The Future of Lignite in the Western Balkans

Scenarios for a 2040 Lignite Exit

STUDY

Agora Energiewende

enervis

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Preface

Dear reader,

In November 2020, the six Western Balkan countries signed the 'Sofia Declaration' committing themselves to climate-neutrality by 2050. The Green Agenda for the Western Balkans, adopted together with the Sofia Declaration, could pool 28 billion euros of investments to support the region's economic recovery and long-term convergence with the EU, particularly by accelerating climate protection and the clean energy transition.

Climate-neutrality by 2050 cannot be achieved without a phasing out of lignite for power production. Still, most of the power sector in the Western Balkans is yet to act. Apart from North Macedonia, no other lignite-reliant country has publicly announced a phase-out. On the contrary: 2 GW of additional lignite capacity is planned in the region either with Chinese or unclear financing; generally, in conflict with state aid rules and air pollution limits. The absence of a CO_2 pricing mechanisms contributes to these developments. Without a change in direction, countries and taxpayers will soon face stranded assets and unserviceable loans, particularly because the EU's Carbon Border Adjustment Mechanism will make the newly planned lignite units unprofitable.

To support the necessary debate on a lignite phase-out strategy for the Western Balkans, we have teamed up with enervis energy advisors and our regional think tank partners RESET from Bosnia and Herzegovina, INDEP from Kosovo and ASOR from Serbia to develop analytically robust scenarios for a lignite phase-out by 2040. The results are clear: countries in the region should align their climate and energy policies with the EU's 2030 and 2050 targets! The EU Green Deal is an opportunity for these countries to initiate a deep decarbonization of their power systems based on renewable energies. Now is the moment for the Western Balkans to seize that chance.

I hope you find this study an inspiring and enjoyable read. Your comments are of course welcome.

Dr. Patrick Graichen
Executive Director, Agora Energiewende

Key findings at a glance:

1. **The strong outlook for carbon pricing in the Western Balkans means that new lignite plants will be loss making.** 2 GW of new lignite capacity is currently planned in the region. If built, these plants will generate a cumulative loss by 2040. This is because of low efficiency of lignite mining, costs to comply with air pollution regulation and limited export opportunities after establishment of the EU Carbon Border Adjustment Mechanism (CBAM). A phase-in of carbon pricing in Energy Community countries would further increase losses.

2. **From an economic perspective, existing lignite units in the region should be closed by 2040.** A 2040 lignite exit increases system costs by 3–4 €/MWh in an unlikely scenario without carbon pricing. With the EU CBAM regime or any other form of domestic carbon pricing, closing lignite plants by 2040 lowers system costs.

3. **The planned and gradual phase-out of lignite will ensure security of supply.** Security of supply is not an issue if the gradual phase-out of lignite is accompanied by a rapid scaling of renewables, enhanced interconnections, regional power market integration, strengthening of existing hydro-storage and targeted investments in flexible gas plants. Expanding renewables also reduces import dependency of the power and energy sectors.

4. **A renewables-based power system is a 'no regret' strategy for the Western Balkans.** Replacing lignite generation by renewables lowers wholesale prices, hedges against carbon prices and avoids that fossil gas infrastructure will become stranded. Renewables deployment can largely be financed from market revenues, especially in case of carbon pricing. Renewables also come with many co-benefits such as improved air quality and new job opportunities. 'Just transition' policies would ensure that no one is left behind.

Contents

Executive summary

The power plant fleet in the Western Balkans consists mostly of hydro and lignite plants. Among the latter, 90 per cent of capacity is older than 30 years. 40 per cent is even older than 40 years.

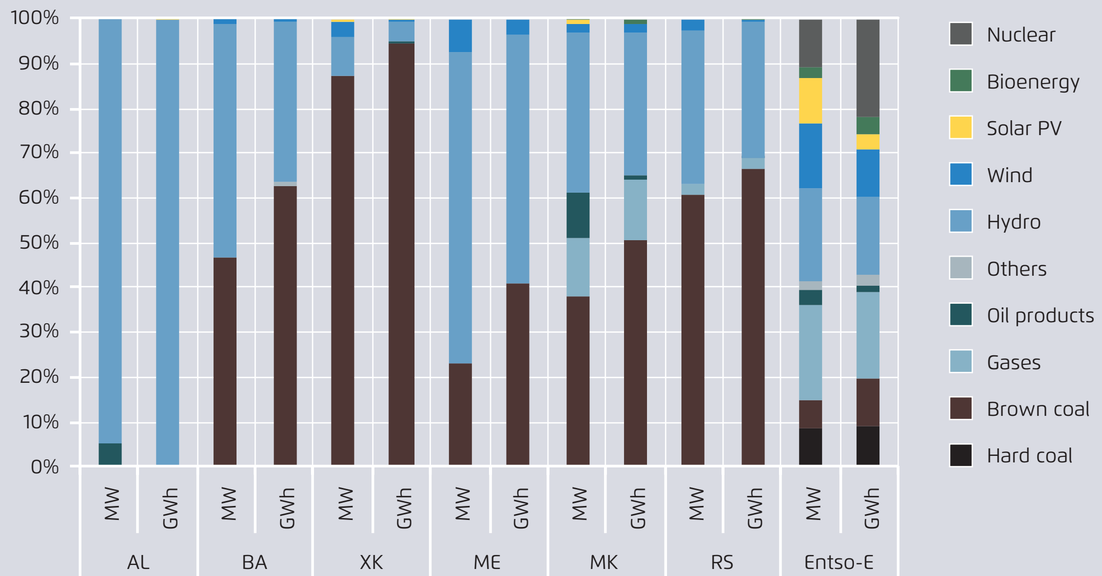
These plants release enormous amounts of air pollution, directly impacting people in the region and inducing negative health effects. Experts estimate that they cause 3,000 premature deaths every year and lead to economic damage totaling 6.1–11.5 bn € (Health and Environment Alliance (HEAL), 2019). In addition to their negative health impacts, the plants produce high levels of CO_2 emissions, are inefficient, and are dependent on high levels of government subsidies. (In 2018–2019, 150 mn € in direct subsidies went to coal electricity producers alone (Miljevic, 2020)). Air pollution regulation requires upgrading and investment for existing lignite plants in operation after 2028. Transitioning from fossil fuels will pose major challenges for the power sector in the Western Balkans, but prolonging the status quo is not a viable option in the long term.

Study objective

This study develops an outlook for the role of lignite in power generation in the Western Balkan countries and identifies possible coal exit paths. It analyzes six core power market scenarios to assess and compare two alternative energy policies strategies: i) the continuation of the current fossil-dependent energy policy ("Fossil strategy") and ii) the "Balkan Green Deal", a clean-energy transition and decarbonization strategy. A subset of scenarios assesses the opportunities and risks of the two strategies based on different types of carbon pricing: no carbon pricing, a carbon border adjustment mechanism (CBA), and the introduction of an emission trading system harmonized with the EU ETS.

2018 power mix of WB-6 countries

Figure 1



Adapted from (ENTSO-E, 2020), (eurostat, 2020)

Scenario architecture — Figure 2

SCENARIOS	Without CO_2 price	Carbon border adjustment mechanism	ETS phase-in in WB-6
"FOSSIL" Strategy	FOSSIL NONE	FOSSIL CBA	FOSSIL ETS
"Balkan GREEN DEAL" Strategy	GREEN DEAL NONE	GREEN DEAL CBA	GREEN DEAL ETS

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Planned lignite projects are not profitable

Our analysis shows that the 2 GW of lignite capacity currently planned in the region (Bosnia and Herzegovina, Kosovo and Serbia) will, if built, not be profitable with any form of carbon pricing and thus would become a stranded asset.

This is due to the low efficiency of lignite mining, the costs for complying with air pollution regulation and, importantly, the limited export opportunities because of the EU's carbon border adjustment. The phase-in of an ETS in the Energy Community would make new lignite an even riskier investment. Some of the announced plants are not even economically feasible in a world without carbon pricing.

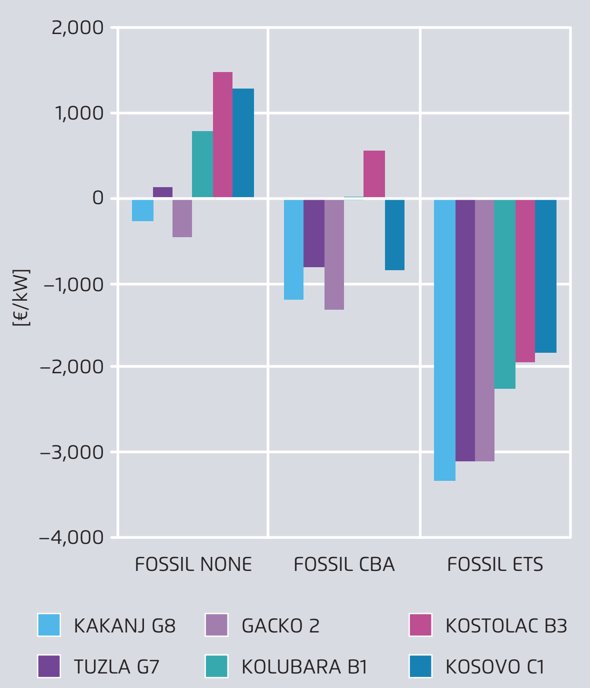
Economic and environmental performance of a lignite exit

Given air pollution regulations, the effects of carbon pricing, and the state subsidies (open and hidden) needed to keep unprofitable lignite plants in operation, replacing the existing lignite fleet in the Western Balkans with renewables by 2040 ("Balkan Green Deal") will increase generation costs by no more than 3–4 €/MWh. If an ETS were introduced, a Balkan Green Deal would effectively reduce generation costs compared with the status quo, as the carbon price would make fossil generation very expensive. The current Fossil strategy is, therefore, very vulnerable to a future phase-in of ETS, which would result in sharply rising generation costs and increasing consumer prices.

Reducing lignite-based power generation via the strategic framework and carbon pricing would significantly lower carbon emissions in the power sector. A Green Deal strategy would effectively halve the cumulative amount; the introduction of an ETS could lower it by another 24 per cent.

Replacing coal also allows for better air quality, because it eliminates the external effects from locally harmful pollutants as well.

Calculated net present values for proposed lignite projects in the region — Figure 3



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Cumulated (2020–2050) incremental generation costs in different scenarios (Green Deal minus Fossil) for the WB-6 region — Figure 4

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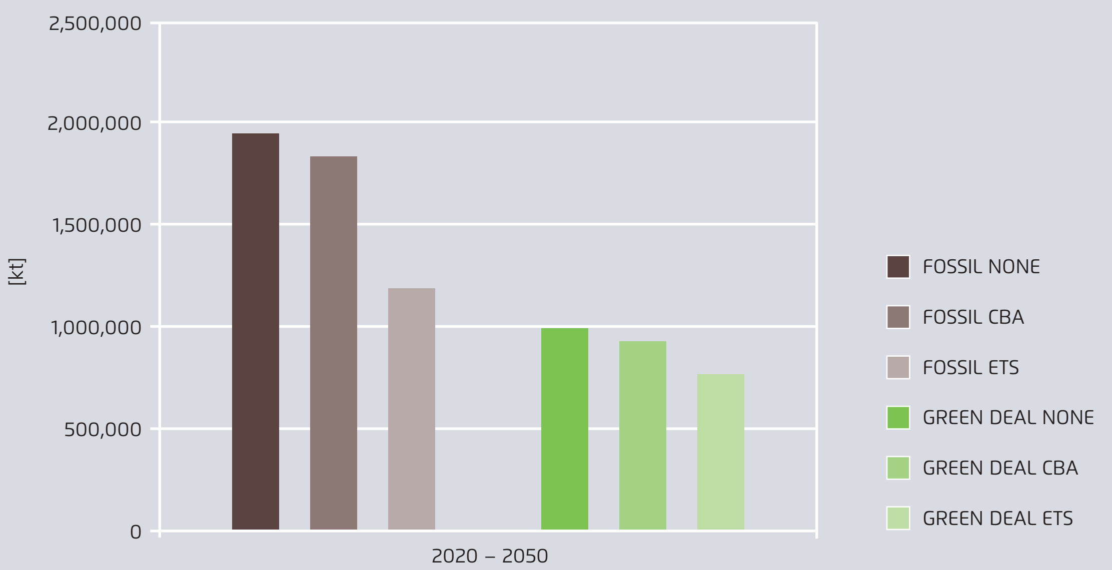
Total CO_2 emissions 2020–2050 for the WB-6 region — Figure 5



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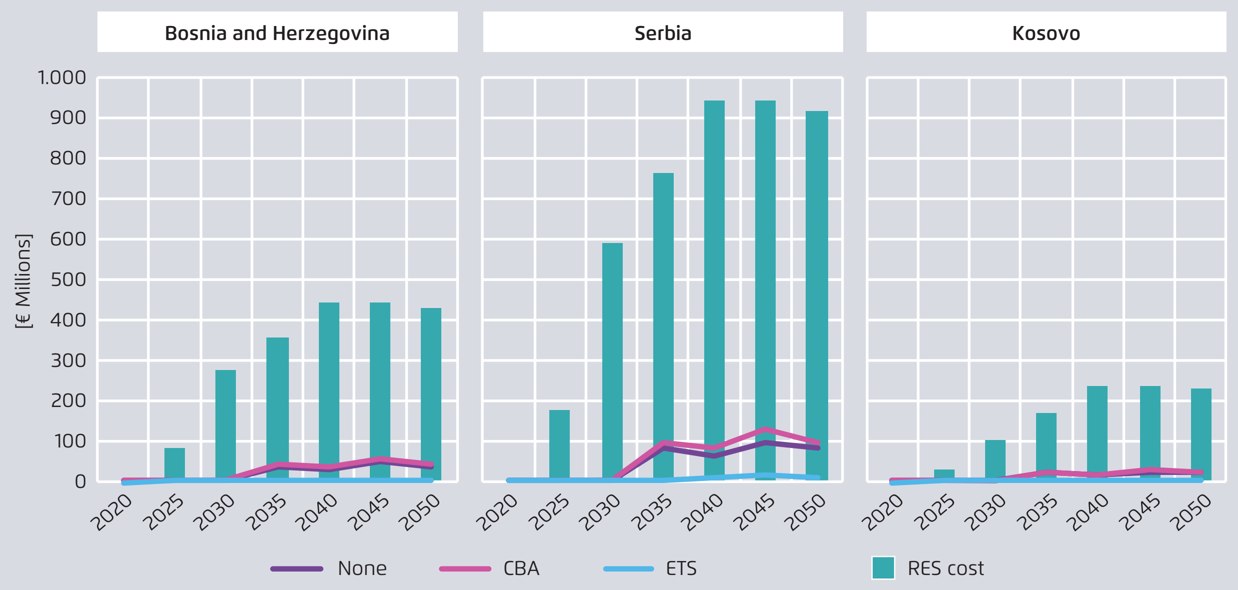
Annual RES support (lines) vs. RES system costs: Bosnia and Herzegovina, Serbia and Kosovo — Figure 6



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In all scenarios, renewables contribute to lower wholesale prices, hedge against the effects of carbon pricing, and reduce power and fuel imports. While costs for RES increase in the Balkan Green Deal scenarios simply because more RES are built compared with the Fossil scenarios, most of it is financed by market revenues (esp. in the ETS scenarios!). Thus, financial support for RES increases disproportionally.

