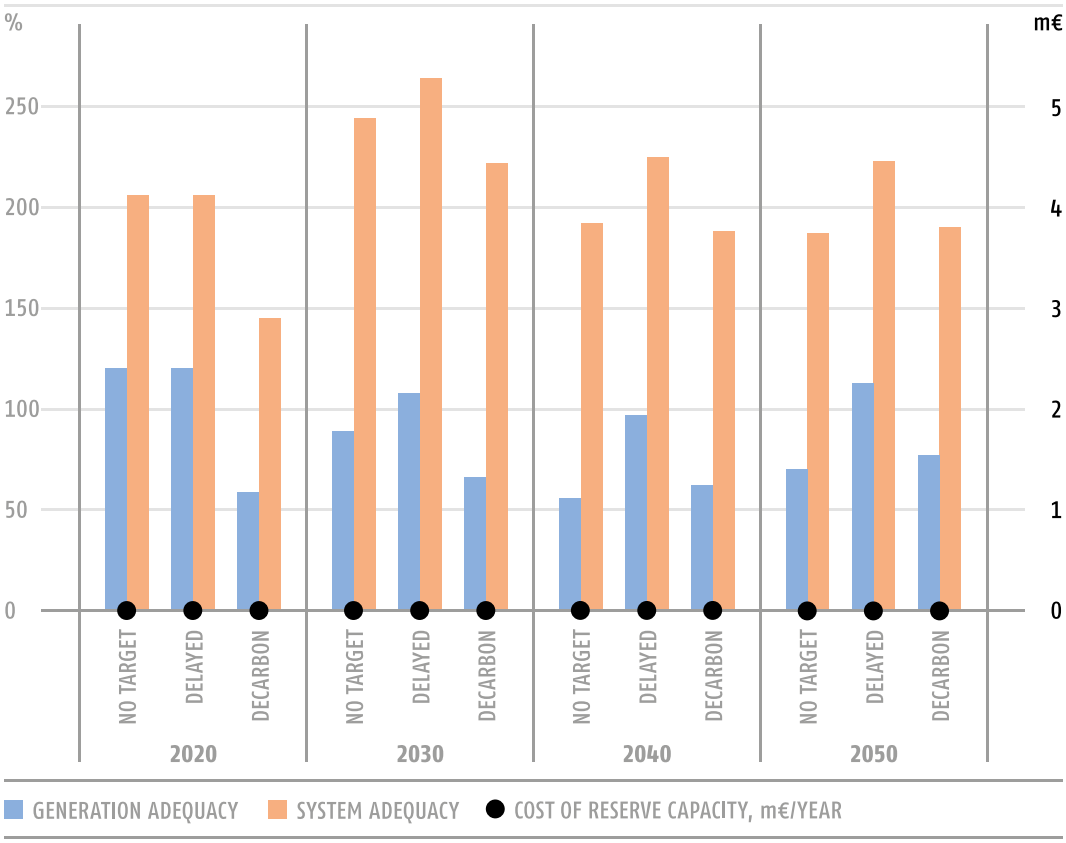
In the 'no target' scenario, Bosnia and Herzegovina remains a net electricity exporter, increasing net exports significantly from current levels over the next fifteen years. By the end of the modelled time horizon, however, as lignite based electricity generation declines significantly, the country becomes a net importer. In the 'delayed' scenario Bosnia and Herzegovina remains a net exporter throughout the modelled time horizon, but net exports drop significantly by 2050. In the 'decarbonisation' scenario, the country is close to being self-sufficient over the entire modelled time horizon, with net imports ranging from +/-10% over time.

The utilisation rate of lignite plants remains above 40% until 2030-2045 and increases up to around 70% in both the 'no target' and 'delayed' scenarios by 2040. However, utilisation rates become uneconomical by 2050, 2045 and 2030, in the 'no target', 'delayed' and 'decarbonisation' scenarios respectively, highlighting the risk for stranded assets. This issue is discussed further in section 5.4.

5.2 Security of supply

Even though the physical and commercial integration of national electricity markets improves security of supply, concerns of decision makers often remain regarding the extent and robustness of this improvement, particularly in the context of a high share of renewables. In order to assess the validity of such concerns three security of supply indices were calculated for all countries and scenarios: the generation capacity margin, the system adequacy margin, and the cost of increasing the generation adequacy margin to zero.

FIGURE 6
GENERATION AND SYSTEM ADEQUACY MARGIN FOR BOSNIA AND HERZEGOVINA, 2020-2050 (% OF LOAD)



The generation adequacy margin is defined as the difference between available capacity and hourly load as a percentage of hourly load. If the resulting value is negative then the load cannot be satisfied with domestic generation capacities alone in a given hour, and imports are needed. The value of the generation adequacy margin was calculated for all of the modelled 90 representative hours, and of the 90 calculated values, the lowest generation adequacy margin value was taken into account in the generation adequacy margin indicator. For this calculation, assumptions were made with respect to the maximum availability of different technologies: fossil fuel based power plants are assumed to be available 95% of the time, hydro storage 100% and for other RES technologies historical availability data was used. System adequacy was defined in a similar way, but net transfer capacity available for imports was 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, 2015, and previous SOAF reports)

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.

For negative generation adequacy indicators the cost of reaching a zero generation adequacy margin was calculated, defined as the yearly fixed cost of an open cycle gas turbine (OCGT) with capacity to ensure that the generation adequacy margin reaches zero. This can be interpreted as a capacity fee, provided that capacity payments are only made to new generation, and that the goal of the payment is to improve generation adequacy margin to zero. As the generation adequacy margin for Bosnia and Herzegovina is positive to begin with for all years across all scenarios, this cost for the country is zero.

5.3 Sustainability

The CO_2 emissions of the three core scenarios were calculated based on representative emission factors for the region. Due to data limitations this calculation did not account for greenhouse gases other than CO_2 and does not include emissions related to heat production from cogeneration.

The 94% decarbonisation target for the EU28+WB6 region translates into a higher than average level of decarbonisation in the electricity sector for Bosnia and Herzegovina. By 2050 CO_2 emissions from the electricity sector in Bosnia and Herzegovina compared to 1990 levels are reduced by more than 98% in the 'decarbonisation' scenario, largely due to a relative advantage for renewable electricity production, particularly for hydro. Emissions are also reduced by close to 92% by 2050 in the 'no target' scenario driven by the high price of carbon.

The share of renewable generation as a percentage of gross domestic consumption in 2050 is 66% in the 'no target' scenario, 103% in the 'delayed' scenario and 107% in the 'decarbonisation' scenario. The most significant contribution to RES generation is made by hydro; it contributes around 60% of total RES generation by 2050, with wind adding around 30% in the 'decarbonisation' scenario. The remainder is mostly solar, with a marginal contribution from biomass. In the scenario with the highest RES share in 2050 (the 'decarbonisation' scenario) long term RES potential utilisation reaches 58%, 90% and 44% for hydro, wind and solar respectively.

5.4 Affordability and competitiveness

In the market model (EEMM) the wholesale electricity price is determined by the highest marginal cost of the power plants needed to satisfy demand. The price trajectories are independent of the level of decarbonisation and similar in all scenarios, only diverging after 2045 when the two scenarios with decarbonisation targets result in lower wholesale prices. This is due to the fact that towards 2050 the share of renewables is high enough to satisfy demand in most hours at a low cost, driving the average annual price down.

The price development has several implications for policy makers. Retail prices depend on the wholesale price as well as taxes, fees and network costs. It is therefore difficult to project retail price evolution based on wholesale price information alone, but it is an important determinant of end user prices and could affect affordability for consumers. The average increase in annual wholesale price over the entire period is 2.9% in the 'no target' scenario, 2.2% in the 'delayed', and 2.3% in the 'decarbonisation' scenario. The lower average growth rate in the latter two scenarios is attributable to a decrease in the wholesale price during the last 5 years of the modelled time period. Although the price increase is significant, in the 2016 baseline wholesale electricity prices in Europe are at historic lows; the analysis projects wholesale prices of 60 EUR/MWh by 2030, the same price level from 10 years ago. Assessing macroeconomic outcomes in section 5.7, if affordability is measured as household electricity expenditure as a share disposable income, the increase is perceived as smaller, although it is still significant, with expenditure as a share of income increasing by approximately 60% in the 'decarbonisation' scenario, and by around 80% in the 'no target' scenario. The increase is highest in the 'delayed scenario, with an almost 120% increase. On the other hand, the price increase incentivises investment for new capacities and reduces the need for RES support.

FIGURE 7
CO_2 EMISSIONS UNDER THE 3 CORE SCENARIOS IN BOSNIA AND HERZEGOVINA, 2020-2050 (mt)

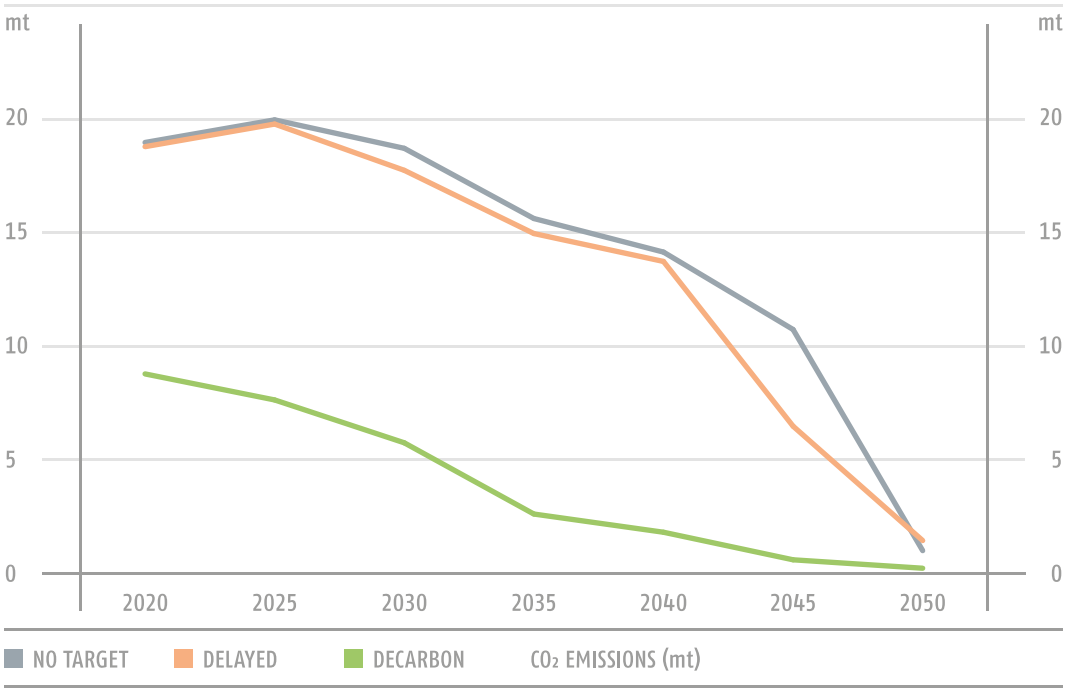


FIGURE 8
WHOLESALE ELECTRICITY PRICE IN BOSNIA AND HERZEGOVINA, 2020-2050 (€/MWh)

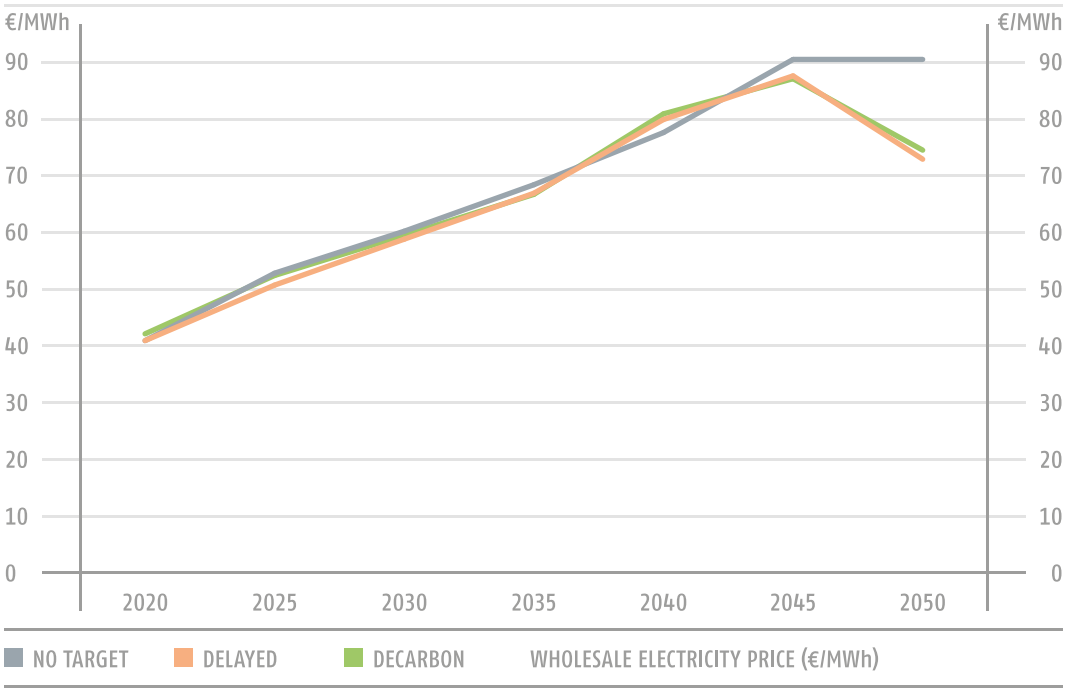
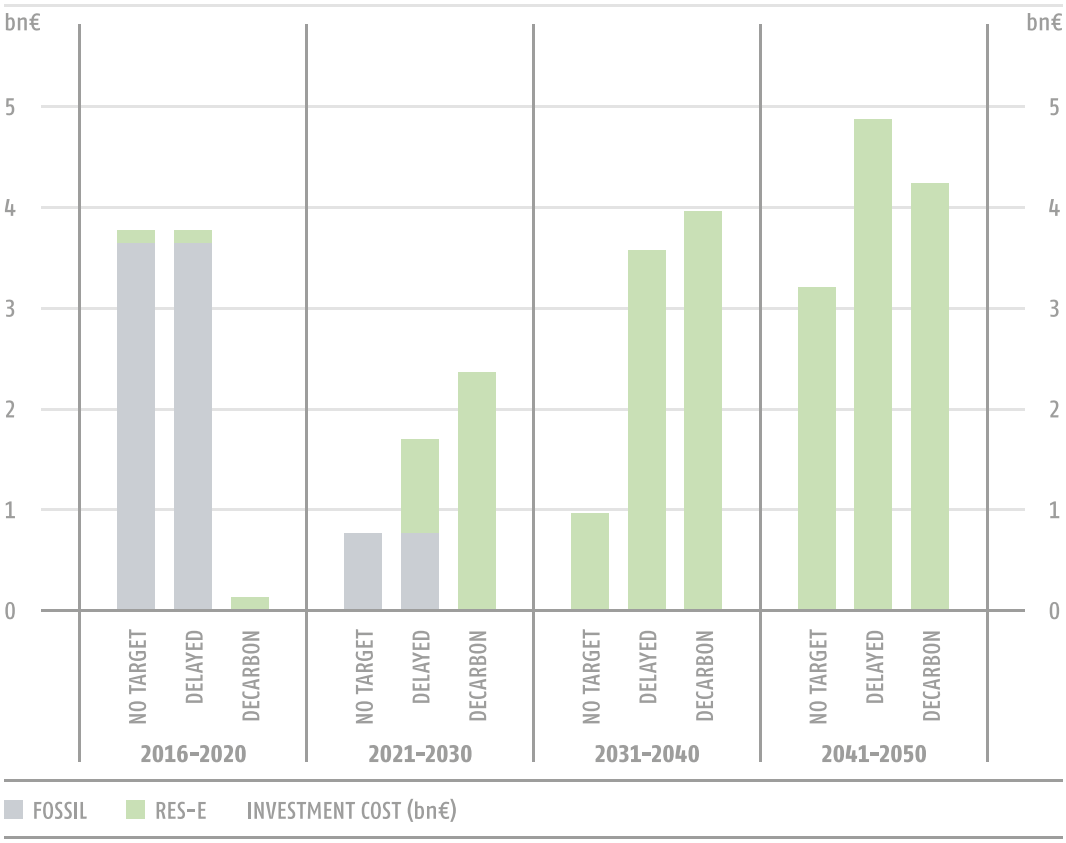


FIGURE 9
CUMULATIVE INVESTMENT COST FOR 4 AND 10 YEAR PERIODS, 2016-2050 (bn€)



The investment for new capacities follows different trends across scenarios. In the 'no target' and 'delayed' scenarios initial investment flows to new lignite capacities which decline until 2030 when investments in RES capacities pick up. In contrast, investment in new capacity stabilises from 2035 onwards in the decarbonisation scenario until 2050. In absolute terms, the investment needs are highest in the 'delayed' scenario. Overall, only 20% more investment is required in the 'decarbonisation' scenario than the 'no target' scenario.