The financial RES support needs are comparable to current estimates of direct subsidies provided to lignite electricity producers. In 2019, the lignite subsidies amounted to 22.71 million EUR in Bosnia and Herzegovina, 6.59 million EUR in Kosovo and 41.36 million EUR in Serbia (Miljevic, 2020).[1]
In addition, renewables offer opportunities for new jobs to ensure that no one is left behind when gradually closing lignite plants and mines up to 2040.

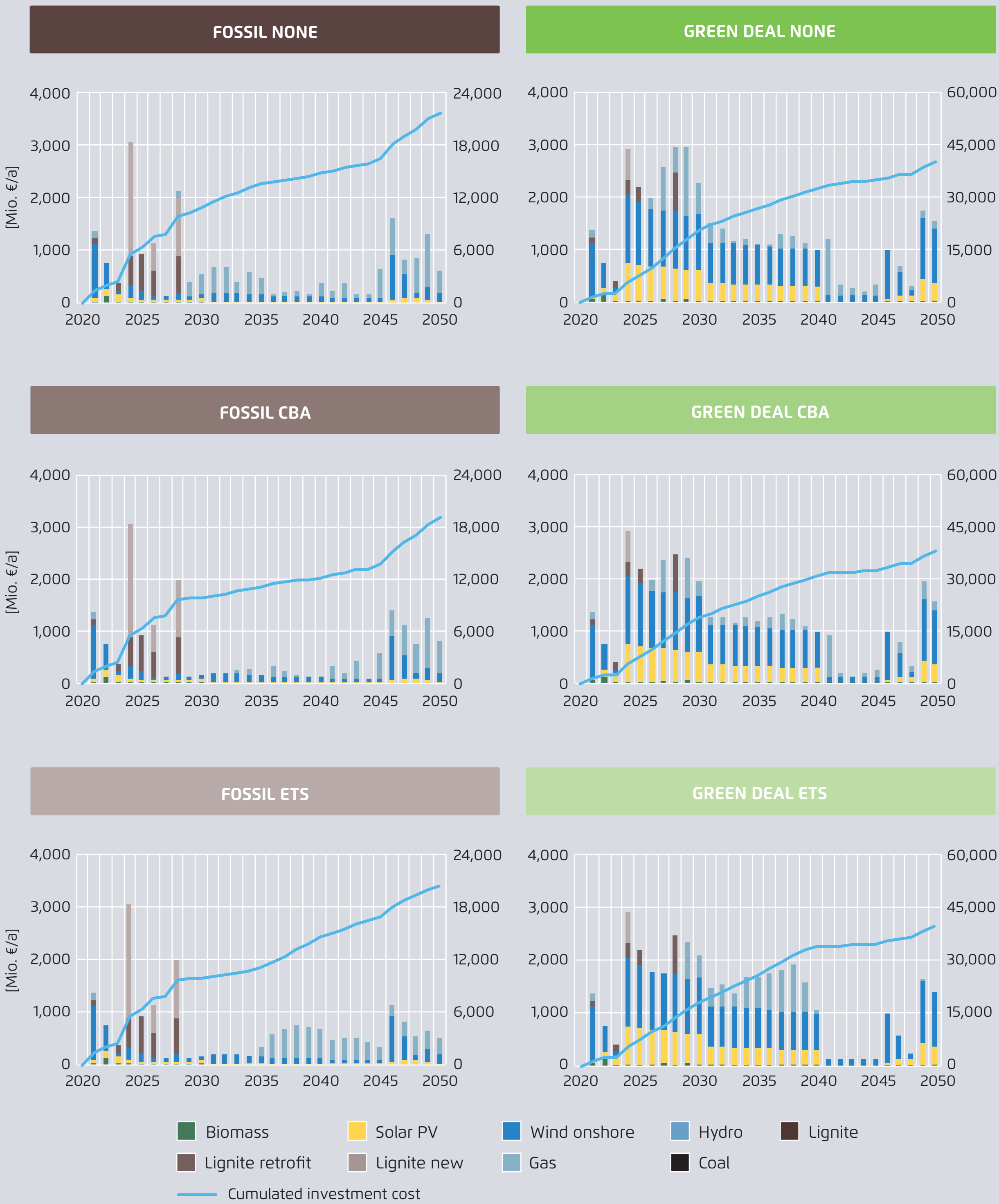
In all scenarios, wind and PV deployment across the WB-6 countries, cross-border system and regional power market integration, and limited investment in flexible gas ensured the security of supply. Expanding renewables yielded lower import dependency for the power sector.

Investments in the Fossil scenarios reached a total of 19–22 bn €, with lignite and gas investments dominating. In the Balkan Green Deal scenarios, fossil investments and other investment volumes were rerouted into renewable energy. Total investment through 2050 amounted to around 38–40 bn €. Part of the investment can be financed by the European Union and thus effectively reduced. The level of investment activity also indicates increased business activity, growth, and employment potential.

1 Miljević, 2020. Investments into the past. An analysis of Direct Subsidies to Coal and Lignite Electricity Production in the Energy Community Contracting Parties 2018–2019.

Investment needs for the WB-6 region in each of the scenarios

Figure 7



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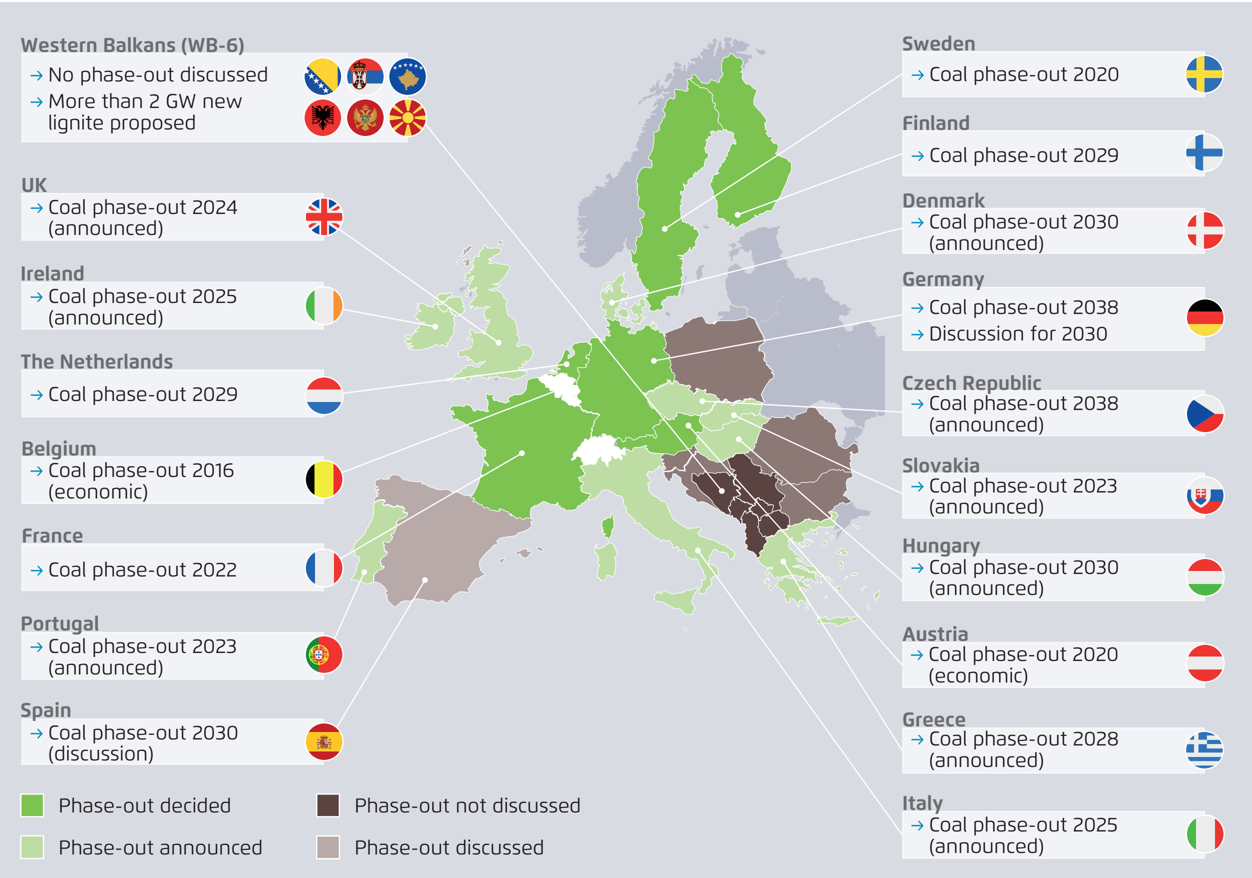
1 Introduction

Climate change and increasing global and European CO_2 reduction ambitions are driving the decommissioning of lignite-fired generation assets. The power plant fleet in the Western Balkans consists mostly of hydro and lignite stations. Among the latter, 90 per cent of capacity is older than 30 years and 40 per cent is older than 40 years. These plants produce significant amounts of air pollution, exceeding the effective limits on major pollutants in many cases by several multiples (CEE Bankwatch Network, 2019). They induce significant health effects that directly impact people in the region and in the EU. Experts estimates that they cause up to 3,000 premature deaths every year and economic damage in the range of 6.1–11.5 bn € (Health and Environment Alliance (HEAL), 2019) per year. In addition to their negative health impacts, the plants produce high levels of CO_2 emissions, are inefficient, and rely on high levels of government subsidies. (In 2018–2019, 150 mn € in direct subsidies went to coal electricity producers alone (Miljevic, 2020)). Transitioning from fossil fuels will pose major challenges for the power sector in the Western Balkans, but prolonging the status quo is not a viable option in the long term.

Overview of coal exit policies across Europe — Figure 8



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Across Europe, coal exit dates before or by 2030 have been decided or announced by the majority of countries not having effected phase-outs already. Within the countries pursuing a coal exit strategy, only Germany and the Czech Republic have announced a later phase-out year – 2038 (see Figure 8).

To date, none of the Western Balkan countries (WB-6) have announced similar plans. Instead, governments have proposed new investment in coal-fired assets. This is at odds with global climate goals and techno-economic realities, and the future of such units is thus likely to be limited, especially when one considers the political aspirations of joining the European Union (EU). In December 2020, the EU increased its reduction target for greenhouse gases (GHG) to -55 per cent by 2030 relative to 1990 levels. By 2050, the EU wants to be climate neutral. Clearly, any alignment of the Western Balkan region with EU climate ambition levels will require direct or indirect carbon pricing.

A coal phase-out needs to be synchronized with a parallel phase-in of other technologies. It implies a substantial expansion of renewable energies (RES) flanked by storage technologies and gas capacities. These technologies can provide substantial investment opportunities, and the construction and operation of these capacities will create much needed employment in the region.

The transformation of the Western Balkan power systems is not only necessary; it will be a chance to align the region with megatrends in the energy sector. The new technologies for modernizing the power system must be utilized carefully and need to be addressed with a consistent energy strategy. Here, the EU's energy and financing frameworks can be an enabler for modernizing the region's power system.

The EU energy and financing background

RES deployment: De-risking and financing opportunities in the EU's MFF and Recovery funds

The EU's financing and policy environment has recognized that reducing renewable financing costs to "best in class" levels across the European continent would be both politically and economically desirable, given the imperative to rapidly replace CO_2-emitting power generation with clean alternatives across the continent while also avoiding a multi-speed Europe on renewables.

Hence, the Commission proposed to include in the new EU budget for 2021-2027 a budget guarantee mechanism for the financial de-risking of renewable energy investments within the EU and the EU's neighbourhood. The EU budget and the funds for recovery financing under Next Generation EU should thus become key enablers of lower cost of capital for RES investors. These and other "de-risking measures" available to governments will reduce renewable energy project costs to levels comparable or lower than those of fossil fuel investments. Low cost renewable energy projects are thus a real alternative for replacing old and polluting lignite power plants. As shown elsewhere, financial derisking have a considerable impact on RES financing costs, for example lowering the LCOE of onshore wind projects in Serbia by 20 per cent.[2] In turn, lowering the cost of capital for a onshore wind project from 12 per cent (SEE average) to 3.5 per cent (Germany) would mean that twice as much onshore wind generation capacity could be built with the same amount of investment capital.[3]

2 NewClimate Institute (2019): De-risking Onshore Wind Investment – Case Study: South East Europe. Study on behalf of Agora Energiewende.

3 Agora Energiewende (2018): Reducing the cost of financing renewables in Europe. Report of a multi-stakeholder dialogue on the proposed EU Renewable Energy Cost Reduction Facility.

Supporting the just transition in the EU's coal regions

Currently, 41 regions in 12 EU member states rely on economic revenues from coal mining and coal use, which provide direct employment to about 185,000 people across the EU. A phase-out of coal will decrease economic revenues and eliminate a significant number of coal-related jobs in affected regions, three-quarters of which are located in Central and Eastern Europe. The European Commission in December 2017 launched the Coal Regions in Transition Initiative to support these regions. Robust financing opportunities exist in the new EU budget through the Just Transition Fund (JTF) (overall there is € 17.5 billion available, of which € 7.5 billion are coming from the Multiannual Financial Framework (MFF) and € 10 billion from the NextGenerationEU). The JTF is considered a crucial element of the European Green Deal which aims to alleviate the social and economic costs resulting from the transition towards a climate-neutral economy, through diversifying the economic activity and helping people adapt in a changing labour market.

The EU budget foresees a new financial instrument as part of the "Invest EU" Fund. Essentially, the scheme is like an export credit guarantee.[4]

The European Commission has developed a similarly tailored new guarantee instrument for the Western Balkans under the umbrella of the "Western Balkans Investment Framework", which is updated by the Western Balkans Guarantee Facility.[5]

The Western Balkan Guarantee Facility is part of the newly established Economic and Investment Plan that shall enable economic recovery and deliver a substantial investment package for the region. The Economic and Investment Plan itself should mobilise up to EUR 9 billion of IPA III grant funding for the period 2021-2027.[6] One investment flagship specifically mentioned in the Economic and Investment Plan is the support of increased use of renewable energies. Therefore, aiming for strong RES expansion will open de-risking and financing opportunities.