Investment is assumed to be financed by the private sector and based on a profitability requirement (apart from the capacities planned in the national strategies), which follow the cost structure of renewables – higher capital expenditure is compensated by low operating expenditure. From a social welfare point of view, the consequences of the overall investment level are limited to the impact on GDP and a small impact on employment. These impacts are discussed in more detail in section 5.7.

Despite the significant investment requirements associated with the 'decarbonisation' scenario, the renewables support needed to incentivise these investments remains low, staying within the range of 0.1-2.1 EUR/MWh throughout the modelled time horizon. This is because of relatively high hydro potential and the rising wholesale price for electricity which reduces the need for residual support.

Although some RES technologies have reached grid parity in some areas, support will still be needed in 2050 to stimulate new investment. Since the best locations with highest potential are used first, the levelised cost of electricity for new capacities increases. The relationship between the cost of RES technologies and installed capacity is shown in figure 10, but does not account for the learning curve adjustments which were embedded in the Green-X model.

FIGURE 10
LONG TERM COST OF RENEWABLE TECHNOLOGIES IN BOSNIA AND HERZEGOVINA (€/MWh)

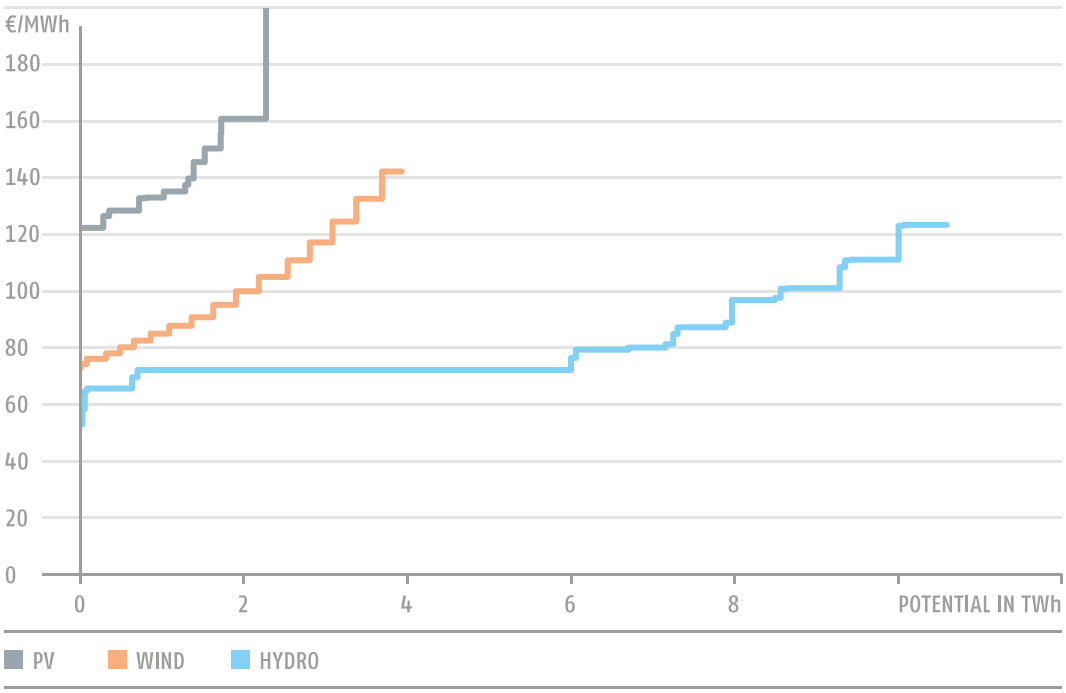


FIGURE 11
AVERAGE RES SUPPORT PER MWh OF TOTAL ELECTRICITY CONSUMPTION AND AVERAGE WHOLESALE PRICE, 2016-2050 (€/MWh)

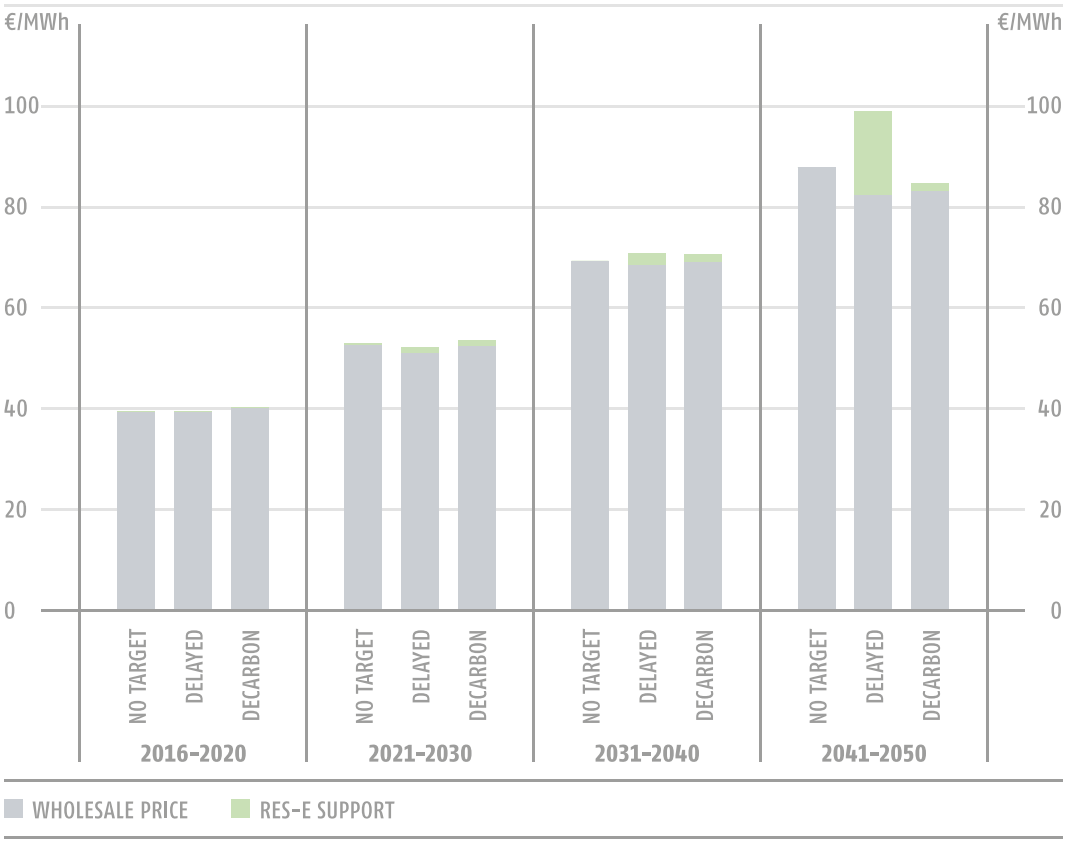
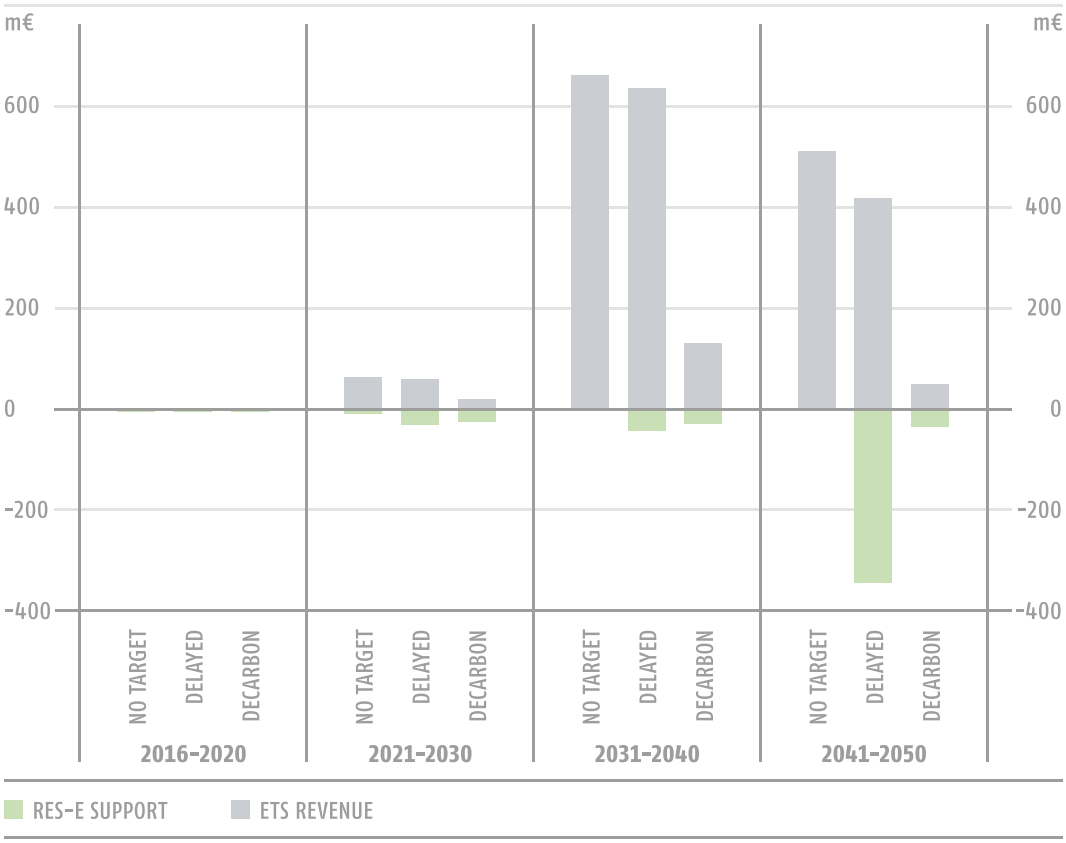


FIGURE 12
CUMULATIVE RES SUPPORT AND AUCTION REVENUES FOR 4 AND 10 YEAR PERIODS, 2016-2050 (m€)



Due to the very significant investment effort needed in renewables in the 'delayed' scenario in the last decade, required support levels rise as high as 16.6 EUR/MWh in this scenario at the end of the modelled time horizon.

Renewable energy investments may be incentivised with a number of support schemes using funding from different sources; in the model sliding feed-in premium equivalent values are calculated. Revenue from the auction of carbon allowances under the EU ETS is a potential source of financing for renewable investment. Figure 12 contrasts cumulative RES support needs with ETS auction revenues, assuming 100% auctioning, and taking into account only allowances to be allocated to the electricity sector.

According to the modelling results, ETS revenues can cover the necessary support for the entire time horizon between 2030 and 2050 provided that a planned effort to invest in renewable capacities is implemented and no disproportionate investment is required to meet 2050 targets towards the end of the period.

A financial calculation was carried out to determine the stranded costs of fossil generation for plants that are built in the period 2017-2050. New fossil generation capacities included in the scenarios are defined either exogenously by national energy strategy documents or are built by the investment algorithm of the EEMM endogenously. The investment module projects 10 years ahead, meaning that investors have limited knowledge of the policies applied in the distant future. By 2050, the utilisation rate of lignite generation assets drops to around 5-8% in all scenarios. This means that coal and lignite capacities which generally need to have a 55 year lifetime with a sufficiently high utilisation rate in order to ensure a positive return on investment will face stranded costs.

Large stranded capacities will likely require public intervention, whereby costs are borne by society/electricity consumers. Therefore, the calculation assumes that stranded cost will be collected as a surcharge on the consumed electricity (as is the case for RES surcharges) over a period of 10 years after these gas and coal capacities finish their operation. Based on these calculations early retired fossil plants would have to receive 7.3 EUR/MWh, 7.6 EUR/MWh and 0 EUR/MWh surcharge over a 10 year period to cover their economic losses in the 'no target', 'delayed' and 'decarbonisation' scenarios respectively. These costs are not included in the wholesale price values shown in this report. These costs are significantly higher than required RES support, which in the 'decarbonisation' scenario is in the range of 0.1-2.1 EUR/MWh between 2020-2050.

5.5 Sensitivity analysis

In order to assess the robustness of the results, a sensitivity analysis was carried out with respect to assumptions that were deemed most controversial by stakeholders during consultations and tested for the following assumptions:

- Carbon price: to test the impact of a lower CO_2 price, a scenario was run which assumed that CO_2 prices would be half of the value used for the three core scenarios for the entire period until 2050;
- Demand: the impact of higher and lower demand growth was tested, with a +/-0.25% change in the growth rate for each year in all the modelled countries (EU28+WB6), resulting in a 8-9% deviation from the core trajectory by 2050;
- RES potential: the potential for large-scale hydropower and onshore wind power were assumed to be 25% lower than in the core scenarios; this is where the NIMBY effect is strongest and where capacity increase is least socially acceptable.

The changes in assumptions were only applied to the 'decarbonisation' scenario since it represents a significant departure from the current policy for many countries, and it was important to test the robustness of results in order to convincingly demonstrate that the scenario could realistically be implemented under different framework conditions.

The most important conclusions of the sensitivity analysis are the following:

- The CO_2 price is a key determinant of wholesale prices. A 50% reduction in the carbon price results in a 33% reduction in the wholesale price over the long term. However, this is more than offset by the need for higher RES support.
- A lower carbon price would increase the utilisation rates of coal power plants by 7% in 2030 and by 20% in 2050. However, this is not enough to make coal competitive by 2050 as significantly higher utilisation rates are required to avoid plant closure. Coal is still only responsible for 3% of total electricity generation by 2050 in this sensitivity run.
- Change in demand has a limited impact on fossil fuel and hydro generation while RES generation, notably PV and wind, are more sensitive to changes. Low demand helps Bosnia and Herzegovina decarbonise its electricity sector without RES support over the last 10 years of the modelled time horizon.
- Lower hydro and wind potential results in increased PV capacity and generation as well as a change in the status of Bosnia and Herzegovina from a net exporter to net importer.

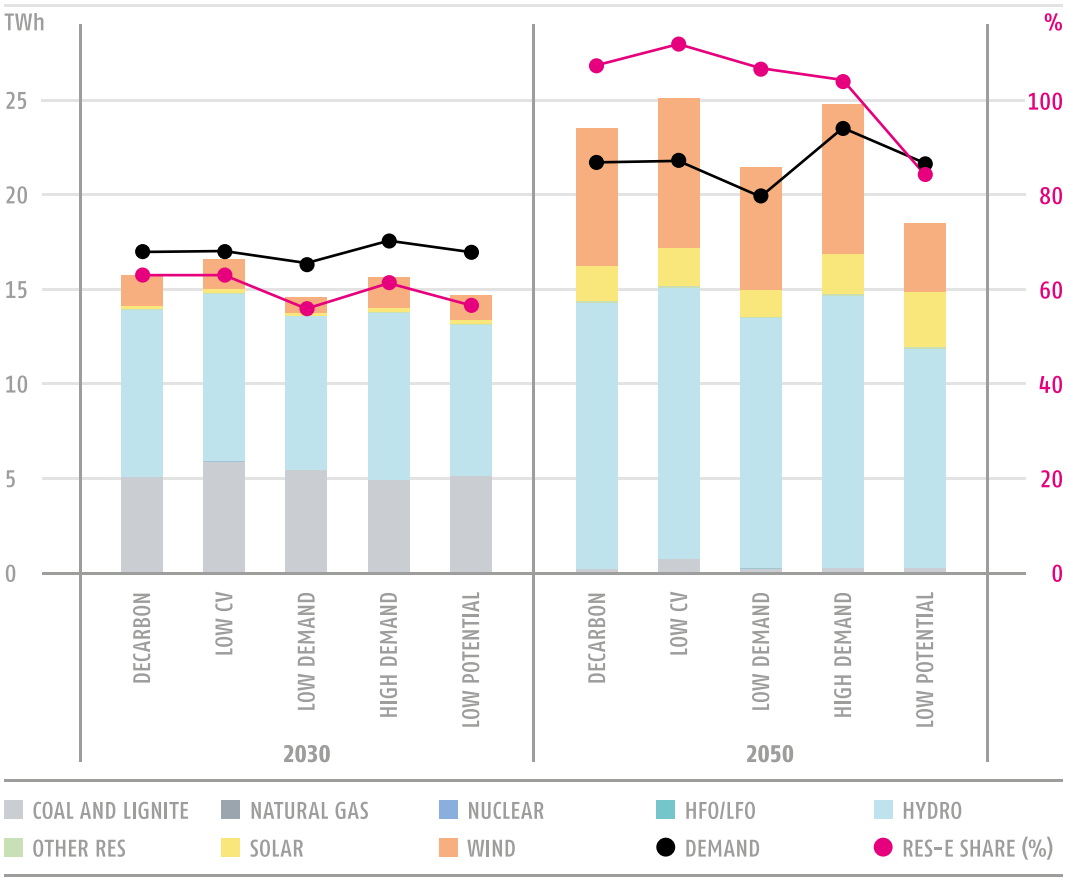


FIGURE 13 GENERATION MIX (TWh) AND RES SHARE (% OF DEMAND) IN THE SENSITIVITY RUNS IN 2030 AND 2050

In addition, there is an enormous increase in required RES support, resulting from the need to shift from inexpensive hydro and wind to higher cost PV, with the sum of RES support and the wholesale price doubling by 2050 compared with the 'decarbonisation' scenario.

5.6 Network

The transmission system in Bosnia and Herzegovina is well connected with neighbouring countries, including Serbia and Montenegro. Future network investments will have to accommodate higher RES integration, cross-border electricity trade and significant growth in peak load. New transmission lines and reinforcements are expected with Serbia, Montenegro and Croatia, according to the ENTSO-E TYNDP. The recorded peak load for Bosnia and Herzegovina in 2016 was 2142 MW (ENTSO-E DataBase), while it is projected to be 2700 MW in 2030 (SECI DataBase) and 3456 MW in 2050. Consequently, high and medium voltage domestic transmission and distribution lines will be needed to deliver the required electricity to end consumers.

For the comparative assessment, a 'base case' network scenario was constructed according to the SECI baseline topology and trade flow assumptions, and the network effect of the higher RES deployment futures ('delayed' and 'decarbonisation' scenarios) were compared to this 'base case' scenario. In this sceanario as well as the modelled core scenarios the transmission network improvements of ENTSO-E TYNDP (2016) are included.

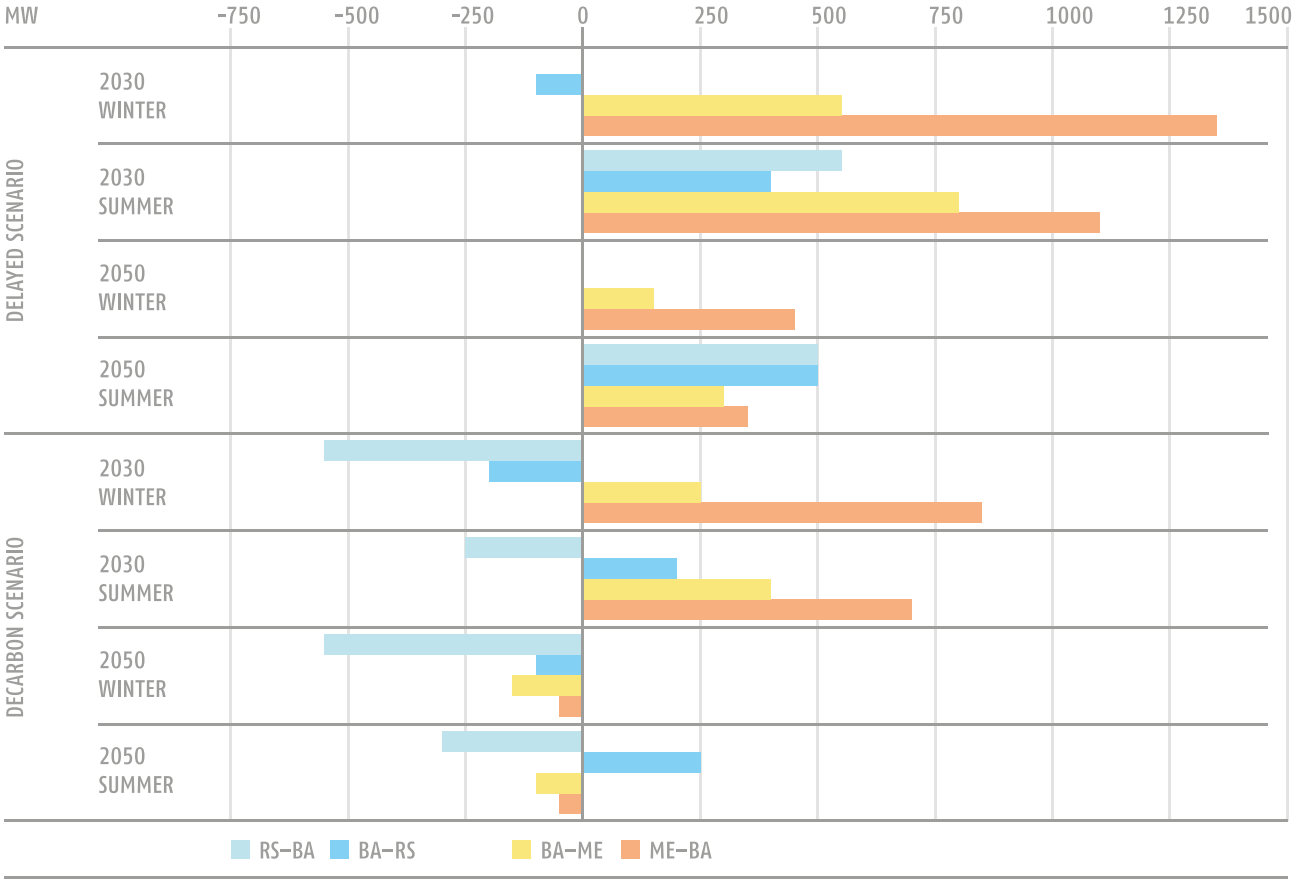


FIGURE 14
NTC VALUE CHANGES IN 2030 AND 2050 IN THE 'DELAYED' AND 'DECARBONISATION' SCENARIOS COMPARED TO THE 'BASE CASE' SCENARIO

The network analysis covered the following ENTSO-E impact categories:

- **Contingency analysis:** Conitngencies are not identified in the analysis of the network constraints for Bosnia and Herzegovina if the planned transmission network developments included in the ENTSO-E TYNDP are realised.

- **TTC and NTC assessment:** Total and Net Transfer Capacity (TTC/NTC) changes against the 'base case' were evaluated between Bosnia and Herzegovina and bordering countries. The production pattern (including the production level and its geographic distribution), and load pattern (load level and its geographical distribution, the latter of which is not known) have a significant influence on these NTC values. Figure 14 depicts the changes in NTC values for 2030 and 2050, revealing two opposing effects of higher RES deployment. First, the high concentration of RES in a geographic area may cause congestion in the transmission network, reducing NTCs and requiring further investment. Second, if RES generation replaces imported electricity it may increase NTC for a given direction.

As the results show, NTC values increase in the 'delayed' scenario between 2030 and 2050, more in the the ME-BA direction. In the 'decarbonisation' scenario, the linear growth of RES capacities does not have a clearly identifiable impact on NTC values. While the ME-BA direction is still positive in 2030 and close to zero in 2050, NTC values fall in the RS-BA direction. Both 'congestion' and import substitution effects are present but their total impact is time and scenario dependent.

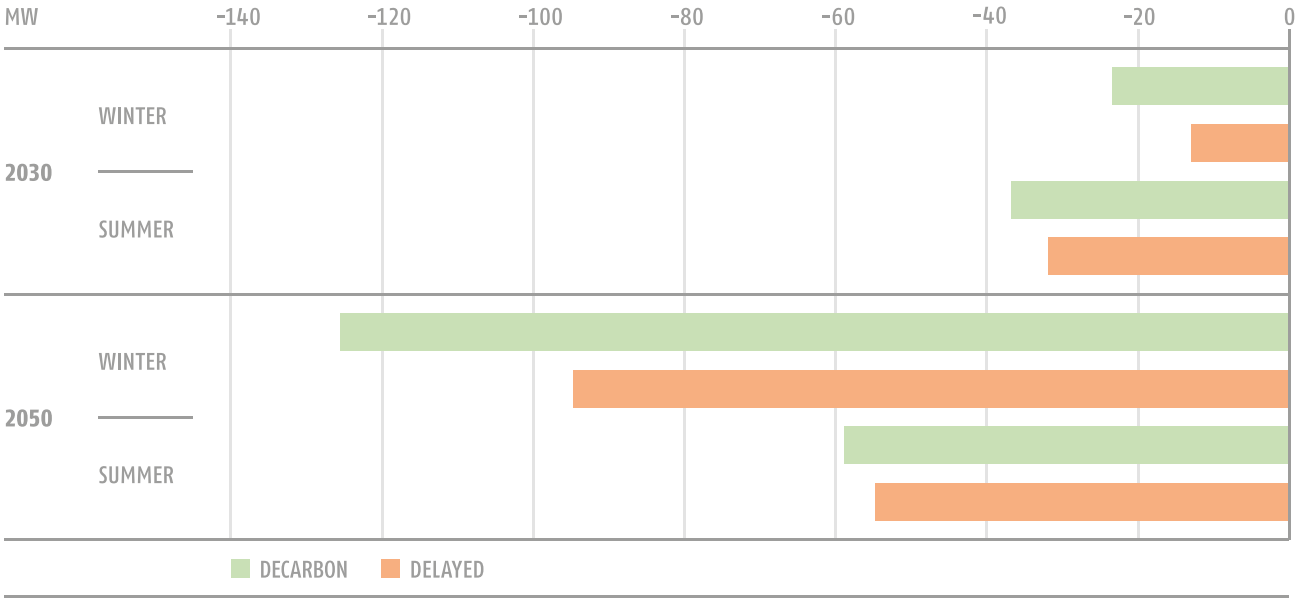


FIGURE 15 LOSS VARIATION COMPARED TO THE BASE CASE IN THE 'DELAYED' AND 'DECARBONISATION' SCENARIOS (MW, NEGATIVE VALUES INDICATE LOSS REDUCTION)

- **Network losses:** 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, reducing the distance between generation and consumption. On the other hand, high levels of electricity trade, in particular in 2050, will increase transmission network losses. Figure 15 shows that in the 'decarbonisation' scenario transmission losses decrease significantly compared to the base case. In the 'delayed' scenario, the decrease is only evident in 2050.

As figure 15 illustrates, the higher RES deployment in the two scenarios with a decarbonisation target reduces transmission losses significantly: 20-40 MW in 2030 and 60-120 MW in 2050. In the 'delayed' scenario this represents a 100 GWh loss variation in 2030 and over 352 GWh in 2050, and a 140 GWh loss variation in 2030 and over 435 GWh in 2050 in the 'decarbonisation' scenario. If monetised at the base-load price, the concurrent benefit for TSOs is in the range of 6-8 mEUR per year in 2030 and 26-30 mEUR in 2050.

The network assessment suggests that if all ENTSO-E TYNDP transmission infrastructure development is realised in the forthcoming 10 to 15 years, no additional investment in the transmission network is necessary to accommodate new RES capacities (as assumed in the scenarios) in the electricity system of Bosnia and Herzegovina in order to avoid contingencies and other network problems. It has to be emphasized, however, that the assessment does not cover the distribution network, where the connection and integration of distributed RES generation will require significant additional developments.

5.7 Macroeconomic impacts

A 'baseline' scenario differing from the three core scenarios was constructed for the macroeconomic analysis to serve as a basis for comparison whereby only power plants with a final investment decision by 2016 are built, investment rates in the sector remain unchanged for the remaining period, no 'decarbonisation' targets are set and no additional renewable support is included beyond existing policies. The 'baseline' scenario assumes lower levels of investment than the three core scenarios.

FIGURE 16
GDP AND EMPLOYMENT IMPACTS COMPARED WITH THE 'BASELINE' SCENARIO

According to the baseline scenario, the economy of Bosnia and Herzegovina will grow by 2.7% per annum on average between 2017 and 2050, thus ensuring substantial convergence toward the EU. Growth rates are expected to be above 3% in the first 10 years partly on account of public investment projects, but later on the increase in GDP could slow down to around 2.5% as the country approaches the EU average in terms of GDP per capita. Employment growth is expected to remain near zero until 2050, reflecting the poor job creation abilities of the economy. Both fiscal and external debt will moderately decrease and stabilize around 35% and 50% of GDP, respectively. This latter could be a source of vulnerability for the economic development of Bosnia and Herzegovina.

Currently, households spend 4.5% of their disposable income on electricity, which is higher than the EU average (2.9%). In the 'baseline' scenario, the share of electricity expenditure increases to around 8% by 2050.

The core scenarios exhibit significant investment requirements compared to the 'baseline' scenario, reaching almost 5% of GDP in some five-year periods. In the 'no target' scenario, most of the investment is concentrated before 2020, while in the 'decarbonisation' scenario this starts after 2020 and remains relatively persistent. In the 'delayed' scenario there are two investment peaks in the periods between 2016-2020 and 2036-2040.

The macroeconomic results were evaluated along three dimensions: macroeconomic gain, macroeconomic vulnerability and affordability. Macroeconomic gain explains the extent to which the scenarios contribute to greater overall economic activity, measured by GDP and employment across two time dimensions. First, the average difference over the whole time horizon (2016-2050) is compared with the baseline. Then the long term effect is determined by the deviation from the baseline in the period 2046-2050. It is important to note that because the population remains the same across scenarios GDP gains also reflect GDP per capita effects.

The results suggest significant macroeconomic gains from the core scenarios. In the 'delayed' scenario the GDP level is more than 8% higher on average compared to the 'baseline' scenario, leading to 13% higher real income per capita by the end of the modelled period. Gains are less high but still significant in the 'no target' scenario, adding