Just transition and job effects

The energy transition will exacerbate existing regional and local challenges such as the downsizing of lignite-fired power production and the loss of well-paid jobs in the lignite-mining industry. Yet it is possible to phase-out coal over the course of a decade or two. But such a transition must be planned well in advance and be embedded in broader regional strategies developed together with affected stakeholders. Such a just transition in coal regions must be underpinned by robust financing opportunities in the EU budget and recovery funds. Regions that are committed to phasing-out lignite mining and coal use need specific support measures to attract new employers (companies, universities, research organizations) for worker retraining and infrastructure upgrades. In some cases, it will be possible to combine the phase-out of coal-related jobs with the creation of new-energy jobs, whether in renewables or in the emerging green hydrogen economy.

The initiative "Coal regions in transition platform in the Western Balkans and Ukraine" has recently been set up, mirroring the initiative within the EU. Its

4 In an export credit guarantee a government organisation takes over risks of exporters that emerge if a foreign buyer does not pay for goods.

5 https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_1819

6 The Commission's proposal for an Instrument for Pre-Accession Assistance (IPA III) amounts to 14.5 billion EUR over 2021-2027, of which the lion's share is destined for the Western Balkans.

objective is to support transition strategies and help coal regions access financing for transition projects. In this vein, one investment flagship specifically mentioned in the Economic and Investment Plan is the support of the transition from coal.

The WB-6 region is already losing jobs in its lignite mining sector. Country data on mines and power plant employment is hard to obtain and verify though as shown in Bankwatch 2018 the total employment in the lignite mining and power sector is around 36,543 in 2017 in Bosnia and Herzegovina, Kosovo, North Macedonia, Montenegro and Serbia. Serbia holds around 40 per cent of all jobs in both mining and the power plants operation in the Western Balkans. However, even with the plans to expand lignite plants, a reduction of workplaces by around 3,900 is more likely than an actual increase. The reason for this lies in the need to bring the lignite mines into line with EU average labour productivity.[7]

With the spread of wind and solar power generation, the energy transition will offer new economic opportunities for current mining areas, especially those with high solar and wind potentials. In general, investment in renewables and energy efficiency is beneficial for employment relative to other energy investment alternatives because they are labour intensive and are difficult to relocate outside Europe. For example, compared with oil and gas sector investments, employment creation is expected to be 2.5 to 4 times larger for energy efficiency and 2.5 to 3 times larger for renewable energy.[8] A recent analysis for Germany has shown that the employment in the PV and wind sectors amounted to 150,000 jobs in 2018.[9] Case studies form other lignite regions show, that net positive employment effects are possible.[10]

Global assessments have shown that the total number of jobs in the RES sector worldwide has been 11.5 million in 2019. 3.8 million of these jobs have been in the solar PV sector. The number of jobs in renewables have increased for 42 per cent in just five years from 2015 to 2019, sending a clear signal that labour markets can change fast changing and adapt to and benefit from new realities.[11]

Market conditions for RES jobs are robust. Even during the tremendous upheaval due to the COVID-19 pandemic, jobs have been less affected in the operation of utility-scale wind and ground-mounted solar plants. By 2023, green recovery policies could create 5.5 million more jobs in energy transition-related technologies than under a business-as-usual approach around the world.[12] Moreover, if the trend of green recovery accelerates, this could create 18 million net additional jobs by 2030 due to changes in the production and use of energy.[13]

Availability of abundant and cost-efficient renewable energy emerges as a new competitive advantage that can attract follow up investments from industries

7 CEE Bankwatch (2018), The Great Coal Jobs Fraud. How unrealistic employment claims are deceiving coal mining communities in southeast Europe and delaying a just transition to sustainable energy

8 See Cedefop, OECD (2015) and Pollin et. al. (2009)

9 This figure comprises gross employment (direct and indirect employment), reflecting employment for building, installing, operating and maintaining wind and PV plants. See O'Sullivan and Edler (2020): Gross Employment Effects in the Renewable Energy Industry in Germany—An Input–Output Analysis from 2000 to 2018.

10 https://www.documents.clientearth.org/wp-content/uploads/library/2019-09-12-enervis-belchatow-lignite-power-plant-full-documentation-ext-en.pdf

11 IRENA, Renewable Energy and Jobs, Annual Review 2020.

12 Ibid.

13 EU Science Hub, Employment in the energy sector: trends and impact of the green energy transition, https://ec.europa.eu/jrc/en/science-update/employment-energy-sector, last accessed on 17.03.2021.

beyond the operation and construction of generation assets itself.

Report outline

This study models and analyzes the economic effects from different energy policies and strategies for the region. The analysis compares i) a continuation of the status quo policy (the "Fossil strategy") with ii) an energy transition-oriented policy package (the "Balkan Green Deal" strategy). The analysis includes the effects of carbon pricing on status quo policies and the opportunities provided by a sweeping transformation of power systems towards clean energy.

Among the factors considered by the study are generation costs, external costs, investment volumes, CO_2 emissions, and import dependency. The broad range of criteria enables a discussion of energy policy from a variety of perspectives and an informed ranking of the energy policy options. This allows for a nuanced view on technologies and scenarios.

Section 2 provides an overview of current Western Balkan Power markets, especially their existing lignite fleet and mines. Section 3 establishes the scenario framework and discusses its key assumptions. Section 4 presents and interprets the results of the modelling. The annex provides additional details about the study and its findings.

2 The status quo of Western Balkan power markets

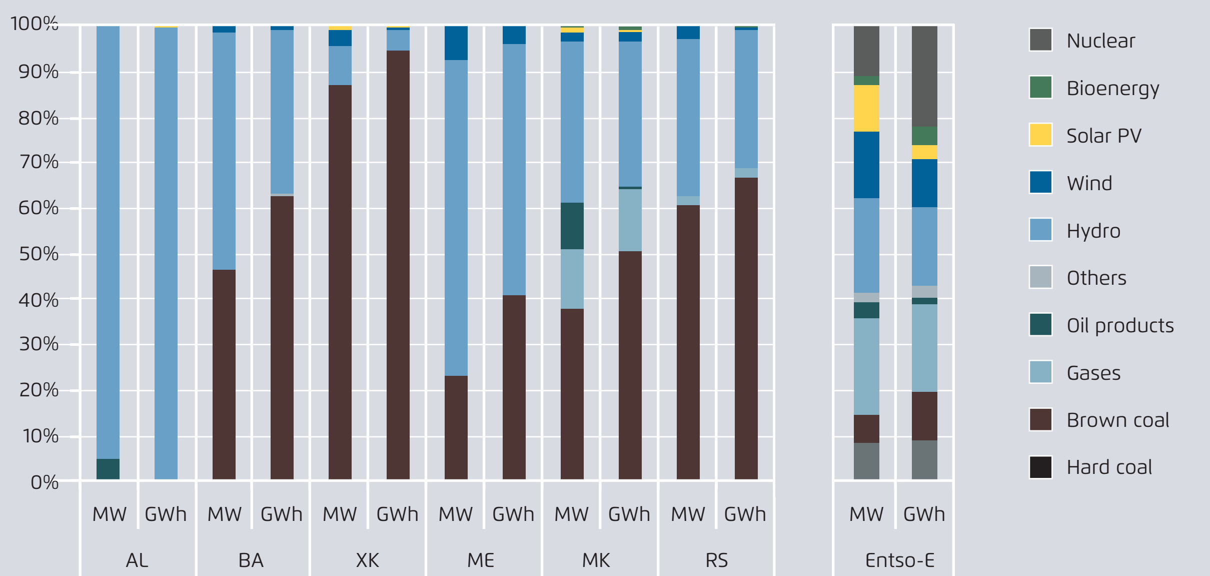
This section gives a brief overview of current power markets and lignite assets in the WB-6 region. It analyzes historical capacity, generation mixes, and trade balances and delves deeper into the region's existing lignite fleet, regulatory situation, and lignite mining economics.

2.1 Regional power mix and markets

Figure 9 shows the 2018 mix of power capacity and generation by fuel type in WB-6 countries in relative terms. For comparison, the power mix of the aggregate ENTSO-E member countries is displayed in the right section of the graph.

Two main aspects become apparent. First, the WB-6 power markets consist almost exclusively of two generation technologies: hydro and lignite. Second, the relative significance of either source varies considerably between the countries. For example, Albania's domestic power mix is exclusively based on hydro. For Montenegro's, hydro is more than half. By contrast, Kosovo's power mix relies almost exclusively on lignite, while the shares of lignite generation in Bosnia and Herzegovina, Serbia, and North Macedonia are well above 60 per cent. In all WB-6 markets, other renewables, including wind and PV, play only negligible roles. The power mix in the Western Balkan region and in the specific countries is undiversified when compared with the technology portfolio of ENTSO-E as a whole, in which gas, various renewables, and nuclear strongly reduce the relative importance of coal and lignite technologies.

2018 power mix of WB-6 countries and ENTSO-E aggregate (relative terms) Figure 9



Adapted from (ENTSO-E, 2020), (Eurostat, 2020)

Figure 10 shows the historical mix of power capacity and generation by fuel type in WB-6 countries in absolute terms.

With 37 TWh of total output, about the same as that of all other the countries combined, Serbia represents by far the largest individual power market. Likewise, Serbia has the most significant lignite-based generation – more than twice the lignite output of any other WB-6 country. Second in both metrics is Bosnia and Herzegovina, which has about half the total and half the lignite generation of Serbia. Kosovo has about half the lignite output of Bosnia and Herzegovina, despite its total market being one third the size. North Macedonia and Albania also range between 5 and 10 TWh of annual generation but are less lignite heavy than Kosovo. Montenegro is the smallest market in the region with only about a tenth the size of Serbia.

Figure 11 shows aggregate domestic power consumption, generation, and net trade positions per country in 2018.

Bosnia and Herzegovina is a net exporter by a relatively large margin, whereas Albania and Montenegro are only slight net exporters. Serbia and Kosovo are minor net importers, while North Macedonia has significant net annual imports.

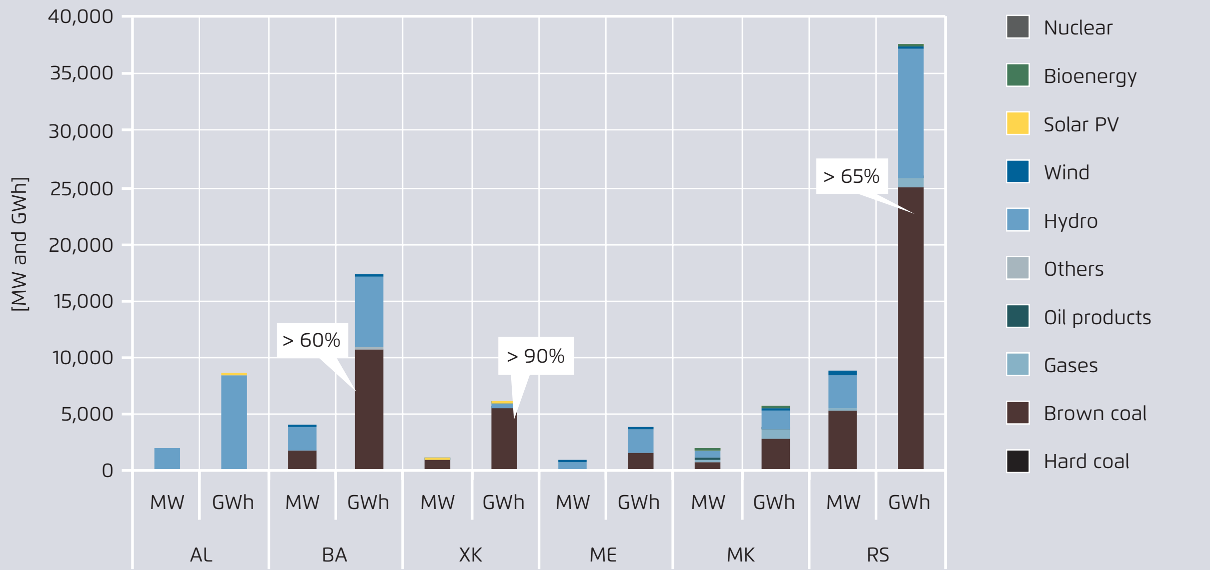
2.2 Economics of the WB-6 lignite fleet and mines

In this section, we zoom into three aspects of lignite technology in the WB-6 region.

First, we analyze the existing lignite power plant fleet with regard to age, size, distribution between countries, and emission performance. Second, we summarize air pollution regulation and its prospective impact. Last, we provide insights into the economics of the region's lignite mines.

2018 power mix of WB-6 countries in absolute numbers

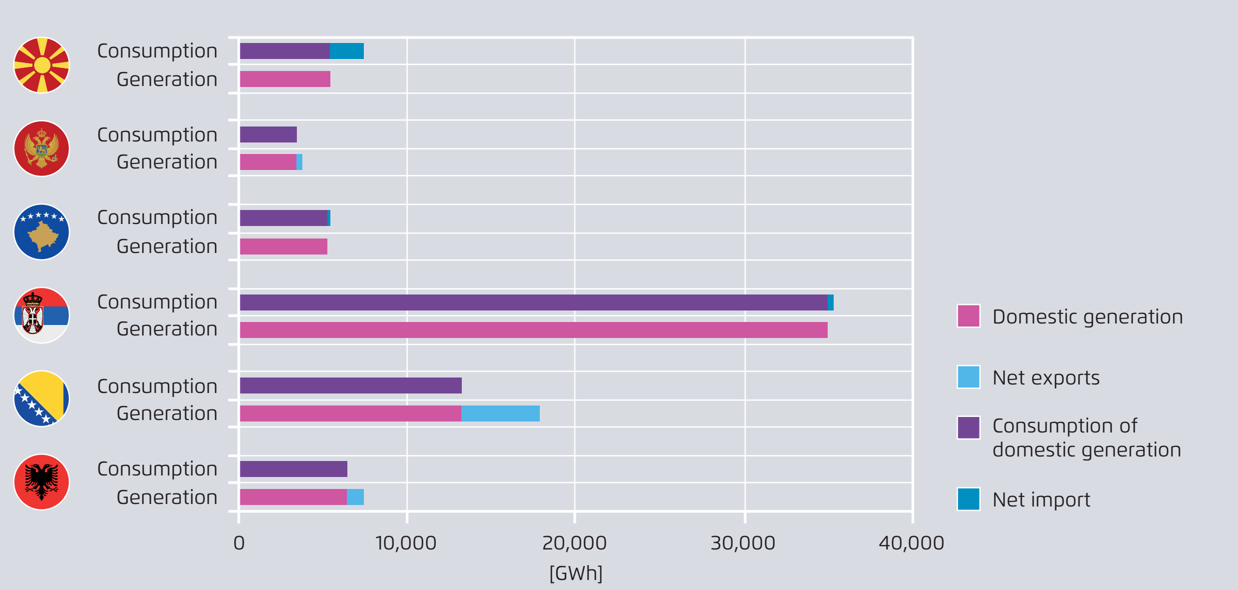
Figure 10



enervis based on (ENTSO-E, 2020), (eurostat, 2020)

2018 power trade balances of WB-6 countries

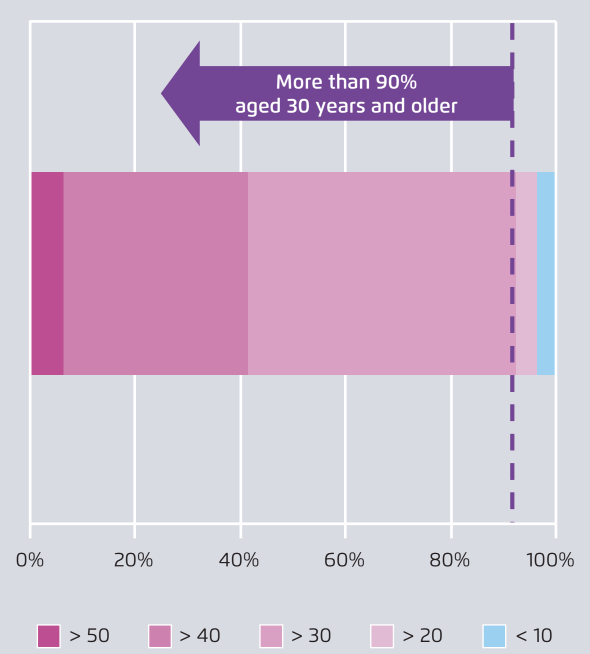
Figure 11



Adapted from (ENTSO-E, 2020), (urostat, 2020)

Distribution of WB-6 lignite fleet (capacity terms) by age cluster

Figure 12



Adapted from (Europe Beyond Coal, 2020), national and company reports

2.2.1 Analysis of the Western Balkan lignite fleet

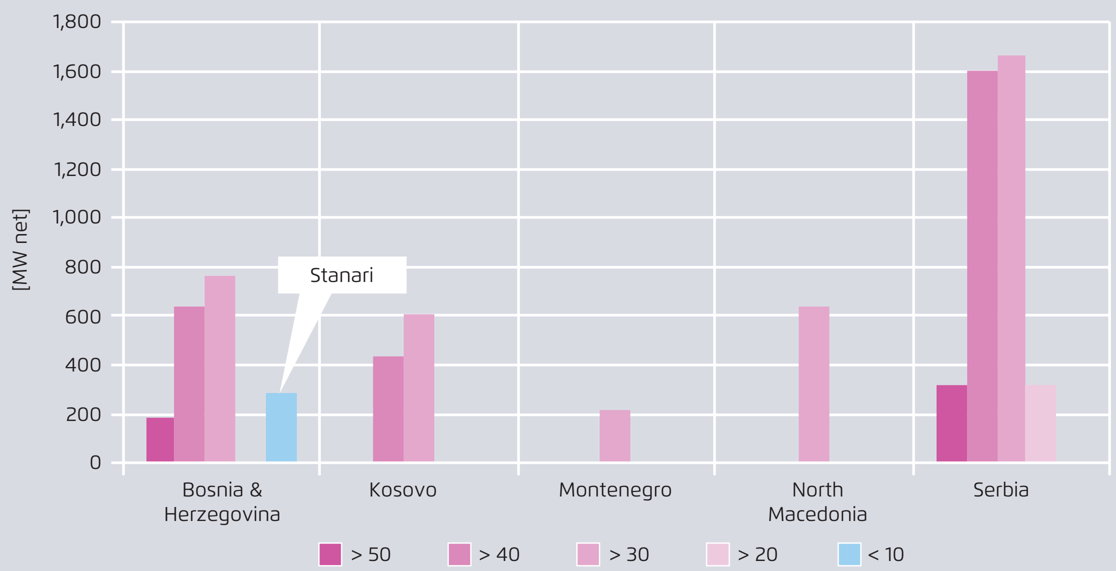
The analysis and power market modeling in this study are based on a compilation and unit-level assessment of the lignite power plants in the region. Figure 12 provides a first overview of operational lignite capacities by age group and reveals that more than 90 per cent of capacity has been commissioned 30 or more years ago. 40 per cent of capacity is older than 40 years.[14]

The age structure of the fleet clearly indicates a growing need for investment in retrofits, replacements, or alternative technologies.

In order to provide an impression of the relative role of the national lignite fleets, Figure 13 shows a breakdown of the capacities by age group and country.

14 The average lifetime of lignite power plants is 40–50 years.

Breakdown of WB-6 lignite fleet by age cluster and country — Figure 13



Adapted from (Europe Beyond Coal, 2020), national and company reports

Clearly, Serbia's roughly 4 GW lignite fleet is the largest and oldest. The youngest unit in the country, Kostolac B2, was commissioned in 1991, while the oldest unit, Kolubara A1, dates back to 1957. Bosnia and Herzegovina's lignite fleet is about half the capacity and has a similar age structure. The exception is the relatively new unit at Stanari. Operational since 2016, it represents the only one commissioned within the last two decades in the entire region. Kosovo, Montenegro, and North Macedonia rely on units older than 30 years. Albania does not have any lignite units.

The need for action becomes even more obvious when looking at emission and pollution figures of the Western Balkan lignite capacities. Figure 14 shows a summary of one of the results of an analysis focusing on pollution and compliance in 2018 (CEE Bankwatch Network, 2019). When comparing the units' actual emissions of NO_x, SO_2, and dust to the ceilings applicable via the 2018 LCPD deadline (see section 2.2.2), the extent of the non-compliance becomes apparent: nearly all the units depicted exceeded the applicable limit (the red line indicates the normalized limit).

The most striking aspect is the emission of sulphur dioxides. For example, the plant at Kakanj in Bosnia and Herzegovina emitted 17 times its ceiling value in 2018.

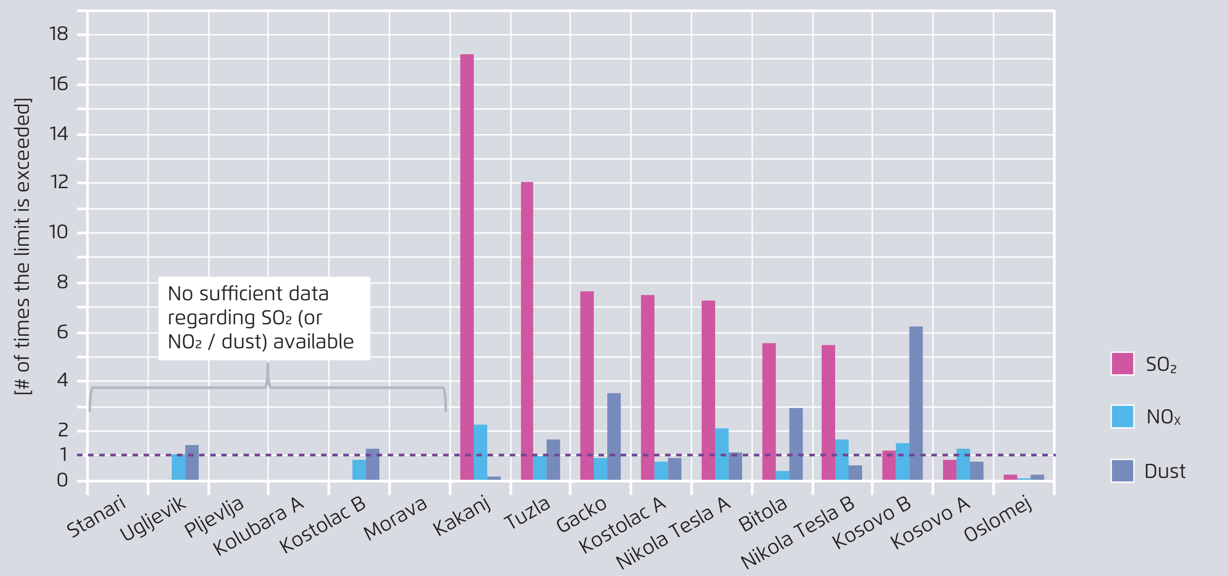
These plants produce highly significant amounts of air pollution, directly impacting people in the region and the EU and inducing significant negative health effects. Experts estimate that each year the pollution causes up to 3,000 premature deaths and leads to economic damage in the range of EUR 6.1–11.5 bn € (Health and Environment Alliance (HEAL), 2019).

2.2.2 Air pollution regulation

In order to develop realistic scenarios for the future of the region's lignite units, it is necessary to take a closer look at the regulatory framework, particularly regarding power plant emissions, which are governed by arrangements under the Energy Community treaty. Though existing provisions are already in breach, emission limits are likely to become both stricter and increasingly binding. Figure 15 summarizes the regulations and implications for power plant emission limit values (ELVs).

WB-6 lignite plants pollution compliance in 2018

Figure 14



Adapted from (Bankwatch, 2019) (accompanying dataset)

Air Pollution Regulation: EU and WB-6

Figure 15

Level	Relevant regulation	Implications
European Union	**LCPD:** Directive 2001/80/EC on large combustion plants	→ Introduction of national ceilings on emissions of NOx, SOx, particles for large (>= 50 MW) combustion plants incl. fixed deadlines → Establishment of monitoring requirements & reporting inventories
	IED: Directive 2010/75/EU on industrial emissions	→ Supersedes LCPD in 2010 → Chapter III and Annex V implement stricter ceilings 2017 via LCP BREFs (CID EU 2017/1442)
Energy Community	Energy Community Treaty	→ Adoption of core EU energy legislation, "acquis communautaire" → Incl. LCPD
	D/2013/05/MC-EnC20	→ Adopts **LCPD** emission limit values (ELVs) for EC parties → Allows for three implementation options of LCPD in WB-6 as of 2018
National	1 **NERP** (National Emission Reduction Plan)	→ Derogation of plant-level ELVs required by **LCPD** via periodical ceilings (2018, 2023, 2026, 2027) at the **national level** → By 2028, **plant-level compliance** with **IED/BREF** limits instead of LCPD
Plant	2 **Opt-Out**	→ Limited lifetime (20,000 h) derogation instead of reduction efforts → Applicable between Jan 1 2018 and Dec 31 2023
	3 **Direct compliance**	→ Direct compliance with LCPD ELVs

Adapted from (ENTSO-E, 2020), (eurostat, 2020)

At the EU level, reporting and limitation of industrial emissions were first introduced in 2001 via LCPD ("Large Combustion Plant Directive", Directive 2001/80/EC (European Commission, 2001)). In 2010, these regulations were superseded by IED ("Industrial Emissions Directive", Directive 2010/75/EU (European Commission, 2010)) and applicable LCP BREF ("BAT Reference Document" (Publications Office of the European Union, 2017)) ceilings. The Energy Community Treaty formally adopted LCPD limits only for contracting parties.

But the regional implementation mechanism provides three derogation options for lignite plants regarding the national adoption of EU standards: National Emission Reduction Plans (NERP), opting out, or direct compliance.

Figure 16 breaks down the past and future regulation periods and the attendant deadlines, including three regional options for responding to emission limit requirements.

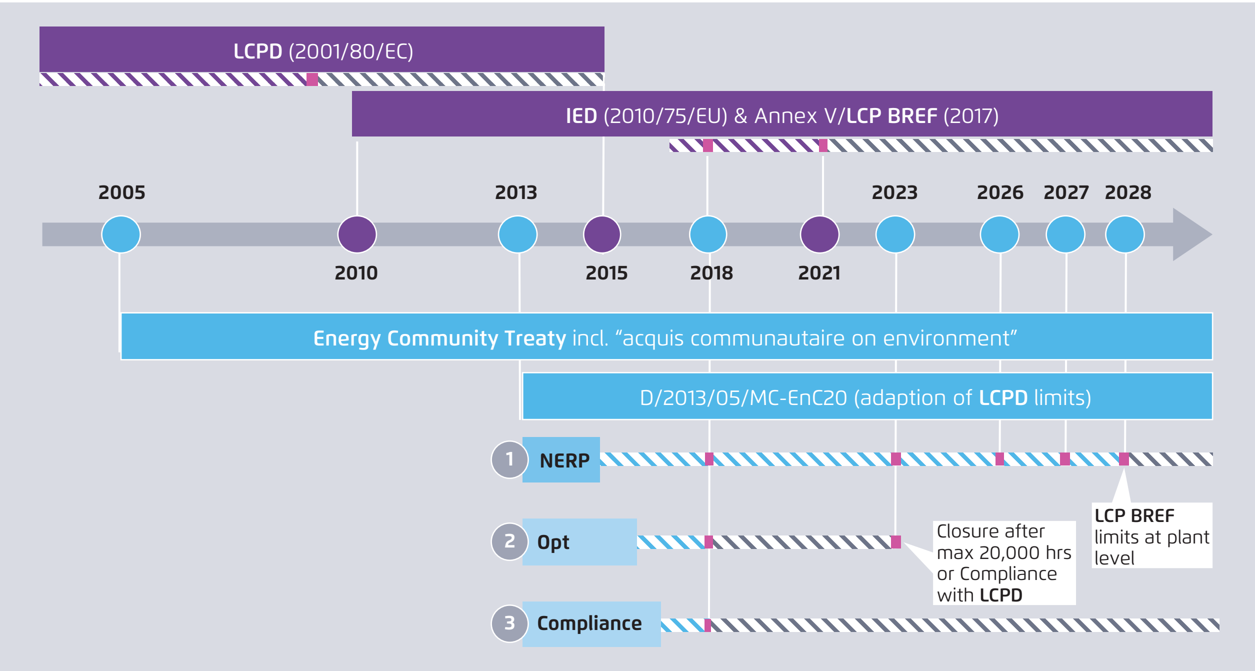
Combined, they effectively imply a 2028 final deadline for plant-level compliance with the newer and stricter EU IED via LCP BREF limits.

Considering the poor compliance performance of the operational fleet today, any compliant operation beyond 2028 will require significant refurbishment and investment.

Figure 17 depicts the current response of the Western Balkan countries to ELV regulation. Most lignite plants fall under the NERP derogation option. This formally implies obligatory refurbishment for gradual emission reduction at national level and plant-level IED compliance by 2028.

Eight plants are in the list of exempted installations and may thus continue operation until 2023. Opted-out plants enter a limited lifetime derogation granting 20,000 operating hours between the start of 2018 and the end of 2023, or ~3,300 hours per year

Timeline of pollution regulation and response options for Energy Community parties — Figure 16



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on average. Most exempted units already exceeded this share in 2018.[15] Pljevlja in Montenegro was initially exempted but is currently undergoing refurbishment.