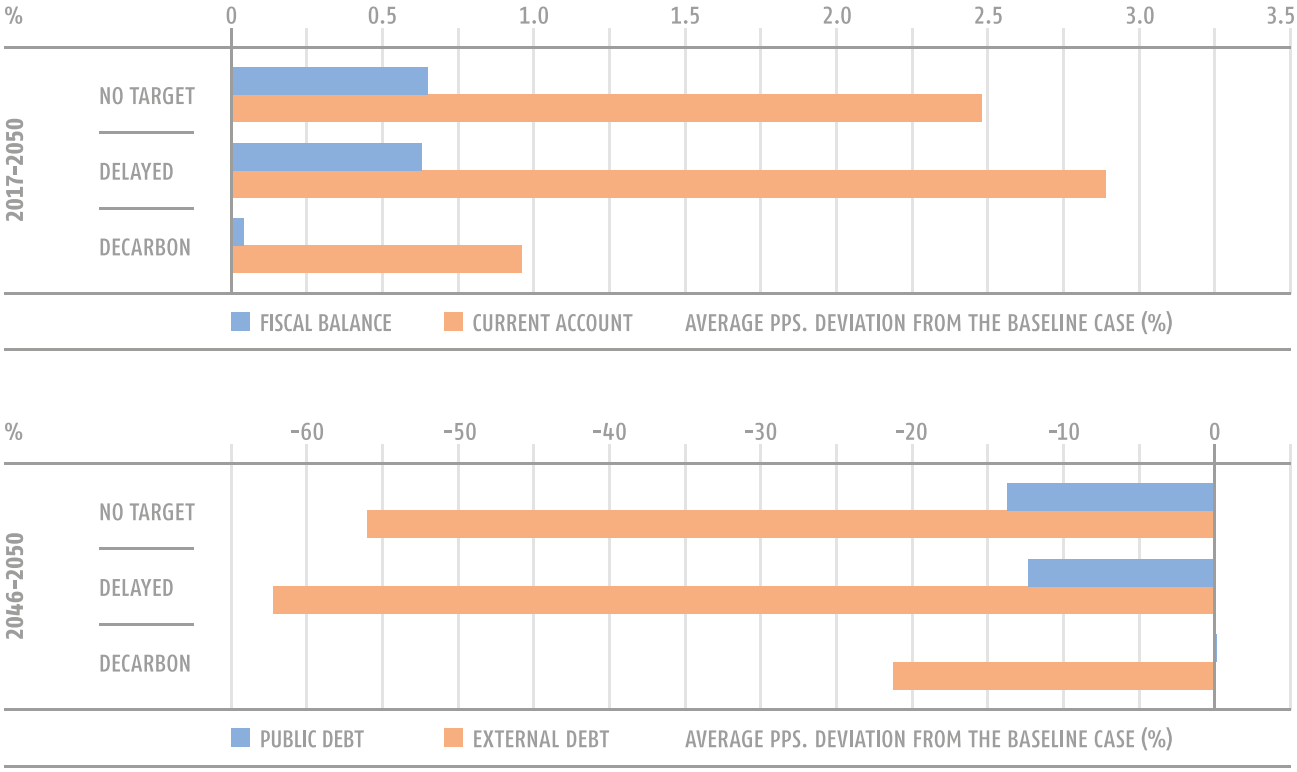


FIGURE 17
PUBLIC AND EXTERNAL BALANCES AND DEBT IMPACTS COMPARED WITH THE 'BASELINE' SCENARIO

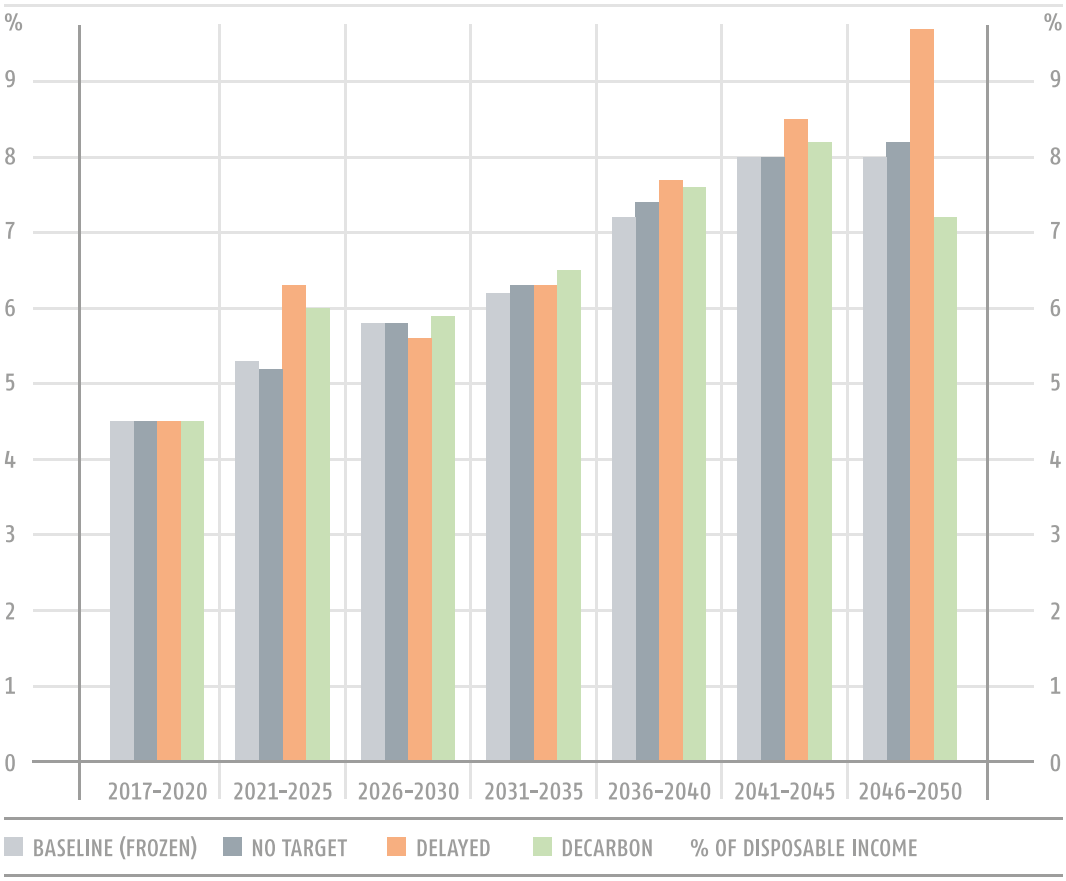
around 6% on average if compared to the baseline, resulting in a long term GDP effect of around 8%. The 'decarbonisation' scenario exhibits somewhat more moderate gains, with a deviation of 4% in GDP on average over the projection horizon and around 6% in the long term. These differences reflect different investment efforts in the scenarios. Employment effects are close to zero in all three scenarios.

Long term GDP gains in the 'decarbonisation' and 'delayed' scenarios emerge from two sources. The additional investment raises the level of productive capital in the economy and the newly installed, mostly foreign technologies increase overall productivity. The lower employment gains compared to the GDP effect are explained by two factors: (i) the energy investments are relatively capital intensive and (ii) the initial employment gains are translated into higher wages in the longer term, as labour supply remains the same across scenarios.

The macroeconomic vulnerability calculation captures how the additional investments contribute to the sustainability of the fiscal and external positions of the country measured by the fiscal and external balances and the public and external debt indicators. While the fiscal and external balances are compared to the 'baseline' scenario over the whole projection horizon (2017-2050), the debt indicators focus on the long term effects, with the difference from the baseline only calculated at the end of the modelled period. This approach is consistent with the fact that debt is accumulated from past imbalances.

The core scenarios significantly improve the macroeconomic vulnerability of Bosnia and Herzegovina. External debt levels decline by up to 60% of GDP while public debt level falls by close to 10% in the 'no target' and 'delayed' scenarios. The 'decarbonisation' scenario results in a more moderate 20% decline in external debt with public debt practically unchanged. Differences in the external debt profiles are primarily explained

FIGURE 18
HOUSEHOLD ELECTRICITY EXPENDITURE 2017-2050



by the fact that net electricity exports initially increase in particular in the 'no target' and 'delayed' scenarios, and somewhat more moderately in the 'decarbonisation' scenario. The fiscal balance improves convincingly at 0.5% of GDP in the 'delayed' and 'no target' scenarios due to higher EU ETS allowance auctioning revenues, reflecting the effect of significant fossil investments. These revenues remain unchanged in the 'decarbonisation' scenario.

Affordability measures the burden of the electricity bill for households as the ratio of household electricity expenditure to household disposable income. The indicator is tracked closely throughout the whole period in order to identify notable increases.

In the core scenarios household electricity expenditure increases significantly over the modelled time horizon, similarly to the 'baseline' scenario. In some 5-year periods the price increase is higher in the 'delayed' and 'decarbonisation' scenarios compared with the 'baseline' scenario. Electricity expenditure could increase by more than 10% in the 2021-2025 period in these two scenarios compared with the 'baseline. Similarly to other countries in the SEERMAP region, a substantial decline in household electricity expenditure is observable the 2046-2050 period in the 'decarbonisation' scenario, which is primarily due to the large fall in real wholesale electricity prices at the end of the modelled horizon. Although wholesale prices also decrease during this time in the 'delayed' scenario, this effect is more than compensated by higher RES support leading to another increase in household expenditure of close to 20%. There are no major differences in the 'no target' scenario compared to the baseline.

6 | Policy conclusions

The modelling work carried out under the SEERMAP project identifies some key findings with respect to the different strategic choices in the electricity sector that Bosnia and Herzegovina can pursue. We review these findings and suggest some policy insights. The analysis has uncovered robust findings relevant for all scenarios, based on which no regret policy options can be identified.

MAIN POLICY CONCLUSIONS

Regardless of whether Bosnia and Herzegovina pursues an active policy to decarbonise its electricity sector a significant shift from fossil fuels to renewables will take place:

- Lignite electricity generation will comprise between 1-6% or by 2050 due mainly to high carbon prices which make electricity generation in these power plants uncompetitive;
- Natural gas does not have a role in the electricity sector due to comparatively high projected natural gas prices;
- Hydro and wind make larger contributions to the generation mix than solar in all three scenarios;
- The high penetration of RES across all scenarios suggests that Bosnia and Herzegovina's energy policy should focus on enabling RES integration;

A long term strategy for decarbonising the electricity sector has a number of advantages, but also a few disadvantages:

- The 'decarbonisation' scenario demonstrates that it is technically feasible and financially viable for Bosnia and Herzegovina to reach 98% emission reduction with its abundant RES resources;
- Decarbonisation does not drive up wholesale prices relative to other scenarios with less ambitious RES policies, and actually reduces them after 2045, representing the lowest long term electricity bill burden for households;
- A long term planned decarbonisation effort can be financed with relatively low RES support, between 0.1-2.1 EUR/MWh over the time period until 2050;
- The long term planned effort described by the 'decarbonisation' scenario enables Bosnia and Herzegovina to retain favourable security of supply indicators throughout the modelled time horizon;
- A long term planned decarbonisation effort reduces the cost of stranded assets from a high level of 7.3-7.6 EUR/MWh (equivalent in absolute terms to around 1500 mEUR) to zero;
- Although the 'delayed' scenario also results in a significant reduction of CO_2 emissions (87.8%), this falls slightly short of the EU indicative targets of 93-99%;
- However, the 'decarbonisation' scenario results in lower GDP, employment and fiscal and external balance impacts than other senarios.

6.1 Main electricity system trends

In Bosnia and Herzegovina, more than 30% of current fossil fuel generation capacity is expected to be decommissioned by the end of 2030, and around 85% of current fossil fuel generation capacity will be decommissioned by 2050. This provides both a challenge in terms of the need to ensure a policy framework which will result in the necessary new investment, but also an opportunity to shape the electricity sector over the long term without being constrained by the current capacity mix.

Whether or not Bosnia and Herzegovina pursues an active policy to support renewable electricity generation, fossil fuel generation capacity will decline significantly driven by the price of carbon; lignite provides only 1-6% of electricity in the three scenarios by 2050, but the decline in the share of lingite begins earlier, as the carbon price is applied to Bosnia and Herzegovina from 2030 onwards.

With ambitious decarbonisation targets and corresponding RES support schemes, Bosnia and Herzegovina can have an electricity mix with close to 100% renewable generation by 2050. Absent a CO_2 emission reduction target and with renewable subsidies phased out under the 'no target' scenario, the share of RES in electricity consumption will reach approximately 66% in 2050, while the RES share is above 100% in both scenarios with a decarbonisation target.

The high penetration of RES in all scenarios suggests that a robust no-regret action for the energy policy of Bosnia and Herzegovina should focus on enabling RES integration involving:

- investing in transmission and distribution networks,
- enabling demand side management and RES production through a combination of technical solutions and appropriate regulatory practices, and
- promoting investment in storage solutions including hydro and small scale storage.

Delayed action in the rollout of renewables is feasible but carries two significant disadvantages compared with a long term planned effort. It results in stranded fossil fuel generation assets, including currently planned power plants. Translated into a price equivalent over a 10 year period, the cost of stranded assets is significantly higher than the size of RES support needed for decarbonising the electricity sector, with stranded costs at 7.3-7.6 EUR/MWh in the ' no target' and 'delayed' scenarios. Assuming delayed action, **the disproportionate push towards the end of the modelled period to meet the CO_2 emission reduction target requires a significant increase in RES support.**

6.2 Security of supply

In all scenarios, generation and system adequacy indicators remain favourable. Installed generation capacity within the country enables Bosnia and Herzegovina to satisfy demand using domestic generation in all seasons and hours of the day for the entire modelled period in all scenarios.

In order to address intermittency of a significant share of the installed generation capacity, Bosnia and Herzegovina could work on the no regret measures discussed above to enable a high share of RES penetration without compromising security of supply, involving demand side measures, increased network connections and storage solutions.

The network modelling results suggest that the planned transmission network developments (according to the ENTSO-E TNDP, 2016) are sufficient for Bosnia and Herzegovina to cover the increasing transmission needs of electricity provided by greater trade and RES deployment. The distribution network – which was not medelled in the network assessment – might need significant development to cover the needs of the integration of distributed RES generation.

6.3 Sustainability

Bosnia and Herzegovina has high renewable potential relative to the EU and the SEERMAP region average, enabling it to make an above average contribution to 2050 emission reduction targets, and enabling higher than 100% RES shares in both the 'delayed' and 'decarbonisation' scenarios. CO_2 emissions in the electricity sector fall by 87.8% in the 'delayed' and 98.3% in the 'decarbonisation' scenarios compared with the 94% target set for the EU28+Western Balkans region. The high RES and CO_2 emission reduction potential is an asset for Bosnia and Herzegovina because it allows the country to meet decarbonisation targets with limited RES support and thus limited burden on electricity consumers.

This potential can be realised with policies eliminating barriers to RES investment. **A no-regret step involves de-risking policies reducing the high cost of capital** that would allow for cost-efficient renewable energy investment.

6.4 Affordability and competitiveness

Decarbonising the electricity sector does not drive up wholesale electricity prices compared to a 'no target' scenario. The wholesale price of electricity is not driven by the level of decarbonisation but by the CO_2 price, which is applied across all scenarios, and the price of natural gas, because the latter is the marginal production needed to meet demand in a significant number of hours of the year for much of the modelled time period in all scenarios.

The wholesale price of electricity follows a similar trajectory under all scenarios and only diverges after 2045 in the decarbonization scenarios when wholesale electricity prices fall due to a high share of low marginal cost RES in the electricity mix.

Wholesale electricity prices are higher across all scenarios compared with current (albeit historically low) price levels. This trend is observable across the SEE region and the EU as a whole in all scenarios for the modelled time period and is driven by the price of carbon and the price of natural gas, both of which increase significantly by 2050. While higher wholesale prices will reach end consumers, it is an important signal for attracting investment to replace retiring capacity. **The macroeconomic analysis shows that despite the high absolute increase in wholesale prices, household electricity expenditure relative to household income is expected to increase more moderately compared with the price increase due to gains in household disposable income. However, the burden on households will still be significant under all scenarios over the long term (less so under the 'decarbonisation' scenario) which may warrant policy intervention to reduce energy poverty.**

From a broad societal point of view, sthe GDP and employment impacts and the impacts on public and external deficit and debt are not the most favourable for the 'decarbonisaiton' scenario.

Although not modelled with sufficient detail, **wholesale electricity price volatility is also expected to increase,** ceteris paribus, in a world with a high share of intermittent renewables. **Demand and supply side measures can reduce this price volatility,** but governments will need to determine the acceptable level in relation to the costs of supply and demand side measures.

High initial investment requirements for RES technologies are extremely sensitive to the cost of capital, which is high in Bosnia and Herzegovina compared with Western European member states. Although much of the value of the cost of capital depends on the country risk profile linked to the general macroeconomic performance, **policymakers can reduce the cost of capital through interventions by ensuring a stable energy policy framework and establishing de-risking measures. These should be considered as no-regret steps because they minimise system cost and consumer expenditures.**

Electricity decarbonisation consistent with EU targets requires continued RES support during the entire period until 2050. However, the level of support is relatively low, between 0.1-2.1 EUR/MWh due to significant cheap hydro and wind capacity, and due to the increasing electricity wholesale price which incentivises significant RES investment even without support. In addition, all of the necessary RES support can be covered from EU ETS revenues from 2030 onwards, thereby eliminating the burden of RES support to consumers. **Long term evidence based policy planning** can provide investors with the necessary stability to ensure that sufficient renewable investments will take place.