15 See the Energy Community Annual Implementation Report 2019 for more details.

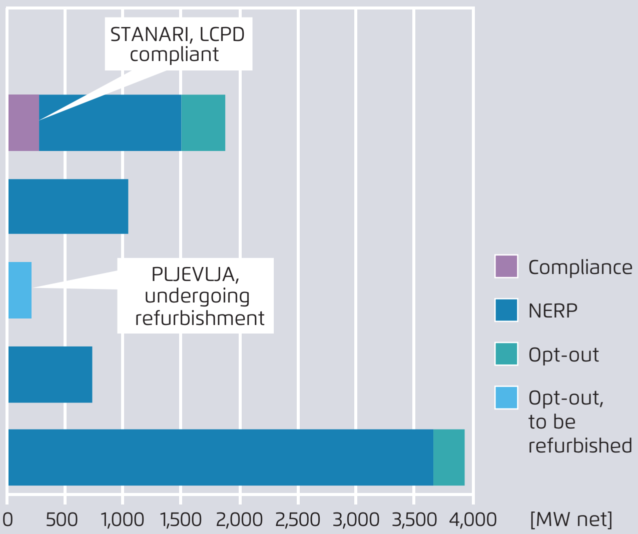
2.2.3 Lignite mining economics

To better assess the economics of lignite power plant operation, additional research was conducted regarding lignite reserves as well as the specific costs of lignite mining in the region. Figure 18 shows the results of this research. Findings indicate that lignite reserves are sufficient to continue mining at current

Overview of lignite plant capacities by derogation option — Figure 17

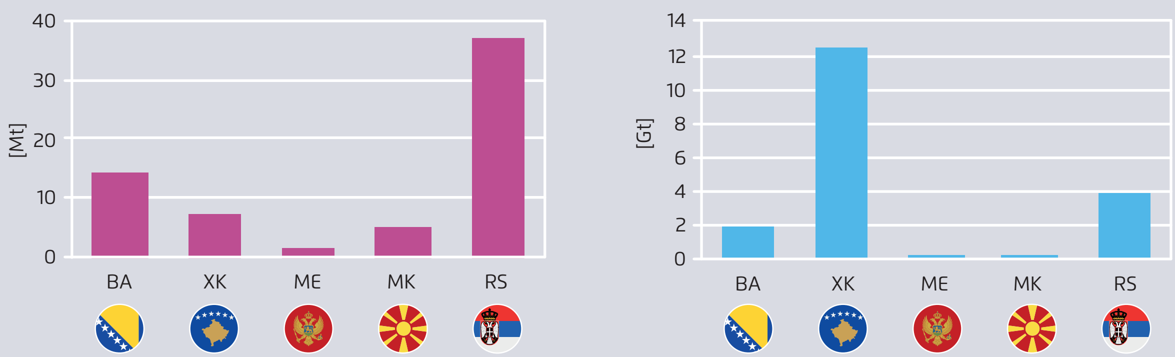
	# of plants	...of these opted out	...of these part of NERP
Albania	–	–	–
Bosnia and Herzegovina	13	3	10
Kosovo	5	0	5
Montenegro	1	1	0
North Macedonia	8	0	8
Serbia	17	4	13

Distribution of lignite capacity by option



Based on countries' NERP documents and „Summary report on final list of opted out plants" (Energy Community Secretariat, 2018)

Overview of 2018 lignite output (left) and existing reserves (right) in the region — Figure 18



WISE Europa based on company reports, national planning documents pace for 100+ years, with the exception of North Macedonia, where they will be sufficient for 25 years.

The crucial limitation for the sector is, therefore, not the availability of reserves but the supply of necessary investments and the maintenance of the mines, which generates fixed costs for lignite fuel use.

Hence, additional research was conducted on the cost situation of lignite mines in the Western Balkan region. Transparent data regarding lignite costs has been difficult to come by. Data was researched by WISE Europa and quality checked with local partners.[16] Figure 19 summarizes the results. The graph on the left shows mining productivity as measured per output of lignite per employee per year. It is clear that lignite mining in the region has a diversity of scale and, even more important, productivity.

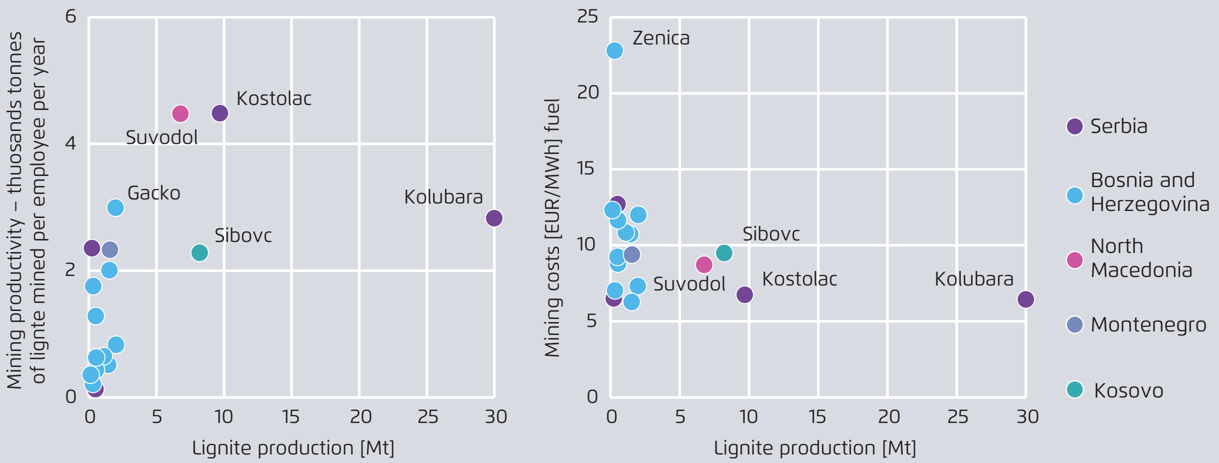
Larger mines are typically more productive and characterized by lower mining costs. Differences in heating values and labor costs further affect final fuel costs from the perspective of power plants.

The graph on the right shows calculations regarding lignite costs in euros per megawatt hour over lignite production scale. Serbia has some of the most cost-efficient mines (Kostolac, Kolubara) within the region. Bosnia and Herzegovina's generally smaller mines cover a relatively wide range of specific fuel costs, most of them among the more cost-intensive. The mines in North Macedonia, Kosovo, and Montenegro range in the mid-field.

In the long term, we can expect improvements in labor productivity to mitigate increasing labor costs, leading to lower employment in the sector.

16 Primary sources include annual reports of respective system and plant or mine operators, regulatory offices, national statistics, and national strategies. They are individually listed in section 6 (references).

Economic performance of lignite mines in the Western Balkan region — Figure 19



WISE Europa based on company reports and national planning documents as listed in section 5

2.3 Summary and conclusions

- Power markets in the WB-6 region consist almost exclusively of hydro and lignite capacities, a noticeable difference compared with the more diversified mix of ENTSO-E markets. Among the WB-6 countries, lignite shares, market sizes, and total lignite output vary significantly, though.
- Most markets in the region show fairly even electricity trade balances at annual levels, with the notable exception of Bosnia and Herzegovina, which has significant net exports.
- The WB-6 lignite fleet is severely aged, with more than 40 per cent of capacity older than 40 years and 90 per cent older than 30 years.
- Serbia operates 4 GW of lignite capacity, half of it older than 40 years. Bosnia and Herzegovina's fleet is half the size but equally old. Kosovo, North Macedonia, and Montenegro have between 1 GW and 200 MW of lignite capacity. Albania has no operational lignite units.
- The Energy Community Treaty formally adopted air pollution limitations for the contracting parties with gradual phase-in mechanisms.
- The limits of the first applicable pollution reduction deadline in 2018 were greatly exceeded. Bosnia and Herzegovina's Kakanj plant emitted as much as 17 times the permitted value of SO_2. These emissions cause strong and economically costly negative effects on public health. Compliance with these standards is likely to remain an issue.
- Most lignite plants fall under the NERP derogation option. Refurbishment will thus be required for gradual emissions reduction at the national level and for plant-level IED compliance by 2028.
- 2028 thus represents a deadline for plant-level compliance with air pollution regulation: any operation of existing plants beyond 2028 necessarily will require refurbishment and investment.
- The crucial limitation for the continued operation of lignite plants is not the availability of reserves but the ability to supply the necessary investments and mine maintenance.
- The diversity in scale and productivity of lignite mines in the Western Balkans means that the specific costs of lignite production varies greatly, which translates into differences in economic performance. The worst performing country is Bosnia and Herzegovina, while Serbia has a number of relatively efficient mines.

3 Scenario overview

This section introduces the power market scenario framework designed for the assessment of the study's questions. We also highlight some of its major assumptions and methodological aspects, with a focus on the scenario differentiators.

3.1 Power market scenario architecture

In our study, we identify six core scenarios for the six Western Balkan power markets along two dimensions: the future energy policy strategy and the presence and design of a regional carbon pricing mechanism.

The derived scenario architecture, illustrated in Figure 20, allows us to assess the general merit of the alternative energy policies, particularly the benefits and risks of carbon pricing.

The first dimension, energy strategy, distinguishes two fundamentally different energy policies.

In the **FOSSIL** scenario – representing a continuation of the current energy strategy in the region – we derived key parameters from energy planning documents currently in place in the region. The Fossil scenario contains the following assumptions regarding lignite and renewable energy deployment:

- → new lignite units are deployed as currently planned
- → existing lignite units will be modernized in order to extend their lifetimes and to be in line with air pollution requirements
- → RES undergoes slow expansion

By contrast, the **BALKAN GREEN DEAL** scenario represents a framework in which energy policy objectives focus on alignment with EU targets for decarbonizing the energy system. The scenario

Scenario architecture

Figure 20

SCENARIOS	Without CO_2 price	Carbon border adjustment mechanism	ETS phase-in in WB-6
"FOSSIL" Strategy	FOSSIL NONE	FOSSIL CBA	FOSSIL ETS
"Balkan GREEN DEAL" Strategy	GREEN DEAL NONE	GREEN DEAL CBA	GREEN DEAL ETS

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assumes an ambitious reduction in coal generation and the steering of future investment towards renewable energies. The Balkan Green Deal framework contains the following assumptions regarding lignite and renewable energy deployment:

→ none of the currently proposed new lignite projects are deployed;
→ existing units are modernized only partially and phased out by 2040; and
→ RES undergoes strong expansion.

The second dimension accounts for three possible carbon pricing regimes. Accordingly, it models three sub-scenarios for the Fossil and the Balkan Green Deal strategies:

→ **"NONE"** represents an extrapolation of the status quo, with no carbon pricing on power plant emissions within the WB-6;
→ **"CBA"** analyzes the effects of a carbon border adjustment mechanism implemented on power exports from WB-6 to EU countries; and

Overview of the main assumptions in the modelled power market scenarios — Figure 21

	"FOSSIL" Scenarios	"GREEN DEAL" Scenarios
Fuel prices	Avg. futures quotes March 2020 for front years to 2023 / 2030–2040 IEA WEO 2019 "Stated Policies" scenario	
CO_2 pricing – EU	EU ETS price acc. to TYNDP 2020 "Distributed Energy" scenario (53 €/t CO_2 in 2030)	
CO_2 pricing – WB-6	No CO_2 pricing on power generation in WB-6 region.	
	Carbon Border Adjustment Mechanism on power exports to EU/phase-in 2025–2030 up to EU ETS level	
	ETS in WB-6 / phase-in 2025 to 2030 to EU ETS price of current ambition level (32 €/t CO2, EU Reference sc.)	
Coal-fired capacities – EU	National coal phase-outs as planned or announced	
Coal-fired capacities – WB-6	Existing: Modernization to make units compliant	Existing: Partial modernization
	NEW: Realization of planned projects	No NEW COAL investment
Deployment of RES – WB-6	According to national targets	According to national targets & replacement of coal (intertemporal balancing of the coal generation gap)
Gas-fired capacities	Merchant & SoS driven deployment in all regions	
Market design	Implementation of EU target model, esp. full establishment of day-ahead wholesale markets & market coupling	
Electricity demand	Based on projections in national planning documents	
Interconnection	Data from entso-e transparency platform / Projections based on entso-e Ten-Year Network Development Plan projects and national TSOs	
WACC	Same WACC assumptions for all scenarios (RES & Conventional)	

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→ **"ETS"** looks at the performance of the two energy strategies with an emission trading system and its eventual harmonization with the existing EU ETS.

Together, these six scenarios assess the two main energy policy strategies, particularly their opportunities and risks.

3.2 Main input parameters and assumptions

For a proper interpretation of the results, it is important to understand scenarios' assumptions, defined based on discussions with different stakeholders in the region. Figure 21 summarizes the key assumptions:

The country-level assumptions are based on the research and synthesis of national energy strategies and institutional planning documents (by national TSOs, say), and informed by discussions with local stakeholders. The data derived from the analysis of the official plans forms the basis for the Fossil scenario pathway, which reflects current regional energy policies.

In the Balkan Green Deal framework, the main input parameters are altered according to the scenario design described above: assumptions

Approach for developing lignite trajectories in the power market scenarios — Figure 22

SCENARIOS	"FOSSIL" Scenarios	"GREEN DEAL" Scenarios
Existing lignite and pollution regulation	• Modernization to make units compliant with 2028 LCP BREF / IED deadline • Costs of modernization according to full IED compliance for all units that run on beyond 2027	• Only partial modernization of existing units towards 2028 deadline to balance SoS & required investment • Coal "cut-off" in 2040
	• Refurbished units run until they reach an extended lifetime (20-year lifetime extension)	• Closure of non-refurbished units in 2028 • Refurbished units are closed after 20 years or by 2040 at the latest
	• Units with announced decommissioning dates & opt-out will be closed (unless refurbishment decided)	
New lignite	• Realization of planned projects	• No NEW COAL investment

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regarding the regional lignite capacities, regional CO_2 pricing, and the expansion of renewables are calibrated to reflect an ambitious but realistic decarbonization strategy.

Commodity prices, CO_2 prices within the EU, coal capacities outside of the region, the deployment regime for gas-fired capacities, market design, power demand, interconnection, and WACC assumptions all the same in each of the two scenario pathways.

The approach and parametrization for the most important assumptions are briefly described in the following sections.

3.2.1 Lignite

The first major scenario differentiator – the role of lignite technology in the energy policy strategy – governs the development of future lignite capacity trajectories in the two scenario pathways. Figure 22 sums up the approach for determining modernization, market entry, and market exit dates for the region's lignite units.

For the Fossil scenarios, where lignite remains central for the future energy supply, the Energy Community regulation of power plant emissions (outlined in section 2.2.2) will require the refurbishment of most of the existing fleet by 2028, except for the units that are exempted or announced for closure. It is assumed that the refurbishment of a unit results in a technical lifetime extension of 20 years, and induces capacity-specific investment costs. After the extended lifetime, the units are shut down.

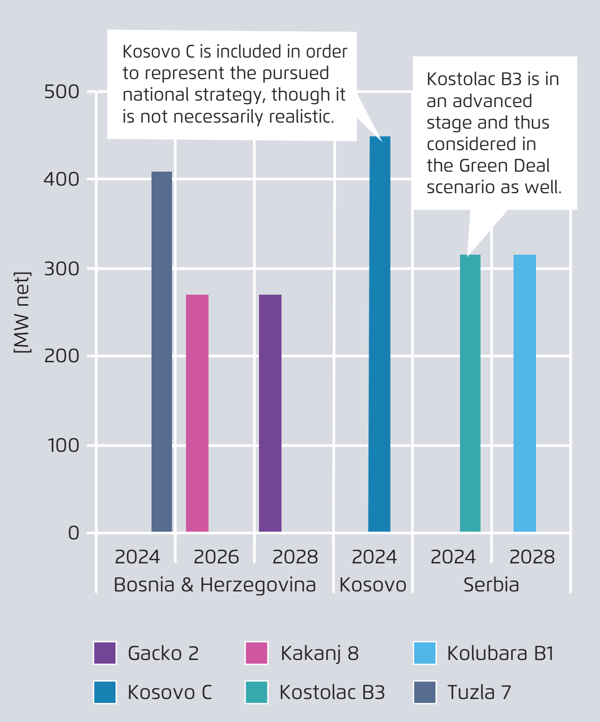
In the Green Deal scenarios, only the newest units are assumed to be modernized before 2028, in order to balance security of supply needs and investment options. In the longer run, refurbished units with an extended lifetime remaining operational after 2039 are exogenously decommissioned to align with the scenario objective.

Figure 23 gives an overview of the new lignite units in the scenarios by country and their assumed commissioning year.

In the Fossil scenario, projects in current national plans are included in the modeling. This approach would require the commissioning of the repeatedly abandoned Kosovo C project because it is still favored politically and included in national plans – despite increasingly well-founded doubts that this project could actually re-secure financing (Balkan Green Energy News, 2020). In total, around 2 GW of additional lignite capacity are commissioned in the next decade in the Fossil scenarios.

The Balkan Green Deal scenarios intentionally do not account for the commissioning of new lignite units, with the exception of Kostolac B3 due to its advanced stage.

Overview of considered new lignite projects in the region — Figure 23



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Resulting lignite capacity trajectories in the two scenario pathways at the regional level

Figure 24

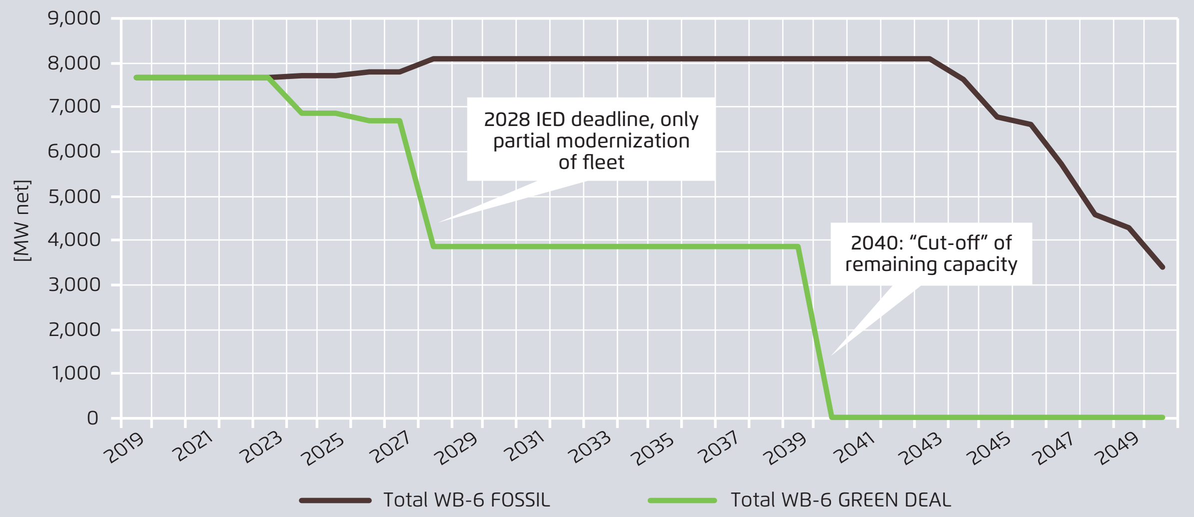

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Figure 24 presents the total lignite capacity trajectories resulting from the above approach in the two scenario pathways at the regional level.

In the Fossil scenarios, the modernization of existing units and the addition of new ones slightly overcompensates capacity retirement. As a result, there is a net increase of aggregated capacity.

In the Balkan Green Deal scenarios, the capacity trajectory features three characteristic periods: by 2028, there is only a marginal decline in lignite capacities due to the retirement of opted-out units. After the 2028 IED deadline, the operational fleet is halved due to BREF-related closures, and the remaining and refurbished block remains operational until the final phase-out date of 2040.

3.2.2 Renewables

The role of lignite in the two scenario pathways is mirrored by the role of renewables. Hence, we assume a limited expansion of renewables in the Fossil scenarios and a "coal to clean" replacement of lignite generation in the Green Deal scenarios. Figure 25 depicts the approach for determining renewable energy capacities.

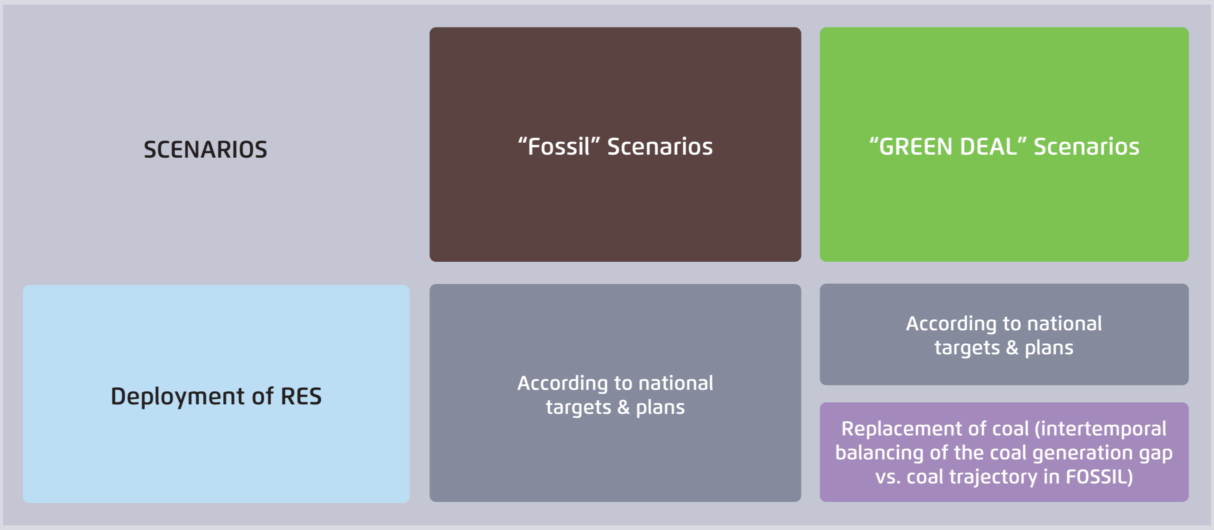
In the Fossil scenario, added renewable capacity is developed from a country-level analysis of available and applicable national planning documents. The expansion is extrapolated in the long term such that the RES share at country level remains stable. The increase necessary to maintain the RES share is made up entirely of a split of onshore wind and PV. Hydro and biomass are not expanded any further than envisioned in current plans.

For the Balkan Green Deal scenarios, onshore wind and PV capacity additions are calibrated so that additional renewable generation compensates for the reduction in lignite generation relative to the Fossil scenario. This condition is applied for each of the region's power markets individually and for a timeframe of ten years each.

3.2.3 Fuel and CO_2 prices

The competitiveness of generation technologies depends largely on fuel and CO_2 prices, which determine the marginal generation cost of conventional generation technologies and in turn strongly impact wholesale power prices.

Approach for developing renewable trajectories in the power market scenarios — Figure 25



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In this study, **fuel price assumptions** are based on the long-term global energy market scenarios published in the "World Energy Outlook 2019" (WEO) by the IEA (International Energy Agency, 2019). The WEO's baseline "Stated Policies" scenario, which account for announced national measures to reduce greenhouse-gas emissions and is thus presently not fully aligned with the Paris Agreement, is used for both scenario sets of this study. For natural gas price development, we assume a flat premium on top of the European gas price[17] for the WB-6 region to account for poorer import and intra-regional infrastructure.

Unlike the WEO, we derive the price trajectory for the EU ETS from the ENTSO-E and the ENTSOG in the context of the "Ten-Year Network Development Plan 2020"[18] (TYNDP2020) (ENTSO-E, ENTSOG, 2019).

The "Distributed Energy" (DE) scenario represents a scenario with a GHG emission reduction of 55 per cent by 2030, and thus reflects the ambition level stated in the European Green Deal.

For the short- and mid-term outlook, futures price quotations from March 2020 were used. Price assumptions for 2023 to 2030 were derived from interpolation between future quotations and the long-term study. The price increase was extrapolated for the period after 2040. Figure 26 illustrates the resulting trajectories.[19]

The EU ETS price is at 53 €/t in 2030 and rises to 147 €/t in 2050. In the Western Balkans, the CO_2 price ranges between zero and 53 €/t in 2030, depending on sub-scenarios described below:

→ In the CBA sub-scenarios, a carbon price on power imports to the EU is implemented with a linear phase-in between 2025 and 2030 from zero up to the

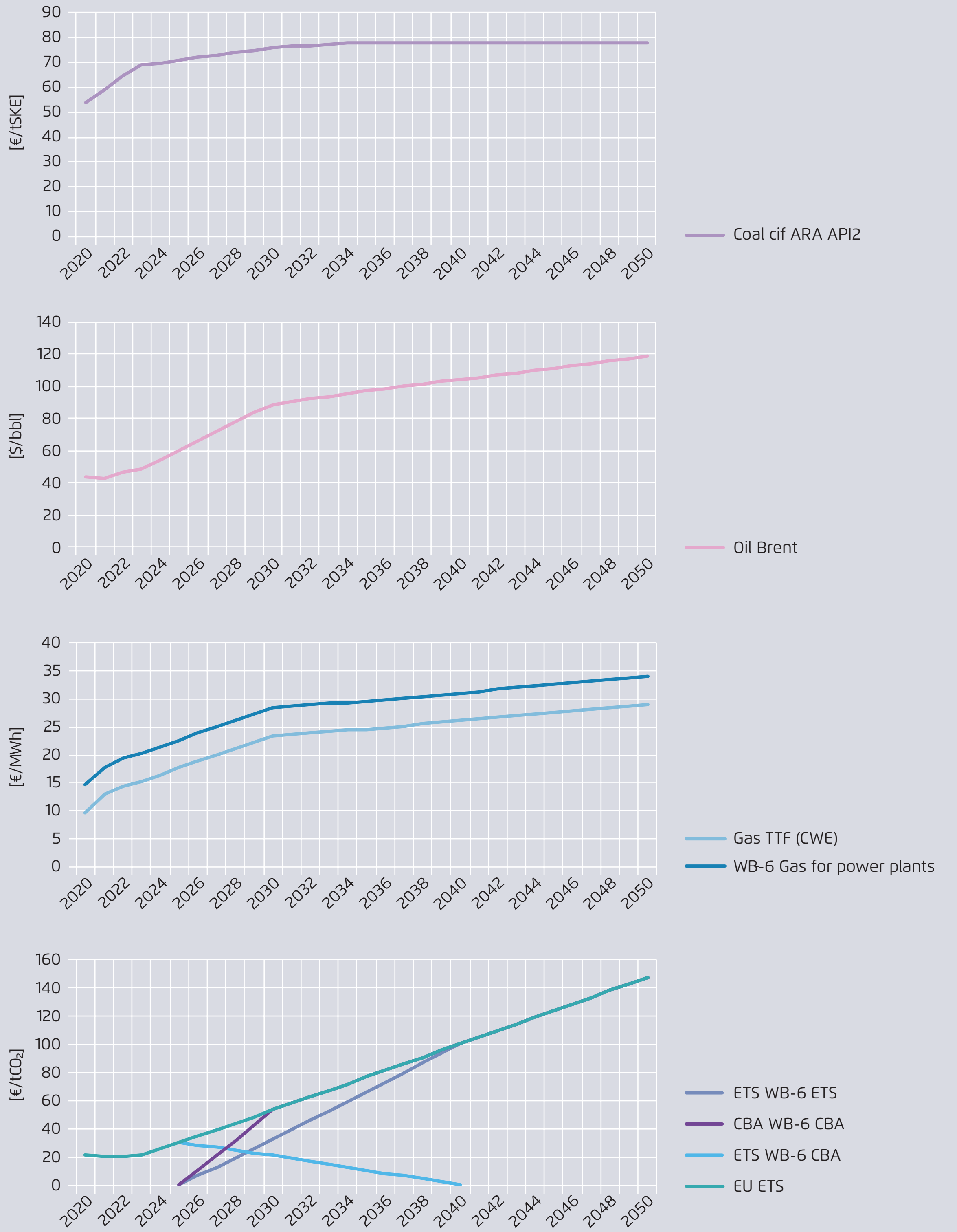
17 This approach was also used in other regional power system studies such as the (Energy Community Secretariat, 2019) and the E3 modelling for the Energy Community.

18 This framework provides the basis for the current cycle of European transmission grid planning and lays out three scenarios. They differ in the achieved carbon emission reduction in the bloc, among other aspects.

19 The figures partially exclude the country-specific transport and structuring costs that are considered in the model.

Fuel and CO_2 price assumptions in the power market scenarios

Figure 26



Adapted from EEX, ICE, (International Energy Agency, 2019), (ENTSO-E, ENTSOG, 2019)

EU ETS price level of 53 €/tCO_2. The specific modeling approach of this price will be described further below.
- For the ETS scenarios, an ETS phase-in in WB-6 is assumed to take place in two periods. First, there is a phase-in between 2026 and 2030, where the WB-6 ETS price is linearly interpolated from zero to 32 € / tCO_2 – a price level associated with the past ambition level of the EU.[20] Second, the WB-6 ETS is gradually harmonized with the EU ETS up to 2040. Additionally, there is a carbon border price in the ETS scenarios during the phase-in period, offsetting the ambition level delta between the EU and the WB-6 region.

Research was conducted on possible implementation designs of a CBA mechanism. We identified an approach that was practical and aligned with the design of power markets and future market coupling. Specifically, we derived the tax rate from the annual average carbon intensity of each country and then applied power imports from the WB-6 countries at the border.