7 | References

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Annexes

Annex 1 | Model output tables

Bosnia and Herzegovina

TABLE A1 | 'NO TARGET' SCENARIO, BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 970	1 660	1 460	1 350	1 130	530	300	300
		New	0	1 400	1 700	1 700	1 700	1 700	1 700	1 700
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 155	2 179	2 221	2 263	2 364	2 738	3 060	3 297
	Wind		0	41	41	31	113	338	900	1 988
	Solar		9	44	44	44	58	93	189	370
	Other RES		0	1	1	2	3	6	9	12
Gross consumption, GWh			12 178	14 129	15 480	16 966	18 141	19 613	20 508	21 442
Net electricity generation, GWh	Total		14 943	23 912	25 183	24 130	21 888	22 252	21 503	15 127
	Coal and lignite		8 974	17 741	19 011	17 974	15 351	14 084	10 746	980
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		5 960	6 044	6 044	6 044	6 249	7 406	8 813	9 928
	Wind		0	78	78	60	216	645	1 721	3 801
	Solar		9	44	44	44	58	93	190	372
	Other RES		0	5	6	8	13	23	34	45
Net import, GWh	Total		-2 765	-9 783	-9 703	-7 164	-3 748	-2 638	-996	6 316
	HR		10	-2 682	-4 978	-1 616	2 165	6 441	3 259	8 446
	ME		-1 977	-3 226	-1 962	-1 782	-1 727	-2 332	-1 846	-282
	RS		-798	-3 874	-2 763	-3 766	-4 186	-6 748	-2 408	-1 848
Net import ratio, %			-22.7%	-69.2%	-62.7%	-42.2%	-20.7%	-13.5%	-4.9%	29.5%
RES-E share (RES-E production/gross consumption, %)			49.0%	43.7%	39.9%	36.3%	36.0%	41.6%	52.5%	66.0%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	40%
	Wind		na	na	na	na	na	na	na	47%
	Solar		na	na	na	na	na	na	na	9%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	66.2%	68.7%	67.3%	61.9%	72.1%	61.3%	5.6%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		94%	120%	108%	89%	74%	56%	59%	70%
	System adequacy margin		191%	206%	264%	244%	221%	192%	185%	187%
CO_2 emission	Emission, Mt CO_2		10.6	19.0	20.0	18.7	15.6	14.1	10.7	1.0
	CO_2 emission reduction compared to 1990, %		9.3%	-62.9%	-71.4%	-60.7%	-34.1%	-21.4%	7.9%	91.6%
Spreads	Clean dark spread, €(2015)/MWh		25.4	30.7	42.8	14.7	13.5	13.9	6.5	-13.6
	Clean spark spread, €(2015)/MWh		-8.5	-6.1	-0.3	-10.8	-10.2	-11.3	-8.3	-16.5
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	40.9	52.8	60.2	68.4	77.6	90.5	90.5
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.1	0.3	0.4	0.1	0	0	0
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	37.0	36.2	36.0	36.1	4.0
Investment cost, m€/5 year period	Coal and lignite		na	3 642	764	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	3 642	764	0	0	0	0	0
	Total RES-E		na	131	0	1	176	793	1 314	1 897
	Total		na	3 773	765	1	176	793	1 314	1 897
Main assumptions	Coal price, €(2015)/GJ		1.78	1.95	1.93	1.89	1.98	2.04	2.04	2.04
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A2 | 'DELAYED' SCENARIO, BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 970	1 660	1 460	1 350	1 130	530	300	300
		New	0	1 400	1 700	1 700	1 700	1 700	1 700	1 700
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 155	2 179	2 557	2 664	3 049	3 499	3 856	4 237
	Wind		0	41	205	292	800	2 089	3 516	4 116
	Solar		9	44	92	100	163	332	702	1 315
	Other RES		0	1	2	3	5	8	12	20
Gross consumption, GWh			12 178	14 129	15 488	16 972	18 155	19 659	20 653	21 729
Net electricity generation, GWh	Total		14 943	23 912	26 715	25 269	25 104	28 074	25 533	23 852
	Coal and lignite		8 974	17 741	19 011	17 159	14 759	13 665	6 480	1 424
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		5 960	6 044	7 210	7 440	8 632	10 049	11 579	13 178
	Wind		0	78	391	557	1 529	3 994	6 720	7 856
	Solar		9	44	93	100	164	334	706	1 318
	Other RES		0	5	9	12	20	32	48	77
Net import, GWh	Total		-2 765	-9 783	-11 226	-8 297	-6 948	-8 415	-4 880	-2 123
	HR		57	-2 860	-5 703	-1 062	1 612	645	-1 986	-1 432
	ME		-1 560	-3 215	-1 728	-1 695	-2 328	-2 103	491	477
	RS		-1 262	-3 708	-3 796	-5 540	-6 232	-6 957	-3 384	-1 167
Net import ratio, %			-22.7%	-69.2%	-72.5%	-48.9%	-38.3%	-42.8%	-23.6%	-9.8%
RES-E share (RES-E production/gross consumption, %)			49.0%	43.7%	49.7%	47.8%	57.0%	73.3%	92.3%	103.2%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	54%
	Wind		na	na	na	na	na	na	na	97%
	Solar		na	na	na	na	na	na	na	31%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	66.2%	68.7%	64.2%	59.5%	70.0%	37.0%	8.1%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		94%	120%	125%	108%	107%	97%	104%	113%
	System adequacy margin		191%	206%	281%	264%	254%	225%	220%	223%
CO_2 emission	Emission, Mt CO_2		10.6	19.0	20.0	17.7	15.0	13.7	6.5	1.4
	CO_2 emission reduction compared to 1990, %		9.3%	-62.9%	-71.4%	-52.3%	-28.4%	-17.8%	44.5%	87.8%
Spreads	Clean dark spread, €(2015)/MWh		25.4	30.7	40.6	13.4	11.9	16.2	3.7	-31.2
	Clean spark spread, €(2015)/MWh		-8.5	-6.2	-2.4	-12.2	-11.7	-9.0	-11.2	-34.0
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	40.9	50.7	58.8	66.9	79.9	87.6	72.9
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.1	1.2	0.8	1.2	3.4	5.1	28.0
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	35.0	34.6	34.9	21.6	5.8
Investment cost, m€/5 year period	Coal and lignite		na	3 642	764	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	3 642	764	0	0	0	0	0
	Total RES-E		na	131	726	215	1 151	2 423	2 906	1 966
	Total		na	3 773	1 491	215	1 151	2 423	2 906	1 966
Main assumptions	Coal price, €(2015)/GJ		1.78	1.95	1.93	1.89	1.98	2.04	2.04	2.04
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A3 | 'DECARBONISATION' SCENARIO, BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 970	1 660	1 460	1 350	1 130	530	300	300
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 155	2 179	2 621	3 069	3 447	3 855	4 223	4 497
	Wind		0	41	266	861	2 071	2 731	3 435	3 809
	Solar		9	44	100	181	320	636	1 197	1 855
	Other RES		0	1	3	4	6	10	15	22
Gross consumption, GWh			12 178	14 124	15 481	16 975	18 226	19 722	20 661	21 716
Net electricity generation, GWh	Total		14 943	13 733	14 701	15 769	16 720	18 902	21 254	23 521
	Coal and lignite		8 974	7 562	6 651	5 080	2 400	1 715	568	200
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		5 960	6 044	7 432	8 844	10 014	11 286	12 857	14 094
	Wind		0	78	508	1 647	3 960	5 221	6 566	7 279
	Solar		9	44	100	182	321	640	1 205	1 864
	Other RES		0	5	10	16	25	40	59	83
Net import, GWh	Total		-2 765	391	780	1 206	1 506	820	-593	-1 804
	HR		57	3 597	3 522	4 621	6 183	6 966	1 693	74
	ME		-1 560	-2 280	-741	-1 153	-482	-1 898	353	525
	RS		-1 262	-927	-2 001	-2 262	-4 195	-4 247	-2 639	-2 403
Net import ratio, %			-22.7%	2.8%	5.0%	7.1%	8.3%	4.2%	-2.9%	-8.3%
RES-E share (RES-E production/gross consumption, %)			49.0%	43.7%	52.0%	63.0%	78.6%	87.1%	100.1%	107.4%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	58%
	Wind		na	na	na	na	na	na	na	90%
	Solar		na	na	na	na	na	na	na	44%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	43.0%	24.2%	36.9%	21.6%	7.6%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		94%	59%	60%	66%	71%	62%	69%	77%
	System adequacy margin		191%	145%	216%	222%	220%	188%	187%	190%
CO_2 emission	Emission, Mt CO_2		10.6	8.8	7.6	5.7	2.6	1.8	0.6	0.2
	CO_2 emission reduction compared to 1990, %		9.3%	24.7%	34.6%	50.8%	77.8%	84.7%	95.1%	98.3%
Spreads	Clean dark spread, €(2015)/MWh		25.4	31.9	42.4	14.1	11.7	17.2	3.2	-29.6
	Clean spark spread, €(2015)/MWh		-8.5	-4.9	-0.7	-11.5	-11.9	-8.0	-11.7	-32.4
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	42.1	52.4	59.5	66.7	80.9	87.1	74.5
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.1	0.5	1.9	2.1	1.2	1.6	1.9
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	11.3	6.0	4.5	1.9	0.8
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	131	916	1 451	2 075	1 885	1 826	2 411
	Total		na	131	916	1 451	2 075	1 885	1 826	2 411
Main assumptions	Coal price, €(2015)/GJ		1.8	2.0	1.9	1.9	2.0	2.0	2.0	2.0
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A4 | SENSITIVITY ANALYSIS – LOW CARBON PRICE, BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 970	1 660	1 460	1 350	1 130	530	300	300
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 155	2 169	2 634	3 077	3 469	3 932	4 310	4 596
	Wind		0	36	257	837	2 148	3 145	3 766	4 175
	Solar		9	44	107	219	420	838	1 292	2 099
	Other RES		0	1	5	6	8	12	17	23
Gross consumption, GWh			12 188	14 138	15 507	17 025	18 288	19 823	20 839	21 795
Net electricity generation, GWh	Total		14 943	13 685	14 744	16 615	19 357	20 547	22 786	25 141
	Coal and lignite		8 974	7 562	6 651	5 895	4 705	2 092	1 108	742
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		5 960	6 006	7 478	8 875	10 092	11 555	13 137	14 333
	Wind		0	68	491	1 600	4 107	6 012	7 185	7 920
	Solar		9	44	107	221	422	843	1 292	2 056
	Other RES		0	5	18	24	31	46	63	90
Net import, GWh	Total		-2 755	453	762	410	-1 069	-725	-1 947	-3 346
	HR		92	3 712	2 849	2 228	1 873	4 354	1 523	-20
	ME		-1 576	-3 123	-865	-729	-838	-843	-506	-88
	RS		-1 271	-136	-1 221	-1 088	-2 104	-4 236	-2 964	-3 238
Net import ratio, %			-22.6%	3.2%	4.9%	2.4%	-5.8%	-3.7%	-9.3%	-15.4%
RES-E share (RES-E production/gross consumption, %)			49.0%	43.3%	52.2%	63.0%	80.1%	93.1%	104.0%	111.9%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	59.0%
	Wind		na	na	na	na	na	na	na	98.4%
	Solar		na	na	na	na	na	na	na	49.7%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	49.8%	47.5%	45.1%	42.2%	28.2%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		94%	58%	60%	66%	73%	69%	74%	82%
	System adequacy margin		191%	144%	216%	223%	222%	193%	191%	193%
CO_2 emission	Emission, Mt CO_2		10.6	8.8	7.6	6.7	5.3	2.2	1.1	0.7
	CO_2 emission reduction compared to 1990, %		9.3%	24.7%	34.6%	42.4%	54.8%	80.8%	90.4%	93.6%
Spreads	Clean dark spread, €(2015)/MWh		22.5	28.4	36.4	3.3	-1.4	7.8	-15.3	-54.2
	Clean spark spread, €(2015)/MWh		-11.3	-8.5	-6.7	-22.3	-25.1	-17.4	-30.1	-57.1
Price impacts	Electricity wholesale price, €(2015)/MWh		31.8	38.5	46.5	48.7	53.5	71.6	68.6	49.9
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.1	2.8	10.5	16.6	19.2	20.7	38.8
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	13.2	12.1	5.6	3.7	3.0
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	109	939	1 436	2 389	2 281	2 060	2 279
	Total		na	109	939	1 436	2 389	2 281	2 060	2 279
Main assumptions	Coal price, €(2015)/GJ		1.78	1.95	1.93	1.89	1.98	2.04	2.04	2.04
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		na	na	na	na	na	na	na	na
	CO_2 price, €(2015)/t		4.30	7.50	11.25	16.75	21.00	25.00	34.50	44.00

TABLE A5 | SENSITIVITY ANALYSIS – LOW DEMAND, BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 970	1 660	1 460	1 350	1 130	530	300	300
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 155	2 179	2 557	2 866	3 188	3 592	3 965	4 244
	Wind		0	41	205	457	1 244	2 104	3 221	3 409
	Solar		9	44	92	129	229	441	870	1 430
	Other RES		0	1	2	4	6	9	14	19
Gross consumption, GWh			12 178	13 986	15 140	16 388	17 313	18 477	19 289	19 900
Net electricity generation, GWh	Total		14 943	13 733	14 354	14 601	14 901	16 758	19 604	21 485
	Coal and lignite		8 974	7 562	6 651	5 442	3 157	1 884	559	238
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		5 960	6 044	7 210	8 141	9 114	10 373	11 959	13 219
	Wind		0	78	391	874	2 378	4 022	6 158	6 515
	Solar		9	44	93	130	230	444	875	1 439
	Other RES		0	5	9	14	22	35	53	74
Net import, GWh	Total		-2 765	253	786	1 787	2 412	1 719	-315	-1 585
	HR		289	3 165	1 598	4 331	5 309	7 961	1 636	511
	ME		-1 842	-2 361	-774	-1 599	-56	-922	353	848
	RS		-1 212	-551	-39	-946	-2 842	-5 320	-2 304	-2 945
Net import ratio, %			-22.7%	1.8%	5.2%	10.9%	13.9%	9.3%	-1.6%	-8.0%
RES-E share (RES-E production/gross consumption, %)			49.0%	44.1%	50.9%	55.9%	67.8%	80.5%	98.7%	106.8%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	54.0%
	Wind		na	na	na	na	na	na	na	80.4%
	Solar		na	na	na	na	na	na	na	33.7%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	46.0%	31.9%	40.6%	21.3%	9.0%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		94%	60%	59%	59%	62%	56%	68%	78%
	System adequacy margin		191%	147%	218%	220%	215%	191%	194%	200%
CO_2 emission	Emission, Mt CO_2		10.6	8.8	7.6	6.2	3.5	2.0	0.6	0.2
	CO_2 emission reduction compared to 1990, %		9.3%	24.7%	34.6%	47.1%	70.2%	83.0%	95.2%	97.9%
Spreads	Clean dark spread, €(2015)/MWh		25.4	31.6	42.3	14.6	15.3	25.2	0.2	-28.8
	Clean spark spread, €(2015)/MWh		-8.5	-5.3	-0.8	-11.0	-8.4	0	-14.7	-31.6
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	41.8	52.4	60.0	70.2	89.0	84.1	75.3
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.1	1.6	2.2	2.7	0.5	0	0
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	12.6	8.4	5.4	2.0	1.1
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	131	726	726	1 473	1 875	2 560	1 449
	Total		na	131	726	726	1 473	1 875	2 560	1 449
Main assumptions	Coal price, €(2015)/GJ		1.8	2.0	1.9	1.9	2.0	2.0	2.0	2.0
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		na	na	na	na	na	na	na	na
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A6 | SENSITIVITY ANALYSIS – HIGH DEMAND, BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 970	1 660	1 460	1 350	1 130	530	300	300
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 155	2 179	2 643	3 077	3 481	3 952	4 293	4 596
	Wind		0	41	266	861	2 198	3 086	3 792	4 161
	Solar		9	44	107	219	420	890	1 446	2 147
	Other RES		0	1	5	6	9	13	18	25
Gross consumption, GWh			12 178	14 263	15 827	17 572	19 106	20 965	22 287	23 539
Net electricity generation, GWh	Total		14 943	13 733	14 796	15 662	17 071	20 067	22 362	24 803
	Coal and lignite		8 974	7 562	6 651	4 895	2 282	1 599	504	260
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		5 960	6 044	7 512	8 875	10 131	11 626	13 092	14 390
	Wind		0	78	508	1 647	4 202	5 898	7 245	7 924
	Solar		9	44	107	221	422	896	1 453	2 132
	Other RES		0	5	19	25	34	49	68	96
Net import, GWh	Total		-2 765	531	1 031	1 910	2 035	898	-75	-1 264
	HR		-364	3 187	4 141	5 557	6 518	7 272	1 875	978
	ME		-1 486	-1 837	-1 068	-1 196	-580	-1 103	528	-55
	RS		-915	-820	-2 042	-2 451	-3 904	-5 272	-2 478	-2 187
Net import ratio, %			-22.7%	3.7%	6.5%	10.9%	10.6%	4.3%	-0.3%	-5.4%
RES-E share (RES-E production/gross consumption, %)			49.0%	43.3%	51.5%	61.3%	77.4%	88.1%	98.1%	104.3%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	59.0%
	Wind		na	na	na	na	na	na	na	98.1%
	Solar		na	na	na	na	na	na	na	51.3%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	41.4%	23.1%	34.4%	19.2%	9.9%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		94%	58%	58%	61%	67%	61%	64%	70%
	System adequacy margin		191%	143%	211%	213%	209%	180%	174%	174%
CO_2 emission	Emission, Mt CO_2		10.6	8.8	7.6	5.5	2.5	1.7	0.5	0.3
	CO_2 emission reduction compared to 1990, %		9.3%	24.7%	34.6%	52.6%	78.9%	85.7%	95.6%	97.7%
Spreads	Clean dark spread, €(2015)/MWh		25.4	32.3	42.6	49.6	56.2	68.8	71.6	61.5
	Clean spark spread, €(2015)/MWh		-8.5	-4.6	-0.5	1.9	4.8	10.6	11.3	0.6
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	42.4	52.7	59.5	66.5	79.5	82.3	72.2
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.1	2.8	8.2	11.6	11.3	9.9	22.6
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	10.5	5.4	4.0	1.6	1.0
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	131	947	1 440	2 443	2 203	2 159	2 223
	Total		na	131	947	1 440	2 443	2 203	2 159	2 223
Main assumptions	Coal price, €(2015)/GJ		1.8	2.0	1.9	1.9	2.0	2.0	2.0	2.0
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		na	na	na	na	na	na	na	na
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A7 | SENSITIVITY ANALYSIS – LOW RENEWABLE POTENTIAL, BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 970	1 660	1 460	1 350	1 130	530	300	300
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 155	2 179	2 522	2 830	3 103	3 459	3 697	3 786
	Wind		0	37	228	691	1 137	1 499	1 855	1 909
	Solar		9	44	112	238	538	1 189	2 037	2 905
	Other RES		0	1	5	6	9	13	18	28
Gross consumption, GWh			12 178	14 123	15 479	16 966	18 156	19 633	20 692	21 670
Net electricity generation, GWh	Total		14 943	13 726	14 306	14 725	14 000	15 742	17 286	18 494
	Coal and lignite		8 974	7 562	6 651	5 127	2 432	1 720	589	243
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		5 960	6 044	7 089	8 014	8 819	9 913	11 029	11 601
	Wind		0	71	435	1 321	2 174	2 865	3 547	3 640
	Solar		9	44	113	239	542	1 196	2 050	2 901
	Other RES		0	5	19	25	33	48	71	109
Net import, GWh	Total		-2 765	398	1 174	2 241	4 156	3 891	3 406	3 176
	HR		251	3 038	3 245	5 943	6 450	7 858	2 746	2 786
	ME		-1 871	-2 131	-723	-1 104	-280	-897	697	1 295
	RS		-1 145	-510	-1 348	-2 598	-2 013	-3 070	-37	-905
Net import ratio, %			-22.7%	2.8%	7.6%	13.2%	22.9%	19.8%	16.5%	14.7%
RES-E share (RES-E production/gross consumption, %)			49.0%	43.6%	49.5%	56.6%	63.7%	71.4%	80.7%	84.2%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	47.5%
	Wind		na	na	na	na	na	na	na	45.0%
	Solar		na	na	na	na	na	na	na	68.2%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	43.4%	24.6%	37.0%	22.4%	9.2%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		94%	59%	55%	55%	52%	40%	43%	43%
	System adequacy margin		191%	145%	211%	211%	200%	173%	162%	151%
CO_2 emission	Emission, Mt CO_2		10.6	8.8	7.6	5.8	2.6	1.8	0.6	0.2
	CO_2 emission reduction compared to 1990, %		9.3%	24.7%	34.6%	50.3%	77.4%	84.6%	94.9%	97.9%
Spreads	Clean dark spread, €(2015)/MWh		25.4	32.0	42.4	49.7	56.4	71.1	74.9	63.9
	Clean spark spread, €(2015)/MWh		-8.5	-4.9	-0.7	2.0	5.0	12.9	14.6	3.0
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	42.2	52.5	59.6	66.8	81.7	85.6	74.5
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.1	2.4	5.3	6.6	6.7	8.7	65.6
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	11.4	6.1	4.6	2.0	1.0
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	1 306.1	0	0	0	0	0	0
	Total Fossil		na	1 306	0	0	0	0	0	0
	Total RES-E		na	125	744	1 132	1 178	1 494	1 841	1 470
	Total		na	1 432	744	1 132	1 178	1 494	1 841	1 470
Main assumptions	Coal price, €(2015)/GJ		1.8	2.0	1.9	1.9	2.0	2.0	2.0	2.0
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		na	na	na	na	na	na	na	na
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