Based on the assumed carbon price trajectories (***CBA price*** in €/tCO_2), we calculated a yearly ***CBA tax***[21] (in €/MWh) by weighing the yearly CBA price with the yearly average carbon intensity (***c*** in t/MWh) of each country's power mix so that

$$\textbf{\textit{CBA tax=CBA price} \textbullet\ \textit{c}}$$

We then applied the resulting carbon border tax by scenario, year, and country to all applicable interconnections to EU power markets.

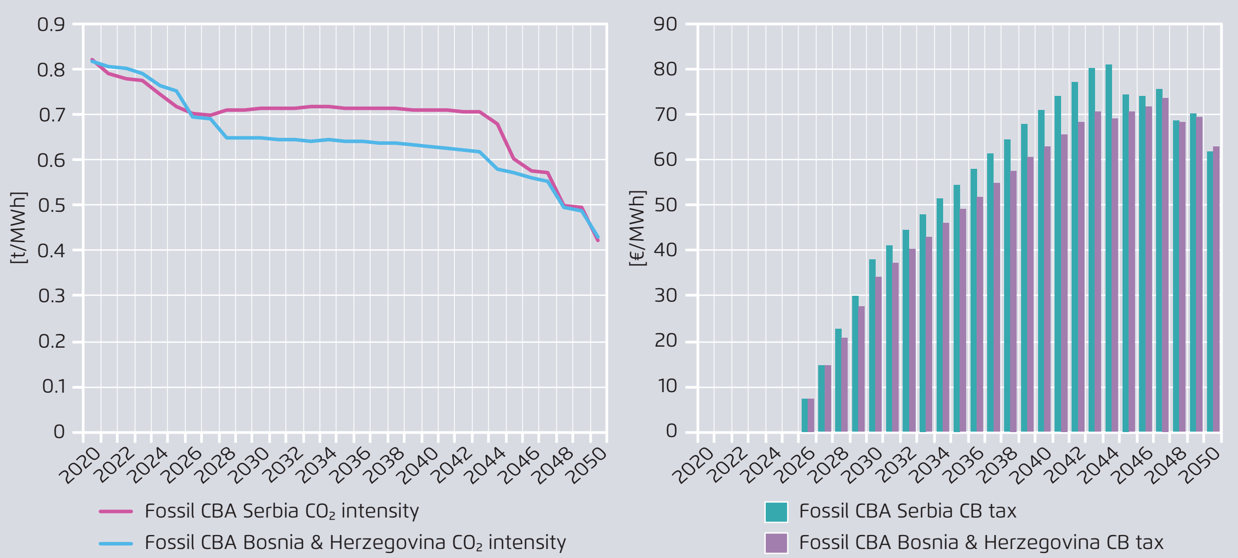
Figure 27 illustrates this logic and the quantitative outcome for Serbia and Bosnia and Herzegovina in one of the scenarios.

The combination of the sustained carbon intensity in the Fossil scenario with the linear increase of the assumed CBA price results in a rising tax rate per MWh throughout the timeframe. This decreases only

20 This is derived from the EC 2016 reference scenario in (European Commission, 2016).

21 Here and in the following we call this a tax, though we do not presume a specific way of implementing it.

Calculation of the CBA tax in the model for the Fossil CBA scenario — Figure 27



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in the late 2040s as many of the lignite units refurbished in the 2020s begin to close.

For **lignite cost assumptions**, we conducted in-depth country level research and analysis. Fixed costs and variable costs were considered separately. The latter are fed into the power market model and thus determine the economic dispatch of the units. The former affect the total costs of providing lignite to the power system and are factored into the "incremental generation costs" (see section 3.3.2).

Figure 28 shows the assumed level and distribution of these two cost components for the WB-6 region countries.[22]

22 Results are weighted averages of indicators for individual mines. They were gathered using publicly available data from annual company reports, double-checked against available studies and national strategies as listed in section 6 (References). The costs are based on the perspective of power plants. Smaller plants and smaller lignite consumers face higher lignite prices.

Short-run (variable) costs depend on current lignite demand levels, and are linked to, say, the cost of energy and the materials needed to mine lignite. Long-run (fixed) costs represent costs that are not linked directly to the actual lignite demand, such as the costs of amortization or the mine personnel costs.

Serbia has the lowest variable and overall lignite costs in the region. Variable costs in the other countries are almost twice as high.

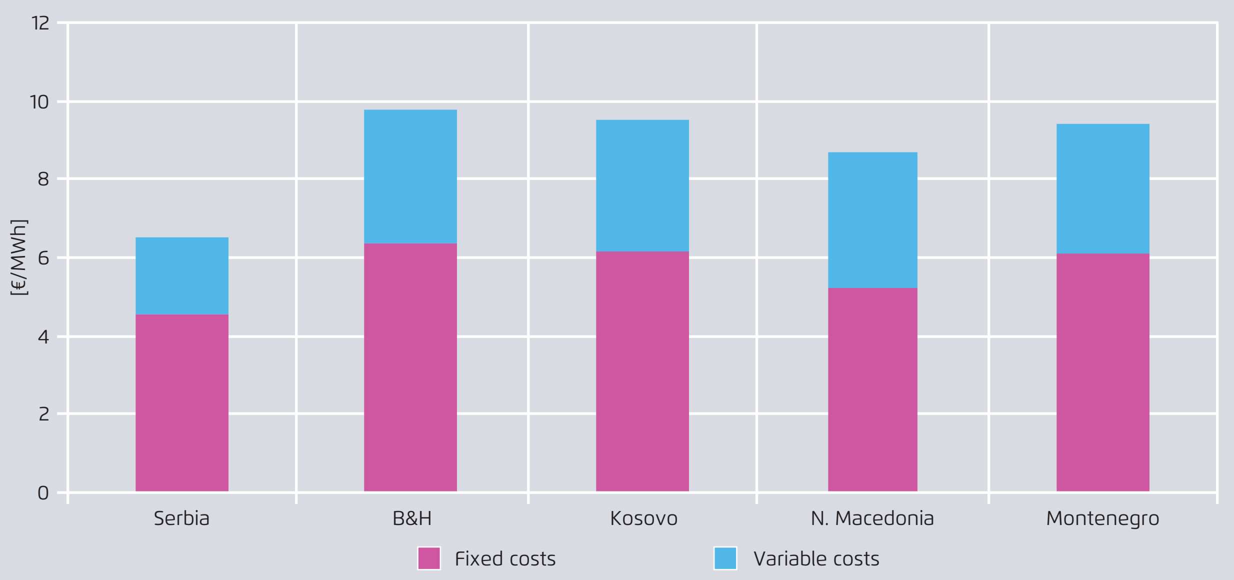
3.3 Modelling approach

3.3.1 The enervis fundamental power market model

All modeling in this study was created using enervis's proprietary power market model, a comprehensive approach for analyzing power markets. It is based on a comprehensive range of fundamental energy market data.

Country-specific lignite cost assumptions

Figure 28



WISE Europa based on company reports and on national planning documents listed in section 5 (References)

The following graph shows a schematic overview of the inputs, outputs, and methods for the enervis European Power Market Model.

The enervis power market model is a Europe-wide model covering the interactions of most ENTSO-E markets / regions via interconnectors. Each market region is modelled with high granularity, including the power plant fleet units, renewable installations, hourly demand, weather data, and country-specific assumptions (e.g. market design, policy framework, the transport cost of commodities, renewable expansion targets, and support mechanisms). The model incorporates all relevant market drivers and provides a comprehensive view on future developments of market prices zones and regions.

The marginal-cost optimization model of the European power markets derives the deployment of generation technologies and investment in new capacity based on a large set of assumptions and input data in high temporal and spatial resolution.

3.3.2 Incremental generation costs

How do different energy mix scenarios perform in terms of costs? An economic indicator is needed to assess and compare scenarios. Differences in generation costs are the most important factor. This study looks at the "Incremental Generation Costs" indicator:

- **Generation costs** arise when generating (or importing) power in a country or system. These costs include all variable and fixed costs (including capital costs) for building and operating power generation units and for demand-side flexibilities.
- **Incremental generation costs** include costs that change between scenarios (like CO_2 or fuel costs). All costs that are the same across the scenarios (such as the costs of existing hydro units) do not influence the scenario comparison and are not always included.

If generation costs are comparatively lower in one scenario than another, this means that power is generated more cost efficiently, which can either reduce end-consumer costs or increase rents ("profits") of the power producers (or both in part). Since both producer rents and consumer prices are distributional in nature from an economic point of view, economic efficiency is best assessed based on generation costs.

- We compared the cost of different scenarios that consider the following generation cost components:
- Net import costs: Net power imports from neighboring markets are assessed based on the wholesale import prices.
- External effects: External effects mostly represent the negative health effects caused by pollutants emitted in the context of coal-based power generation. These negative health effects were evaluated in monetary terms and expressed as costs.
- CO_2: This includes all costs caused by the procurement of CO_2 certificates. Please note that these costs also create additional income for, say, governmental institutions.
- OPEX: This component covers the operational costs of conventional power generation. This includes fuel costs (also short-run marginal lignite costs) and fixed operational costs but excludes carbon costs, which were addressed separately.
- CAPEX: This component represents the capital costs caused by conventional power generation. It includes investment and capital costs.
- RES: These are the costs for the investment in and operation of renewable energy sources (OPEX and CAPEX of RES).
- Lignite costs: All costs of lignite mining that do not fall under the short-term variable fuel costs of power plants (like fixed operational costs) are included in lignite costs.
- The costs of network development are not included in the calculation because we assume that they are dominated by the investments present in all scenarios.

Whereas incremental generation costs are a suitable energy economic indicator to assess the general merit

The enervis power market model

Figure 29

INPUT
(initial analyses and databases)

Policy / framework

Weather data

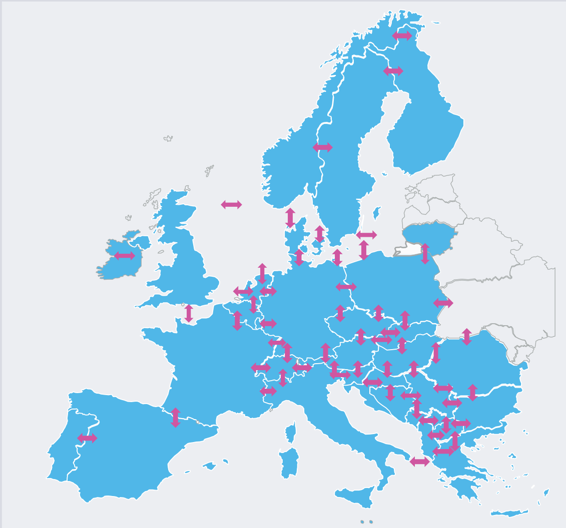
Load development

Interconnections

Commodities
fuel, CO_2, transport costs, exchange rates

European generation capacities

Market Model
(fundamantal simulation)



Fundamental energy market model: eMP

- EU 28 + Switzerland, Norway, Balkan
- Hourly resolution
- Power plant blocks > 50 MW
- Individual analysis: regions, technologies
- "Off the shelf" or individual assumptions
- Embedded in enervis modelling landscape

RESULTS
(selection)

Market prices

- Wholesale: spot, intraday
- Capture prices of renewables
- Ancillary services: PCR, SCR, TCR
- Capacity prices
- CO_2 certificate prices
- Revennues of interconnectors

Other results

- Capacity-/generation development
- Commercial exchanges (import/export)
- CO_2 emissions
- Spreads

Individual results (examples)

- System costs for generation (econ.)
- Market value of renewables (site specific)
- Power plant dispatch / valuation

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of scenarios, other indicators can provide insights into distributional effects, especially those targeting power consumers. We therefore consider the following indicators as well:

→ "Wholesale base volume": This is calculated as the hourly power demand in a country/region multiplied by hourly wholesale power prices, aggerated for the year. This represents what power consum-

ers pay at the wholesale price level to power generators in their market zone and for imports.
- RES support: This represents the share of costs that RE generators cannot recover in wholesale power markets and that would have to be covered by consumers (or other financing sources) via some form of support payment.

3.4 Summary and conclusions

- In this study, we analyzed six core scenarios. They are designed to assess two alternative energy political strategies along with their opportunities and risks with regards to carbon pricing.
- We assessed two fundamentally different future energy policy strategies: the "Fossil" strategy and the "Balkan Green Deal" strategy. The "Fossil" strategy reflects a continuation of current energy political strategies in the region, whereas the "Balkan Green Deal" strategy describes a clean-energy transition strategy.
- We applied a subset of three carbon pricing regimes per policy strategy: No carbon pricing, a carbon border adjustment mechanism, and the introduction of an emission trading system harmonized with the EU ETS.
- In the Fossil scenarios, we generally assumed that existing lignite units will be retrofitted by 2028, whereas in the Green Deal scenario, we assumed that only the newest ones will be retrofitted and that all other ones will be shut down by 2028.
- In the Fossil scenarios, we assumed that 2 GW of additional lignite capacity will be commissioned within the next decade, whereas the Green Deal scenarios include no new lignite (with the exception of Kostolac B3).
- Lignite trajectories: In the Fossil scenarios, overall lignite capacity is more or less stable until the early 2040s, whereas in the Green Deal scenarios, capacities are halved in 2028 and phased out by 2040.
- While the ambition for RES extension is rather limited in the Fossil pathways, we assume a "coal to clean" replacement of lignite generation in the Green Deal scenarios. For the Fossil scenarios, RES trajectories are based on current policy targets. The "coal to clean" methodology for Green Deal scenarios requires the introduction of renewables to make up for decreasing lignite generation.
- Long-term projections for commodity and CO_2 prices, which determine the marginal costs of the conventional fleet, are derived from suitable international energy scenario frameworks. The EU ETS price is 53 €/t in 2030 and increases to 147 €/t in 2050. In the Western Balkans, the CO_2 price ranges between zero and 53 €/t in 2030, depending on sub-scenario.
- The CBA mechanism is modelled as a country-specific tax rate applied at points of interconnection between WB-6 and EU power markets, increasing the respective import costs. To compute the tax rate, we weighted the annual country-level average carbon intensities with the assumed carbon price.
- Country-specific lignite costs differentiate variable costs, which serve as direct input in power market modeling, and fixed cost components, which are reflected in the "incremental generation costs" used for the overall scenario assessment.
- All modeling in this study was performed using enervis' proprietary power market model.
- For an economic comparison of power market scenarios, the differences in generation costs are key, which is why we focus on "Incremental Generation Costs". We consider the costs to the general energy economic system independently of who (producer or consumer) bears them.
- The economic analysis is supported by an analysis of two distributional indicators (wholesale volumes and renewable energy support payments) to assess costs for specific power consumers.

4 Power market scenarios: results

In this section, we present the evolution of the power mix and generation in our scenarios.