Federation of Bosnia and Herzegovina

TABLE A8 | 'NO TARGET' SCENARIO, FEDERATION OF BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 070	760	560	450	230	230	0	0
		New	0	800	1 100	1 100	1 100	1 100	1 100	1 100
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		1 493	1 517	1 559	1 601	1 676	1 896	2 028	2 125
	Wind		0	6	6	5	42	143	390	904
	Solar		7	24	24	24	30	47	96	189
	Other RES		0	1	1	1	2	4	6	9
Gross consumption, GWh			7 934	9 546	10 454	11 452	12 241	13 230	13 833	14 473
Net electricity generation, GWh	Total		8 541	13 060	14 331	13 605	12 431	13 174	12 863	8 465
	Coal and lignite		4 874	9 278	10 549	9 821	8 448	8 355	6 769	656
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		3 660	3 744	3 744	3 744	3 862	4 482	5 228	5 856
	Wind		0	11	11	10	80	274	746	1 728
	Solar		7	25	25	25	30	47	96	190
	Other RES		0	2	3	5	10	16	24	35
Net import, GWh	Total		-608	-3 514	-3 877	-2 152	-189	56	970	6 008
	HR		-136	-1 410	-4 429	-2 084	654	3 718	2 731	6 351
	BA_SRP		-472	-2 104	552	-69	-844	-3 662	-1 761	-343
Net import ratio, %			-7.7%	-36.8%	-37.1%	-18.8%	-1.5%	0.4%	7.0%	41.5%
RES-E share (RES-E production/gross consumption, %)			46.2%	39.6%	36.2%	33.0%	32.5%	36.4%	44.1%	54.0%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	44%
	Wind		na	na	na	na	na	na	na	42%
	Solar		na	na	na	na	na	na	na	8%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	67.9%	72.5%	72.3%	72.5%	71.7%	70.3%	6.8%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		64%	74%	68%	44%	27%	28%	25%	32%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		6.0	10.0	11.0	10.1	8.5	8.4	6.7	0.7
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		25.4	30.7	42.8	14.7	13.5	13.9	6.5	-13.6
	Clean spark spread, €(2015)/MWh		-8.5	-6.1	-0.3	-10.8	-10.2	-11.3	-8.3	-16.5
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	40.9	52.8	60.2	68.4	77.6	90.5	90.5
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.2	0.4	0.4	0	0	0	0
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	29.6	29.1	31.6	33.5	4.0
Investment cost, m€/5 year period	Coal and lignite		na	2 075	764	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	2 075	764	0	0	0	0	0
	Total RES-E		na	60	0	1	95	383	629	965
	Total		na	2 135	765	1	95	383	629	965
Main assumptions	Coal price, €(2015)/GJ		1.78	1.95	1.93	1.89	1.98	2.04	2.04	2.04
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A9 | 'DELAYED' SCENARIO, FEDERATION OF BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 070	760	560	450	230	230	0	0
		New	0	800	1 100	1 100	1 100	1 100	1 100	1 100
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		1 493	1 517	1 747	1 828	2 065	2 318	2 477	2 635
	Wind		0	6	81	124	376	1 008	1 751	2 089
	Solar		7	24	49	52	83	161	349	678
	Other RES		0	1	1	2	4	6	9	14
Gross consumption, GWh			7 934	9 547	10 459	11 456	12 253	13 280	13 972	14 722
Net electricity generation, GWh	Total		8 541	13 060	15 155	14 306	14 297	16 187	14 753	13 256
	Coal and lignite		4 874	9 278	10 549	9 474	8 269	8 128	4 232	914
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		3 660	3 744	4 397	4 534	5 212	5 947	6 789	7 619
	Wind		0	11	155	237	719	1 927	3 347	3 988
	Solar		7	25	49	53	84	162	351	679
	Other RES		0	2	5	8	14	23	34	55
Net import, GWh	Total		-608	-3 514	-4 696	-2 850	-2 044	-2 907	-782	1 466
	HR		-104	-1 509	-4 760	-833	1 177	370	-1 828	-426
	BA_SRP		-503	-2 005	64	-2 018	-3 221	-3 277	1 046	1 893
Net import ratio, %			-7.7%	-36.8%	-44.9%	-24.9%	-16.7%	-21.9%	-5.6%	10.0%
RES-E share (RES-E production/gross consumption, %)			46.2%	39.6%	44.0%	42.2%	49.2%	60.7%	75.3%	83.8%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	57%
	Wind		na	na	na	na	na	na	na	97%
	Solar		na	na	na	na	na	na	na	28%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	67.9%	72.5%	69.8%	71.0%	69.8%	43.9%	9.5%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		64%	74%	81%	58%	50%	53%	53%	60%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		6.0	10.0	11.0	9.7	8.3	8.1	4.2	0.9
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		25.4	30.7	40.6	13.4	11.9	16.2	3.7	-31.2
	Clean spark spread, €(2015)/MWh		-8.5	-6.2	-2.4	-12.2	-11.7	-9.0	-11.2	-34.0
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	40.9	50.7	58.8	66.9	79.9	87.6	72.9
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.2	1.7	0.7	0.8	2.6	3.9	21.5
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	28.3	28.4	30.7	20.7	5.4
Investment cost, m€/5 year period	Coal and lignite		na	2 075	764	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	2 075	764	0	0	0	0	0
	Total RES-E		na	60	383	109	612	1 210	1 502	1 062
	Total		na	2 135	1 147	109	612	1 210	1 502	1 062
Main assumptions	Coal price, €(2015)/GJ		1.78	1.95	1.93	1.89	1.98	2.04	2.04	2.04
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A10 | 'DECARBONISATION' SCENARIO, FEDERATION OF BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 070	760	560	450	230	230	0	0
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		1 493	1 517	1 784	2 046	2 263	2 505	2 653	2 730
	Wind		0	6	106	367	971	1 371	1 675	1 823
	Solar		7	24	52	94	161	305	587	949
	Other RES		0	1	2	3	4	7	10	15
Gross consumption, GWh			7 934	9 543	10 454	11 460	12 323	13 345	13 979	14 713
Net electricity generation, GWh	Total		8 541	7 244	7 339	7 693	8 240	9 952	11 236	12 452
	Coal and lignite		4 874	3 462	2 551	1 596	302	403	0	0
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		3 660	3 744	4 526	5 292	5 903	6 595	7 402	7 957
	Wind		0	11	203	701	1 856	2 620	3 203	3 483
	Solar		7	25	53	94	162	307	591	954
	Other RES		0	2	6	10	16	27	40	59
Net import, GWh	Total		-608	2 299	3 115	3 767	4 083	3 393	2 743	2 261
	HR		-104	1 732	2 960	3 193	4 489	4 686	1 535	564
	BA_SRP		-503	567	155	574	-405	-1 294	1 207	1 697
Net import ratio, %			-7.7%	24.1%	29.8%	32.9%	33.1%	25.4%	19.6%	15.4%
RES-E share (RES-E production/gross consumption, %)			46.2%	39.6%	45.8%	53.2%	64.4%	71.6%	80.4%	84.6%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	59%
	Wind		na	na	na	na	na	na	na	84%
	Solar		na	na	na	na	na	na	na	39%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	40.5%	15.0%	20.0%	na	na
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		64%	23%	19%	15%	20%	18%	18%	24%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		6.0	4.2	3.0	1.9	0.3	0.5	0	0
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		25.4	31.9	42.4	14.1	11.7	17.2	3.2	-29.6
	Clean spark spread, €(2015)/MWh		-8.5	-4.9	-0.7	-11.5	-11.9	-8.0	-11.7	-32.4
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	42.1	52.4	59.5	66.7	80.9	87.1	74.5
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.2	0.7	1.3	1.3	0.8	1.2	1.0
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	5.5	1.2	1.7	0	0
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	60	481	693	1 130	941	891	1 205
	Total		na	60	481	693	1 130	941	891	1 205
Main assumptions	Coal price, €(2015)/GJ		1.8	2.0	1.9	1.9	2.0	2.0	2.0	2.0
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A11 | SENSITIVITY ANALYSIS – LOW CARBON PRICE, FEDERATION OF BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 070	760	560	450	230	230	0	0
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		1 493	1 507	1 785	2 046	2 263	2 544	2 701	2 804
	Wind		0	0	98	342	944	1 546	1 858	2 116
	Solar		7	24	56	113	214	434	686	1 156
	Other RES		0	1	3	4	5	8	11	16
Gross consumption, GWh			7 940	9 553	10 471	11 493	12 363	13 428	14 120	14 742
Net electricity generation, GWh	Total		8 541	7 196	7 332	8 015	8 913	11 012	11 830	13 362
	Coal and lignite		4 874	3 462	2 551	1 941	970	858	0	0
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		3 660	3 707	4 528	5 292	5 903	6 733	7 557	8 154
	Wind		0	1	187	655	1 804	2 955	3 545	4 014
	Solar		7	25	56	113	215	436	686	1 132
	Other RES		0	2	10	15	20	30	43	62
Net import, GWh	Total		-601	2 356	3 140	3 478	3 451	2 416	2 290	1 380
	HR		-64	1 817	2 615	1 989	2 258	3 208	2 532	460
	BA_SRP		-537	539	524	1 489	1 193	-792	-242	920
Net import ratio, %			-7.6%	24.7%	30.0%	30.3%	27.9%	18.0%	16.2%	9.4%
RES-E share (RES-E production/gross consumption, %)			46.2%	39.1%	45.7%	52.9%	64.2%	75.6%	83.8%	90.6%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	61.2%
	Wind		na	na	na	na	na	na	na	97.8%
	Solar		na	na	na	na	na	na	na	47.5%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	49.2%	48.1%	42.6%	na	na
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		64%	22%	19%	15%	20%	22%	22%	29%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		6.0	4.2	3.0	2.3	1.1	1.0	0	0
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		22.5	28.4	36.4	3.3	-1.4	7.8	-15.3	-54.2
	Clean spark spread, €(2015)/MWh		-11.3	-8.5	-6.7	-22.3	-25.1	-17.4	-30.1	-57.1
Price impacts	Electricity wholesale price, €(2015)/MWh		31.8	38.5	46.5	48.7	53.5	71.6	68.6	49.9
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.2	4.2	7.7	11.9	14.5	15.7	29.8
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	6.7	3.8	3.7	0	0
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	38	485	678	1 149	1 286	1 057	1 213
	Total		na	38	485	678	1 149	1 286	1 057	1 213
Main assumptions	Coal price, €(2015)/GJ		1.78	1.95	1.93	1.89	1.98	2.04	2.04	2.04
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		4.30	7.50	11.25	16.75	21.00	25.00	34.50	44.00

TABLE A12 | SENSITIVITY ANALYSIS – LOW DEMAND, FEDERATION OF BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 070	760	560	450	230	230	0	0
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		1 493	1 517	1 747	1 943	2 110	2 335	2 501	2 592
	Wind		0	6	81	193	572	1 016	1 559	1 616
	Solar		7	24	49	67	117	229	469	810
	Other RES		0	1	1	2	4	6	10	14
Gross consumption, GWh			7 934	9 450	10 225	11 063	11 690	12 486	13 069	13 470
Net electricity generation, GWh	Total		8 541	7 244	7 157	7 130	7 095	8 772	10 362	11 436
	Coal and lignite		4 874	3 462	2 551	1 750	500	568	0	0
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		3 660	3 744	4 397	4 934	5 369	6 006	6 872	7 477
	Wind		0	11	155	369	1 093	1 943	2 981	3 089
	Solar		7	25	49	68	118	231	472	815
	Other RES		0	2	5	10	15	24	37	55
Net import, GWh	Total		-608	2 207	3 068	3 933	4 596	3 714	2 707	2 034
	HR		73	1 731	1 337	3 350	3 923	5 895	1 341	758
	BA_SRP		-680	476	1 731	583	672	-2 181	1 366	1 276
Net import ratio, %			-7.7%	23.3%	30.0%	35.6%	39.3%	29.7%	20.7%	15.1%
RES-E share (RES-E production/gross consumption, %)			46.2%	40.0%	45.0%	48.6%	56.4%	65.7%	79.3%	84.9%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	55.8%
	Wind		na	na	na	na	na	na	na	74.7%
	Solar		na	na	na	na	na	na	na	33.3%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	44.4%	24.8%	28.2%	na	na
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		64%	24%	18%	11%	5%	13%	17%	24%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		6.0	4.2	3.0	2.1	0.6	0.7	0	0
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		25.4	31.6	42.3	14.6	15.3	25.2	0.2	-28.8
	Clean spark spread, €(2015)/MWh		-8.5	-5.3	-0.8	-11.0	-8.4	0	-14.7	-31.6
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	41.8	52.4	60.0	70.2	89.0	84.1	75.3
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.2	2.3	1.7	2.0	0.4	0	0
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	6.3	2.1	2.6	0	0
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	60	383	367	710	953	1 287	706
	Total		na	60	383	367	710	953	1 287	706
Main assumptions	Coal price, €(2015)/GJ		1.8	2.0	1.9	1.9	2.0	2.0	2.0	2.0
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A13 | SENSITIVITY ANALYSIS – HIGH DEMAND, FEDERATION OF BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 070	760	560	450	230	230	0	0
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		1 493	1 517	1 794	2 046	2 275	2 554	2 684	2 804
	Wind		0	6	106	367	992	1 486	1 884	2 102
	Solar		7	24	56	113	214	460	744	1 116
	Other RES		0	1	3	4	6	8	12	17
Gross consumption, GWh			7 934	9 637	10 687	11 861	12 916	14 192	15 092	15 909
Net electricity generation, GWh	Total		8 541	7 244	7 383	7 639	8 360	10 487	11 898	13 364
	Coal and lignite		4 874	3 462	2 551	1 517	285	383	0	0
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		3 660	3 744	4 562	5 292	5 941	6 767	7 505	8 186
	Wind		0	11	203	701	1 897	2 841	3 600	4 003
	Solar		7	25	56	113	215	463	748	1 109
	Other RES		0	2	11	16	22	32	46	66
Net import, GWh	Total		-608	2 393	3 303	4 222	4 556	3 705	3 194	2 546
	HR		-166	1 547	3 271	4 064	4 733	5 422	2 425	2 037
	BA_SRP		-441	845	32	158	-177	-1 717	769	509
Net import ratio, %			-7.7%	24.8%	30.9%	35.6%	35.3%	26.1%	21.2%	16.0%
RES-E share (RES-E production/gross consumption, %)			46.2%	39.2%	45.2%	51.6%	62.5%	71.2%	78.8%	84.0%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	61.2%
	Wind		na	na	na	na	na	na	na	97.1%
	Solar		na	na	na	na	na	na	na	45.9%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	38.5%	14.2%	19.0%	na	na
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		64%	22%	17%	12%	16%	17%	15%	21%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		6.0	4.2	3.0	1.8	0.3	0.4	0	0
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		25.4	32.3	42.6	49.6	56.2	68.8	71.6	61.5
	Clean spark spread, €(2015)/MWh		-8.5	-4.6	-0.5	1.9	4.8	10.6	11.3	0.6
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	42.4	52.7	59.5	66.5	79.5	82.3	72.2
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.2	4.1	6.2	8.4	8.5	7.5	17.2
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	5.1	1.1	1.6	0	0
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	60	493	681	1 200	1 175	1 130	1 163
	Total		na	60	493	681	1 200	1 175	1 130	1 163
Main assumptions	Coal price, €(2015)/GJ		1.8	2.0	1.9	1.9	2.0	2.0	2.0	2.0
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A14 | SENSITIVITY ANALYSIS – LOW RENEWABLE POTENTIAL, FEDERATION OF BOSNIA AND HERZEGOVINA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	1 070	760	560	450	230	230	0	0
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		1 493	1 517	1 720	1 894	2 059	2 254	2 338	2 346
	Wind		0	2	91	321	562	739	943	973
	Solar		7	24	59	123	280	650	1 165	1 691
	Other RES		0	1	3	4	6	8	12	19
Gross consumption, GWh			7 934	9 543	10 453	11 451	12 253	13 257	14 006	14 666
Net electricity generation, GWh	Total		8 541	7 236	7 098	7 131	6 883	8 245	9 326	10 228
	Coal and lignite		4 874	3 462	2 551	1 615	311	422	0	0
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		3 660	3 744	4 303	4 764	5 193	5 725	6 305	6 610
	Wind		0	3	173	613	1 075	1 412	1 802	1 856
	Solar		7	25	59	123	282	654	1 172	1 689
	Other RES		0	2	11	16	22	32	47	73
Net import, GWh	Total		-608	2 307	3 355	4 320	5 371	5 013	4 681	4 438
	HR		30	1 527	3 128	4 483	4 554	6 004	2 634	2 147
	BA_SRP		-638	780	228	-163	817	-991	2 047	2 290
Net import ratio, %			-7.7%	24.2%	32.1%	37.7%	43.8%	37.8%	33.4%	30.3%
RES-E share (RES-E production/gross consumption, %)			46.2%	39.5%	43.5%	48.2%	53.6%	59.0%	66.6%	69.7%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	49.4%
	Wind		na	na	na	na	na	na	na	45.0%
	Solar		na	na	na	na	na	na	na	69.5%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	41.0%	15.5%	20.9%	na	na
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		64%	23%	15%	6%	-1%	4%	1%	4%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		6.0	4.2	3.0	1.9	0.4	0.5	0	0
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		25.4	32.0	42.4	49.7	56.4	71.1	74.9	63.9
	Clean spark spread, €(2015)/MWh		-8.5	-4.9	-0.7	2.0	5.0	12.9	14.6	3.0
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	42.2	52.5	59.6	66.8	81.7	85.6	74.5
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0.2	3.5	4.0	5.0	5.1	6.7	51.5
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	5.6	1.2	1.8	0	0
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	54	383	562	628	757	1 023	816
	Total		na	54	383	562	628	757	1 023	816
Main assumptions	Coal price, €(2015)/GJ		1.8	2.0	1.9	1.9	2.0	2.0	2.0	2.0
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

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TABLE A15 | 'NO TARGET' SCENARIO, REPUBLIKA SRPSKA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	900	900	900	900	900	300	300	300
		New	0	600	600	600	600	600	600	600
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		662	662	662	662	687	842	1 032	1 172
	Wind		0	35	35	26	71	194	510	1 084
	Solar		2	19	19	19	28	46	93	181
	Other RES		0	1	1	1	1	2	3	3
Gross consumption, GWh			4 244	4 582	5 026	5 514	5 900	6 383	6 675	6 969
Net electricity generation, GWh	Total		6 402	10 851	10 851	10 525	9 458	9 078	8 640	6 661
	Coal and lignite		4 100	8 462	8 462	8 153	6 903	5 729	3 977	324
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 300	2 300	2 300	2 300	2 387	2 924	3 585	4 073
	Wind		0	67	67	50	136	372	975	2 072
	Solar		2	20	20	20	28	46	94	182
	Other RES		0	3	3	3	3	7	10	11
Net import, GWh	Total		-2 157	-6 269	-5 825	-5 011	-3 558	-2 695	-1 965	308
	HR		146	-1 272	-549	468	1 511	2 723	528	2 095
	ME		-1 977	-3 226	-1 962	-1 782	-1 727	-2 332	-1 846	-282
	RS		-798	-3 874	-2 763	-3 766	-4 186	-6 748	-2 408	-1 848
	BA_FED		472	2 104	-552	69	844	3 662	1 761	343
Net import ratio, %			-50.8%	-136.8%	-115.9%	-90.9%	-60.3%	-42.2%	-29.4%	4.4%
RES-E share (RES-E production/gross consumption, %)			54.2%	52.1%	47.5%	43.0%	43.3%	52.5%	69.9%	90.9%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	37%
	Wind		na	na	na	na	na	na	na	52%
	Solar		na	na	na	na	na	na	na	10%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	64.4%	64.4%	62.1%	52.5%	72.7%	50.4%	4.1%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		154%	222%	195%	171%	159%	106%	130%	151%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		4.6	9.0	9.0	8.6	7.2	5.8	4.0	0.3
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		25.4	30.7	42.8	14.7	13.5	13.9	6.5	-13.6
	Clean spark spread, €(2015)/MWh		-8.5	-6.1	-0.3	-10.8	-10.2	-11.3	-8.3	-16.5
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	40.9	52.8	60.2	68.4	77.6	90.5	90.5
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0	0	0.5	0.2	0	0	0
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	52.3	50.9	45.3	41.5	4.1
Investment cost, m€/5 year period	Coal and lignite		na	1 567	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	1 567	0	0	0	0	0	0
	Total RES-E		na	71	0	0	82	410	685	932
	Total		na	1 638	0	0	82	410	685	932
Main assumptions	Coal price, €(2015)/GJ		1.78	1.95	1.93	1.89	1.98	2.04	2.04	2.04
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A16 | 'DELAYED' SCENARIO, REPUBLIKA SRPSKA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	900	900	900	900	900	300	300	300
		New	0	600	600	600	600	600	600	600
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		662	662	810	837	984	1 181	1 379	1 602
	Wind		0	35	123	167	424	1 081	1 765	2 026
	Solar		2	19	44	47	80	171	353	637
	Other RES		0	1	1	1	2	3	3	6
Gross consumption, GWh			4 244	4 582	5 029	5 516	5 902	6 379	6 681	7 007
Net electricity generation, GWh	Total		6 402	10 851	11 560	10 963	10 806	11 887	10 779	10 596
	Coal and lignite		4 100	8 462	8 462	7 685	6 490	5 537	2 248	510
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 300	2 300	2 814	2 906	3 420	4 102	4 790	5 558
	Wind		0	67	236	320	811	2 066	3 374	3 867
	Solar		2	20	44	48	80	172	355	639
	Other RES		0	3	4	4	6	10	13	22
Net import, GWh	Total		-2 157	-6 269	-6 531	-5 447	-4 904	-5 508	-4 098	-3 589
	HR		161	-1 351	-942	-229	435	275	-158	-1 006
	ME		-1 560	-3 215	-1 728	-1 695	-2 328	-2 103	491	477
	RS		-1 262	-3 708	-3 796	-5 540	-6 232	-6 957	-3 384	-1 167
	BA_FED		503	2 005	-64	2 018	3 221	3 277	-1 046	-1 893
Net import ratio, %			-50.8%	-136.8%	-129.9%	-98.7%	-83.1%	-86.3%	-61.3%	-51.2%
RES-E share (RES-E production/gross consumption, %)			54.2%	52.1%	61.6%	59.4%	73.1%	99.5%	127.7%	144.0%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	51%
	Wind		na	na	na	na	na	na	na	97%
	Solar		na	na	na	na	na	na	na	35%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	64.4%	64.4%	58.5%	49.4%	70.2%	28.5%	6.5%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		154%	222%	220%	199%	205%	164%	196%	226%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		4.6	9.0	9.0	8.1	6.7	5.6	2.3	0.5
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		25.4	30.7	40.6	13.4	11.9	16.2	3.7	-31.2
	Clean spark spread, €(2015)/MWh		-8.5	-6.2	-2.4	-12.2	-11.7	-9.0	-11.2	-34.0
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	40.9	50.7	58.8	66.9	79.9	87.6	72.9
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0	0.1	1.0	1.7	5.0	7.5	40.7
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	48.9	47.6	43.8	23.4	6.5
Investment cost, m€/5 year period	Coal and lignite		na	1 567	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	1 567	0	0	0	0	0	0
	Total RES-E		na	71	344	106	539	1 214	1 404	904
	Total		na	1 638	344	106	539	1 214	1 404	904
Main assumptions	Coal price, €(2015)/GJ		1.78	1.95	1.93	1.89	1.98	2.04	2.04	2.04
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A17 | 'DECARBONISATION' SCENARIO, REPUBLIKA SRPSKA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	900	900	900	900	900	300	300	300
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		662	662	837	1 023	1 183	1 350	1 570	1 767
	Wind		0	35	159	495	1 100	1 361	1 759	1 987
	Solar		2	19	47	87	158	331	610	906
	Other RES		0	1	1	1	2	3	5	6
Gross consumption, GWh			4 244	4 581	5 027	5 515	5 903	6 377	6 682	7 003
Net electricity generation, GWh	Total		6 402	6 489	7 361	8 076	8 480	8 950	10 018	11 069
	Coal and lignite		4 100	4 100	4 100	3 485	2 098	1 312	568	200
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 300	2 300	2 906	3 552	4 111	4 690	5 454	6 138
	Wind		0	67	304	946	2 103	2 601	3 363	3 797
	Solar		2	20	48	88	159	334	614	911
	Other RES		0	3	4	5	8	13	19	24
Net import, GWh	Total		-2 157	-1 908	-2 335	-2 561	-2 577	-2 573	-3 336	-4 065
	HR		161	1 866	562	1 428	1 694	2 279	158	-490
	ME		-1 560	-2 280	-741	-1 153	-482	-1 898	353	525
	RS		-1 262	-927	-2 001	-2 262	-4 195	-4 247	-2 639	-2 403
	BA_FED		503	-567	-155	-574	405	1 294	-1 207	-1 697
Net import ratio, %			-50.8%	-41.7%	-46.4%	-46.4%	-43.7%	-40.3%	-49.9%	-58.0%
RES-E share (RES-E production/gross consumption, %)			54.2%	52.2%	64.9%	83.2%	108.1%	119.8%	141.4%	155.2%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	56%
	Wind		na	na	na	na	na	na	na	96%
	Solar		na	na	na	na	na	na	na	50%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	44.2%	26.6%	49.9%	21.6%	7.6%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		154%	138%	148%	161%	174%	124%	155%	183%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		4.6	4.6	4.6	3.8	2.2	1.3	0.6	0.2
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		25.4	31.9	42.4	14.1	11.7	17.2	3.2	-29.6
	Clean spark spread, €(2015)/MWh		-8.5	-4.9	-0.7	-11.5	-11.9	-8.0	-11.7	-32.4
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	42.1	52.4	59.5	66.7	80.9	87.1	74.5
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0	0.1	3.0	3.7	1.9	2.2	3.6
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	23.4	16.0	10.4	5.9	2.5
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	71	435	757	945	944	935	1 206
	Total		na	71	435	757	945	944	935	1 206
Main assumptions	Coal price, €(2015)/GJ		1.8	2.0	1.9	1.9	2.0	2.0	2.0	2.0
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A18 | SENSITIVITY ANALYSIS – LOW CARBON PRICE, REPUBLIKA SRPSKA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	900	900	900	900	900	300	300	300
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		662	662	849	1 031	1 206	1 388	1 609	1 792
	Wind		0	35	159	495	1 204	1 599	1 908	2 059
	Solar		2	19	51	107	206	404	606	943
	Other RES		0	1	2	2	3	4	5	7
Gross consumption, GWh			4 248	4 585	5 035	5 532	5 925	6 394	6 719	7 053
Net electricity generation, GWh	Total		6 402	6 489	7 413	8 599	10 445	9 535	10 955	11 780
	Coal and lignite		4 100	4 100	4 100	3 954	3 735	1 234	1 108	742
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 300	2 300	2 950	3 583	4 190	4 821	5 580	6 179
	Wind		0	67	304	946	2 303	3 057	3 640	3 907
	Solar		2	20	51	107	207	407	606	924
	Other RES		0	3	8	9	11	16	21	28
Net import, GWh	Total		-2 154	-1 903	-2 377	-3 068	-4 520	-3 141	-4 237	-4 726
	HR		156	1 895	234	239	-385	1 146	-1 008	-481
	ME		-1 576	-3 123	-865	-729	-838	-843	-506	-88
	RS		-1 271	-136	-1 221	-1 088	-2 104	-4 236	-2 964	-3 238
	BA_FED		537	-539	-524	-1 489	-1 193	792	242	-920
Net import ratio, %			-50.7%	-41.5%	-47.2%	-55.5%	-76.3%	-49.1%	-63.1%	-67.0%
RES-E share (RES-E production/gross consumption, %)			54.2%	52.1%	65.8%	84.0%	113.3%	129.8%	146.6%	156.5%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	56.7%
	Wind		na	na	na	na	na	na	na	99.0%
	Solar		na	na	na	na	na	na	na	52.0%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	50.2%	47.4%	47.0%	42.2%	28.2%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		154%	138%	150%	162%	178%	131%	161%	187%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		4.6	4.6	4.6	4.4	4.2	1.2	1.1	0.7
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		22.5	28.4	36.4	3.3	-1.4	7.8	-15.3	-54.2
	Clean spark spread, €(2015)/MWh		-11.3	-8.5	-6.7	-22.3	-25.1	-17.4	-30.1	-57.1
Price impacts	Electricity wholesale price, €(2015)/MWh		31.8	38.5	46.5	48.7	53.5	71.6	68.6	49.9
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0	0.3	15.8	25.7	28.5	30.3	56.2
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	26.7	29.4	9.7	11.5	9.3
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	71	454	758	1 241	994	1 003	1 066
	Total		na	71	454	758	1 241	994	1 003	1 066
Main assumptions	Coal price, €(2015)/GJ		1.78	1.95	1.93	1.89	1.98	2.04	2.04	2.04
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		4.30	7.50	11.25	16.75	21.00	25.00	34.50	44.00

TABLE A19 | SENSITIVITY ANALYSIS – LOW DEMAND, REPUBLIKA SRPSKA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	900	900	900	900	900	300	300	300
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		662	662	810	923	1 078	1 257	1 464	1 653
	Wind		0	35	123	264	672	1 087	1 662	1 792
	Solar		2	19	44	62	112	212	400	620
	Other RES		0	1	1	1	2	3	4	5
Gross consumption, GWh			4 244	4 536	4 915	5 324	5 623	5 991	6 220	6 430
Net electricity generation, GWh	Total		6 402	6 489	7 197	7 471	7 806	7 986	9 241	10 049
	Coal and lignite		4 100	4 100	4 100	3 693	2 656	1 316	559	238
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 300	2 300	2 814	3 207	3 745	4 367	5 086	5 742
	Wind		0	67	236	505	1 285	2 079	3 177	3 426
	Solar		2	20	44	62	112	213	403	623
	Other RES		0	3	4	4	7	11	16	20
Net import, GWh	Total		-2 157	-1 953	-2 282	-2 146	-2 184	-1 995	-3 021	-3 619
	HR		217	1 435	261	981	1 386	2 066	296	-247
	ME		-1 842	-2 361	-774	-1 599	-56	-922	353	848
	RS		-1 212	-551	-39	-946	-2 842	-5 320	-2 304	-2 945
	BA_FED		680	-476	-1 731	-583	-672	2 181	-1 366	-1 276
Net import ratio, %			-50.8%	-43.1%	-46.4%	-40.3%	-38.8%	-33.3%	-48.6%	-56.3%
RES-E share (RES-E production/gross consumption, %)			54.2%	52.7%	63.0%	71.0%	91.6%	111.3%	139.6%	152.6%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	52.3%
	Wind		na	na	na	na	na	na	na	86.2%
	Solar		na	na	na	na	na	na	na	34.2%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	46.8%	33.7%	50.1%	21.3%	9.0%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		154%	140%	148%	150%	167%	121%	157%	188%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		4.6	4.6	4.6	4.1	2.9	1.3	0.6	0.2
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		25.4	31.6	42.3	14.6	15.3	25.2	0.2	-28.8
	Clean spark spread, €(2015)/MWh		-8.5	-5.3	-0.8	-11.0	-8.4	0	-14.7	-31.6
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	41.8	52.4	60.0	70.2	89.0	84.1	75.3
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0	0.2	3.0	4.1	0.8	0	0
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	25.8	21.6	11.1	6.3	3.3
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	71	344	359	762	922	1 274	743
	Total		na	71	344	359	762	922	1 274	743
Main assumptions	Coal price, €(2015)/GJ		1.8	2.0	1.9	1.9	2.0	2.0	2.0	2.0
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A20 | SENSITIVITY ANALYSIS – HIGH DEMAND, REPUBLIKA SRPSKA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	900	900	900	900	900	300	300	300
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		662	662	849	1 031	1 206	1 398	1 609	1 792
	Wind		0	35	159	495	1 206	1 599	1 908	2 059
	Solar		2	19	51	107	206	430	702	1 031
	Other RES		0	1	2	2	3	4	6	8
Gross consumption, GWh			4 244	4 627	5 140	5 712	6 189	6 774	7 195	7 630
Net electricity generation, GWh	Total		6 402	6 489	7 413	8 023	8 711	9 581	10 463	11 439
	Coal and lignite		4 100	4 100	4 100	3 377	1 997	1 215	504	260
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 300	2 300	2 950	3 583	4 190	4 858	5 587	6 204
	Wind		0	67	304	946	2 306	3 057	3 645	3 922
	Solar		2	20	51	107	207	433	705	1 024
	Other RES		0	3	8	9	12	17	22	30
Net import, GWh	Total		-2 157	-1 862	-2 272	-2 311	-2 521	-2 807	-3 269	-3 809
	HR		-197	1 640	870	1 494	1 785	1 851	-550	-1 058
	ME		-1 486	-1 837	-1 068	-1 196	-580	-1 103	528	-55
	RS		-915	-820	-2 042	-2 451	-3 904	-5 272	-2 478	-2 187
	BA_FED		441	-845	-32	-158	177	1 717	-769	-509
Net import ratio, %			-50.8%	-40.3%	-44.2%	-40.5%	-40.7%	-41.4%	-45.4%	-49.9%
RES-E share (RES-E production/gross consumption, %)			54.2%	51.6%	64.4%	81.3%	108.5%	123.5%	138.4%	146.5%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	56.7%
	Wind		na	na	na	na	na	na	na	99.0%
	Solar		na	na	na	na	na	na	na	56.8%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	42.8%	25.3%	46.2%	19.2%	9.9%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		154%	136%	145%	154%	166%	120%	144%	165%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		4.6	4.6	4.6	3.7	2.1	1.2	0.5	0.3
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		25.4	32.3	42.6	49.6	56.2	68.8	71.6	61.5
	Clean spark spread, €(2015)/MWh		-8.5	-4.6	-0.5	1.9	4.8	10.6	11.3	0.6
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	42.4	52.7	59.5	66.5	79.5	82.3	72.2
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0	0.3	12.3	17.8	16.7	14.6	33.0
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	21.9	14.5	9.0	4.9	3.0
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	71	454	758	1 244	1 028	1 028	1 060
	Total		na	71	454	758	1 244	1 028	1 028	1 060
Main assumptions	Coal price, €(2015)/GJ		1.8	2.0	1.9	1.9	2.0	2.0	2.0	2.0
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A21 | SENSITIVITY ANALYSIS – LOW RENEWABLE POTENTIAL, REPUBLIKA SRPSKA

			2016	2020	2025	2030	2035	2040	2045	2050
Installed capacity, MW	Coal, lignite	Existing	900	900	900	900	900	300	300	300
		New	0	0	0	0	0	0	0	0
	Natural gas	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	Nuclear	Existing	0	0	0	0	0	0	0	0
		New	0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		662	662	802	935	1 044	1 205	1 360	1 440
	Wind		0	36	137	371	575	760	913	936
	Solar		2	19	54	115	258	539	873	1 213
	Other RES		0	1	2	2	3	4	6	9
Gross consumption, GWh			4 244	4 581	5 027	5 515	5 903	6 376	6 686	7 004
Net electricity generation, GWh	Total		6 402	6 490	7 208	7 594	7 117	7 497	7 960	8 266
	Coal and lignite		4 100	4 100	4 100	3 511	2 120	1 298	589	243
	Natural gas		0	0	0	0	0	0	0	0
	Nuclear		0	0	0	0	0	0	0	0
	HFO/LFO		0	0	0	0	0	0	0	0
	Hydro		2 300	2 300	2 786	3 250	3 626	4 188	4 725	4 991
	Wind		0	68	262	708	1 099	1 453	1 745	1 785
	Solar		2	20	54	116	259	543	878	1 211
	Other RES		0	3	7	9	12	16	24	36
Net import, GWh	Total		-2 157	-1 909	-2 182	-2 080	-1 214	-1 121	-1 274	-1 262
	HR		221	1 511	117	1 460	1 896	1 854	112	638
	ME		-1 871	-2 131	-723	-1 104	-280	-897	697	1 295
	RS		-1 145	-510	-1 348	-2 598	-2 013	-3 070	-37	-905
	BA_FED		638	-780	-228	163	-817	991	-2 047	-2 290
Net import ratio, %			-50.8%	-41.7%	-43.4%	-37.7%	-20.6%	-17.6%	-19.1%	-18.0%
RES-E share (RES-E production/gross consumption, %)			54.2%	52.2%	61.8%	74.0%	84.6%	97.2%	110.2%	114.5%
Utilisation rates of RES-E technical potential, %	Hydro		na	na	na	na	na	na	na	45.5%
	Wind		na	na	na	na	na	na	na	45.0%
	Solar		na	na	na	na	na	na	na	66.9%
Utilisation rates of conventional power production, %	Coal and lignite		52.0%	52.0%	52.0%	44.5%	26.9%	49.4%	22.4%	9.2%
	Natural gas		na	na	na	na	na	na	na	na
	Nuclear		na	na	na	na	na	na	na	na
Natural gas consumption of power generation, TWh			0	0	0	0	0	0	0	0
Security of supply	Generation adequacy margin		154%	138%	142%	146%	150%	99%	119%	128%
	System adequacy margin		na	na	na	na	na	na	na	na
CO_2 emission	Emission, Mt CO_2		4.6	4.6	4.6	3.9	2.3	1.3	0.6	0.2
	CO_2 emission reduction compared to 1990, %		na	na	na	na	na	na	na	na
Spreads	Clean dark spread, €(2015)/MWh		25.4	32.0	42.4	49.7	56.4	71.1	74.9	63.9
	Clean spark spread, €(2015)/MWh		-8.5	-4.9	-0.7	2.0	5.0	12.9	14.6	3.0
Price impacts	Electricity wholesale price, €(2015)/MWh		34.7	42.2	52.5	59.6	66.8	81.7	85.6	74.5
	Total RES-E support/gross consumption, €(2015)/MWh, five year average		na	0	0.3	7.8	9.7	9.7	12.6	93.0
	Revenue from CO_2 auction/gross consumption, €(2015)/MWh		0	0	0	23.6	16.1	10.3	6.1	3.1
Investment cost, m€/5 year period	Coal and lignite		na	0	0	0	0	0	0	0
	Natural gas		na	0	0	0	0	0	0	0
	Total Fossil		na	0	0	0	0	0	0	0
	Total RES-E		na	71	361	570	551	737	819	654
	Total		na	71	361	570	551	737	819	654
Main assumptions	Coal price, €(2015)/GJ		1.8	2.0	1.9	1.9	2.0	2.0	2.0	2.0
	Lignite price, €(2015)/GJ		0.98	1.07	1.06	1.04	1.09	1.12	1.12	1.12
	Natural gas price, €(2015)/MWh		21.58	23.52	26.58	28.78	30.87	34.44	35.52	35.79
	CO_2 price, €(2015)/t		8.60	15.00	22.50	33.50	42.00	50.00	69.00	88.00

TABLE A22 | BREAK DOWN OF CUMULATIVE CAPITAL EXPENDITURE BY RES TECHNOLOGY (m€)

Capital expenditures	No target 2016-2050	Delayed 2016-2050	Decarbon 2016-2050
Biogas	24	36	76
Solid biomass	2	9	93
Biowaste	0	0	0
Geothermal ele.	0	0	0
Hydro large-scale	1 297	2 361	2 566
Hydro small-scale	267	709	848
Central PV	66	228	351
Decentralised PV	198	709	1 053
CSP	0	0	0
Wind onshore	2 459	5 467	5 708
Wind offshore	0	0	0
RES-E total	4 313	9 519	10 695

TABLE A23 | DEVELOPMENT OF SUPPORT EXPENDITURES (FOR RES TOTAL) OVER TIME (5-YEAR TIME PERIODS)

Support expenditures in M€	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040	2041-2045	2046-2050	Total
No target	**24**	**54**	**36**	**6**	**–**	**–**	**–**	**121**
Central PV	4	8	7	1	–	–	–	20
Decentralised PV	5	11	8	1	–	–	–	25
Wind onshore	6	16	9	2	–	–	–	33
Delayed	**24**	**240**	**66**	**101**	**324**	**514**	**2 923**	**4 191**
Central PV	4	13	7	2	2	6	63	97
Decentralised PV	5	15	9	3	10	22	191	255
Wind onshore	6	73	20	45	184	316	1 695	2 340
Decarbon	**24**	**98**	**150**	**184**	**110**	**157**	**195**	**917**
Central PV	4	13	13	9	8	3	33	83
Decentralised PV	5	13	14	5	1	–	1	38
Wind onshore	6	52	109	168	72	2	77	487

Annex 2 | Assumptions

Assumed technology investment cost trajectories: RES and fossil

TABLE A24 | ASSUMED SPECIFIC COST TRAJECTORIES FOR RES TECHNOLOGIES (2016 €/kW)

Technology	2015	2020	2025	2030	2035	2040	2045	2050
Biogas (low cost options: landfill and sewage gas)	1 663	1 608	1 555	1 504	1 454	1 406	1 360	1 315
Biogas (high cost options: agricultural digestion in small-scale CHP plants)	5 602	5 378	5 163	4 956	4 758	4 568	4 385	4 210
Solid biomass (low cost options: cofiring)	619	597	574	553	533	513	494	476
Solid biomass (medium cost options: large-scale CHP)	2 505	2 410	2 318	2 230	2 145	2 064	1 985	1 910
Solid biomass (high cost options: small/medium-scale CHP)	4 067	3 912	3 764	3 621	3 483	3 351	3 223	3 101
Biowaste	6 840	6 573	6 317	6 070	5 833	5 606	5 387	5 177
Geothermal electricity (average cost trend for SEERMAP region – i.e. mix of high-temperature (default technology concepts) and medium-temperature resources (novel enhanced systems))	2 570	3 273	2 410	2 963	3 482	3 269	3 038	3 167
Hydro large-scale*	1 304	1 333	1 464	1 396	1 618	1 667	1 608	1 765
Hydro small-scale*	1 321	1 338	1 402	1 763	1 919	1 956	1 944	1 994
Photovoltaics*	1 309	1 015	908	824	764	693	640	596
Wind onshore*	1 491	1 395	1 311	1 271	1 246	1 199	1 150	1 125
Wind offshore*	3 797	2 693	2 636	2 521	2 407	2 293	2 416	2 346

Source: Green-X database

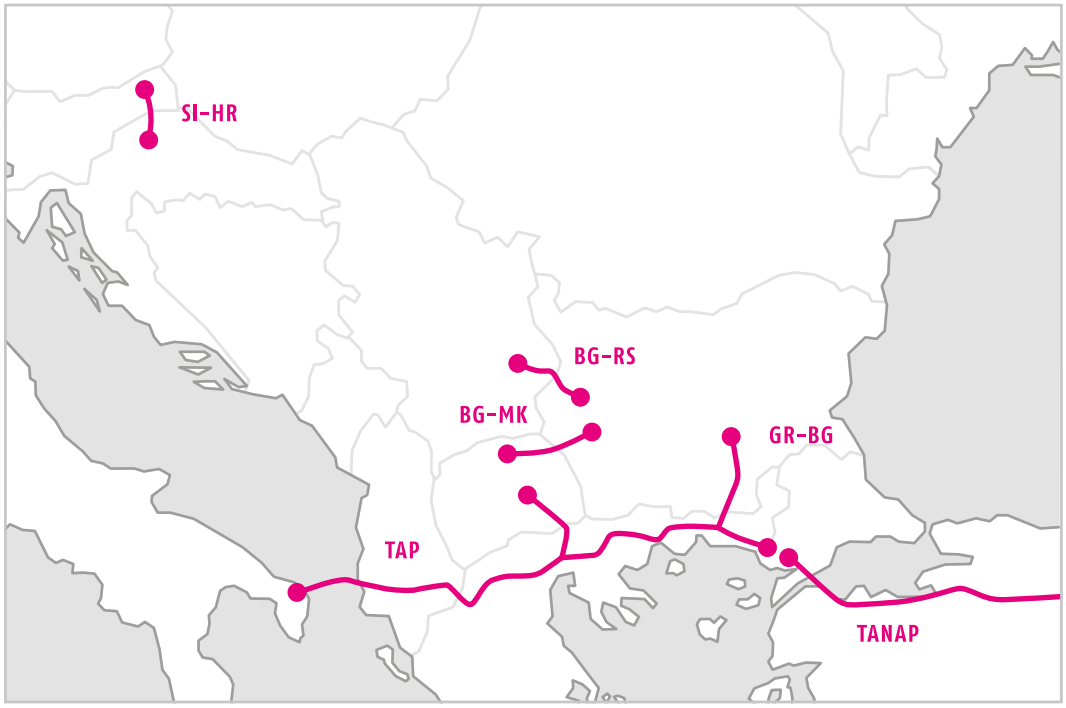
Infrastructure (table for the whole region)

TABLE A25 | NEW GAS INFRASTRUCTURE IN THE REGION

Pipeline	From	To	Capacity, GWh/day	Date of commissioning
BG-RS	BG	RS	51	2018
RS-BG	RS	BG	51	2018
TR-GR2_TAP	TR	GR	350	2019
GR-MK_TAP	GR	MK	25	2019
AZ-TR_TANAP	AZ	TR	490	2018
GR-BG	GR	BG	90	2018
GR-BG	GR	BG	151	2021
GR-IT_TAP	GR	IT	334	2019
SI-HR2	SI	HR	162	2019
HR-SI	HR	SI	162	2019
GR-AL	GR	AL	40	2019
BG-MK	BG	MK	27	2020
HR-LNG		HR	108	2020
BG-RO	BG	RO	14	2016
RO-BG	RO	BG	14	2016
GR-LNG expansion		GR	81	2017
RO-HU (BRUA)	RO	HU	126	2020
HU-RO (BRUA)	HU	RO	77	2020

Source: ENTSO-G TYNDP

FIGURE A1
NEW GAS INFRASTRUCTURE INVESTMENT ASSUMED TO TAKE PLACE IN ALL SCENARIOS



Source: ENTSO-G TYNDP 2017

TABLE A26 | CROSS BORDER TRANSMISSION NETWORK CAPACITIES

From	To	Year of commissioning	Capacity, MW O → D	Capacity, MW D → O
ME	IT	2019	500	500
ME	IT	2023	700	700
BA_FED	HR	2022	650	950
BG	RO	2020	1 000	1 200
GR	BG	2021	0	650
RS	RO	2023	500	950
ME	RS	2025	400	600
AL	RS	2016	700	700
AL	MK	2020	250	250
RS	ME	2025	500	500
RS	BA_SRP	2025	600	500
BA_SRP	HR	2030	350	250
HR	RS	2030	750	300
HU	RO	2035	200	800
RS	RO	2035	500	550
RS	BG	2034	50	200
RS	RO	2035	0	100
RS	BG	2034	400	1 500
GR	BG	2030	250	450
KO*	MK	2030	1 100	1 200
KO*	AL	2035	1 400	1 300
MD	RO	2030	500	500
BG	GR	2045	1 000	1 000
HU	RO	2043	1 000	1 000
HU	RO	2047	1 000	1 000
IT	ME	2045	2 000	2 000
IT	GR	2037	2 000	2 000
IT	GR	2045	3 000	3 000

Source: ENTSO-E TYNDP 2017

Generation units and their inclusion in the core scenarios

TABLE A27 | LIST OF GENERATION UNITS INCLUDED EXOGENOUSLY IN THE MODEL IN THE CORE SCENARIOS

Unit name	Installed capacity [MW]	Expected year of commissioning	Expected year of decommissioning	Fuel type	Type	CCS	No target	Delay	De-carbon
BA_FED Tuzla G3	100	1966	2015	lignite	thermal	no	yes	yes	yes
BA_FED Kakanj G5	110	1969	2019	lignite	thermal	no	yes	yes	yes
BA_FED Tuzla G4	200	1971	2018	lignite	thermal	no	yes	yes	yes
BA_FED Tuzla G5	200	1974	2024	lignite	thermal	no	yes	yes	yes
BA_FED Kakanj G6	110	1977	2027	lignite	thermal	no	yes	yes	yes
BA_FED Tuzla G6	220	1978	2033	lignite	thermal	no	yes	yes	yes
BA_FED Kakanj G7	230	1988	2043	lignite	thermal	no	yes	yes	yes
BA_FED Tuzla 7	450	2019	2074	lignite	thermal	no	yes	yes	no
BA_FED Kakanj 8	300	2023	2078	lignite	thermal	no	yes	yes	no
BA_FED Banovići	350	2020		lignite	thermal	no	yes	yes	no
BA_SRP Gacko	300	1983	2038	lignite	thermal	no	yes	yes	yes
BA_SRP Ugljevik A	300	1985	2040	lignite	thermal	no	yes	yes	yes
BA_SRP Stanari	300	2015	2070	lignite	thermal	no	yes	yes	yes
BA_SRP Ugljevik 3	600	2018	2073	lignite	thermal	no	yes	yes	no

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