4.1 Results for the WB-6 region

4.1.1 Installed capacity and power generation

Figure 30 shows the total installed capacity and generation by technology for the whole WB-6 region across the scenarios.[23] Depending on the dimension of CO_2 pricing, the installed net capacity increases from 18.5 GW to 31.4 GW (None), 28.4 GW (CBA), 30 GW (ETS) by 2050 in the Fossil scenarios. In the Green Deal scenarios, we consider no new lignite investment and only a partial modernization of exiting units. The resulting gap is covered by PV and onshore wind capacities. In total, installed capacity increases to 59.6 GW (None), 57.4 GW (CBA), and 58.9 GW (ETS) by 2050.

Figure 31 shows the commissioning and decommissioning of capacities over time. Positive bars represent the commissioning of capacities, whereas negative bars represent the decommissioning of capacities.[24] Most capacity development in the Fossil scenarios occurs before 2028 via the refurbishment of existing and the commissioning of new lignite units. The different CO_2 pricing schemes result in differences in gas capacity commissioning. In the Fossil scenarios, the absence of CO_2 pricing results in two major gas investment cycles, the first taking place in the period from 2030 to 2035 and a second starting in 2045.

These investment cycles are triggered in part by the competitive advantage that new gas capacities in the Western Balkan region have over new gas units in the European Union, which can be subject to carbon pricing. These gas units can be categorized as a kind of "carbon leakage" within Europe's power system. However, introducing a CBA mechanism prevents the first gas investment cycle, almost completely suppressing the commissioning of export-oriented gas deployment in the model.

By contrast, the Balkan Green Deal scenarios have less lignite retrofitting and an earlier and more significant RES expansion. Lignite will be phased out by 2040, a decade earlier than in the Fossil scenarios. The decommissioning of PV and wind onshore capacities starting in 2045 is a result of the lifetime assumptions (25 years) for the installations and can be traced back to the to the first investment cycle through 2025.

Compared with the Fossil pathways, lignite generation is phased out much earlier in the Green Deal scenarios, and the power mixes are dominated more strongly by RES at an earlier point due to the lignite and RES trajectories. The increase in demand is kept unchanged across the scenarios (100 TWh by 2050).

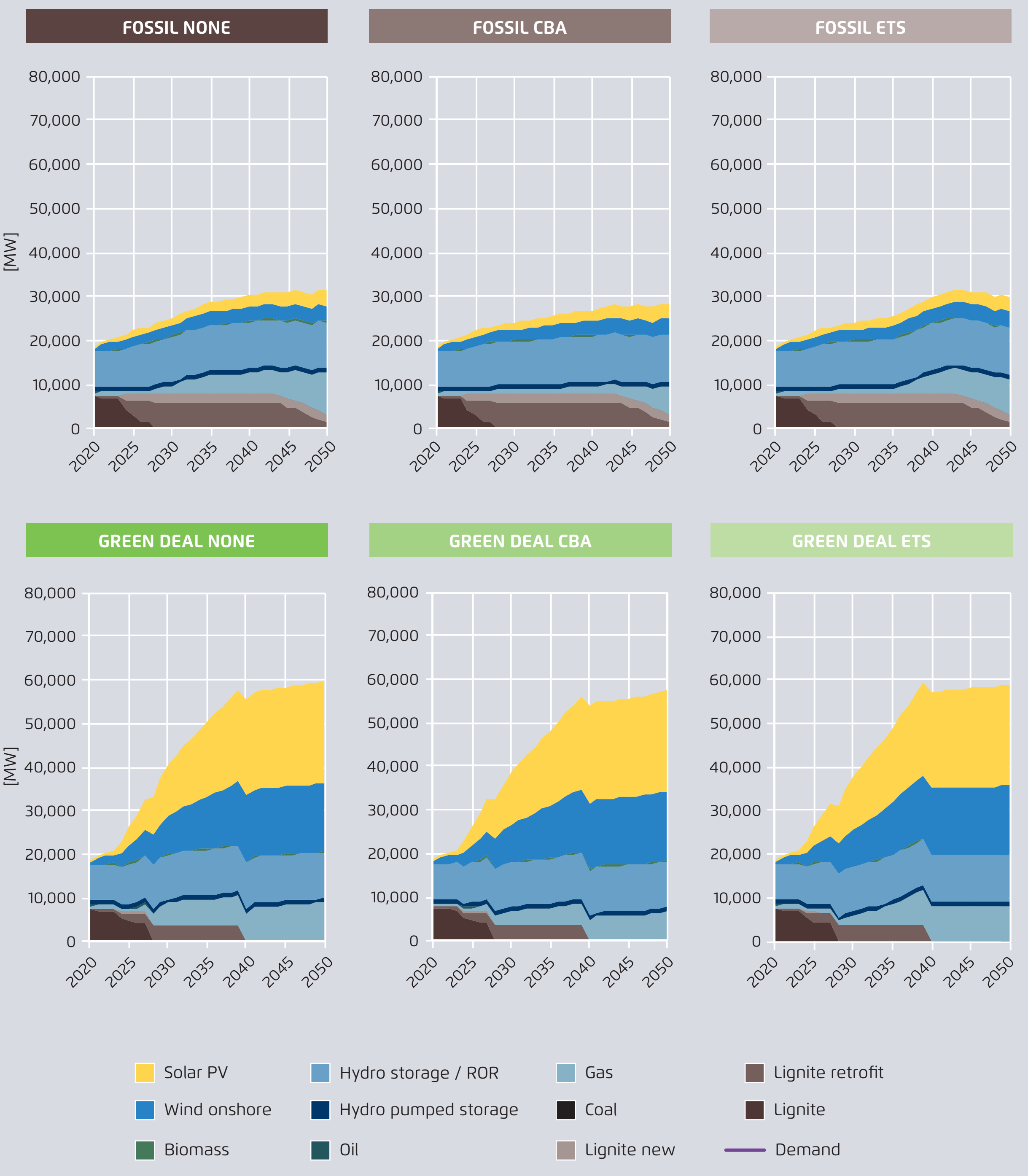
A look at the development of the generation mix shows that the effects of the different CO_2 pricing schemes are noticeable. As can be observed in the following figure, lignite generation is strongly reduced by an ETS phase-in. By contrast, the CBA mechanism reduces lignite generation to a much lower extent but diminishes incentives for export-oriented gas generation.

23 This excludes "out-of-market reserves" necessary in case peak demand is covered at the national level.

24 Please note that a refurbishment is classified as both a decommissioning of the old unit and a commissioning of the refurbished unit in the same year.

Power market outlook for the WB-6 region across the scenarios — Figure 30 a

CAPACITY



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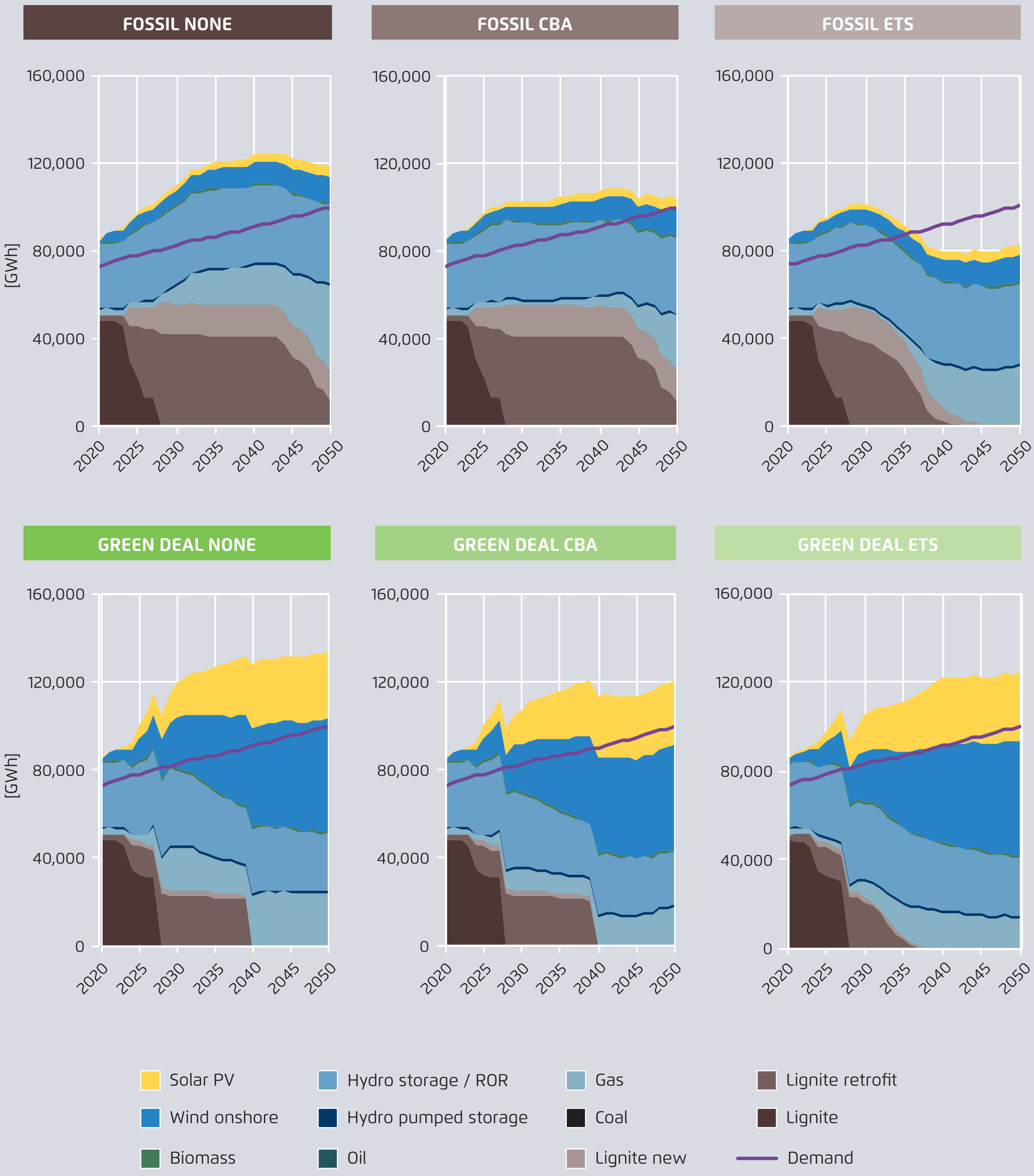
Power market outlook for the WB-6 region across the scenarios

Figure 30 b

GENERATION



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Development of capacity for the WB-6 region across the scenarios

Figure 31

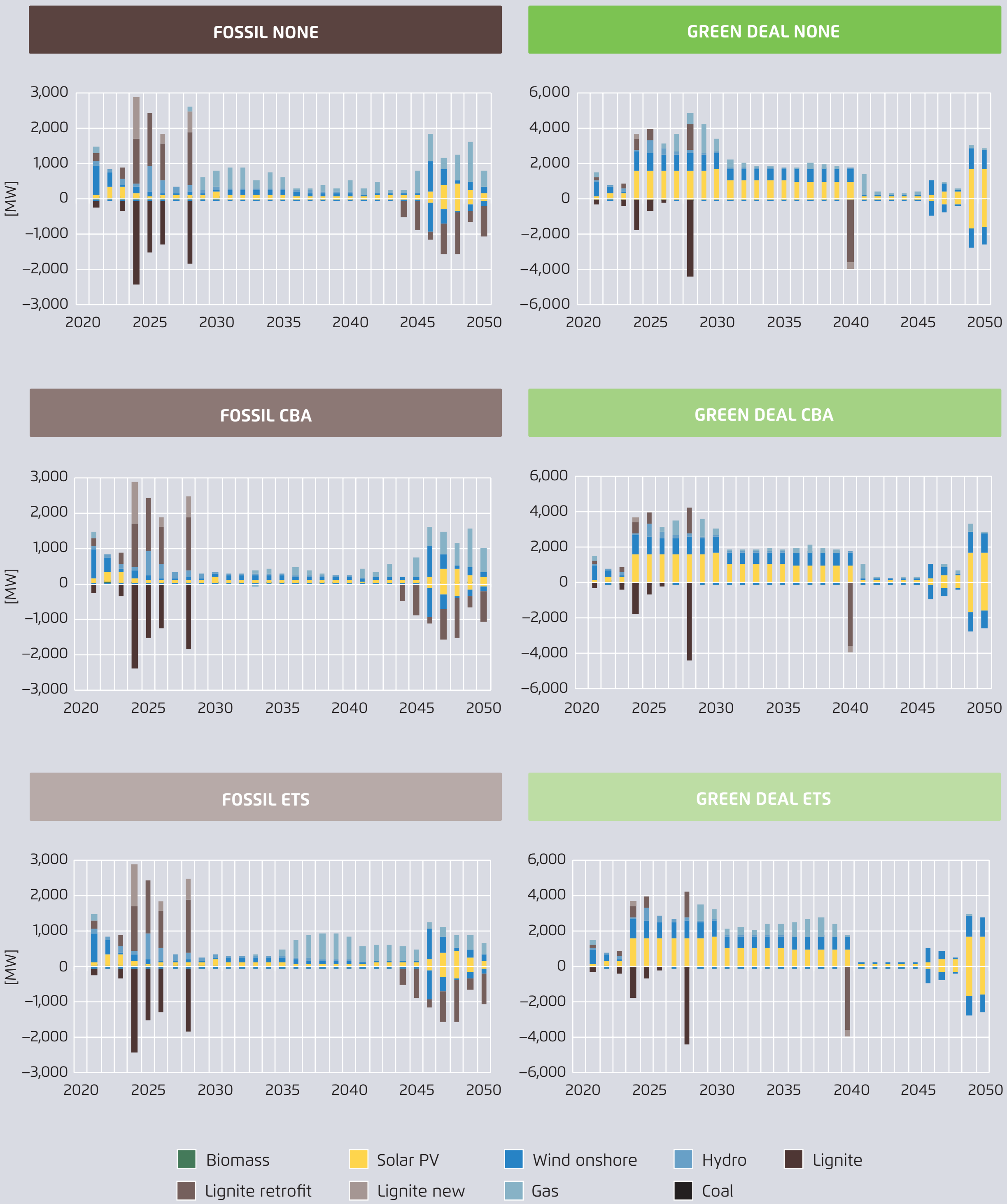

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Figure 32 shows that RES shares in demand remain low in the Fossil scenarios but increase significantly in the Green Deal scenarios, mostly due to the coal-to-clean approach for lignite replacement (see also section 3.2.2).[25] The highest RES share results from the introduction of an ETS in the Fossil and Green Deal pathways.

Interestingly, the CBA mechanism leads to a lower share than in the scenarios without CO_2 pricing. It increases RES curtailment by limiting exports to European neighbor countries because of the price effect of the CBA. We assume that CBA increases the costs of all exports to European Union countries independently of the specific situation and production mix of the power markets. Hence, when high levels of renewables are available in the Balkan region it gets more expensive to export those volumes to the European Union. This leads to more market-based curtailment of renewables in the Balkans.

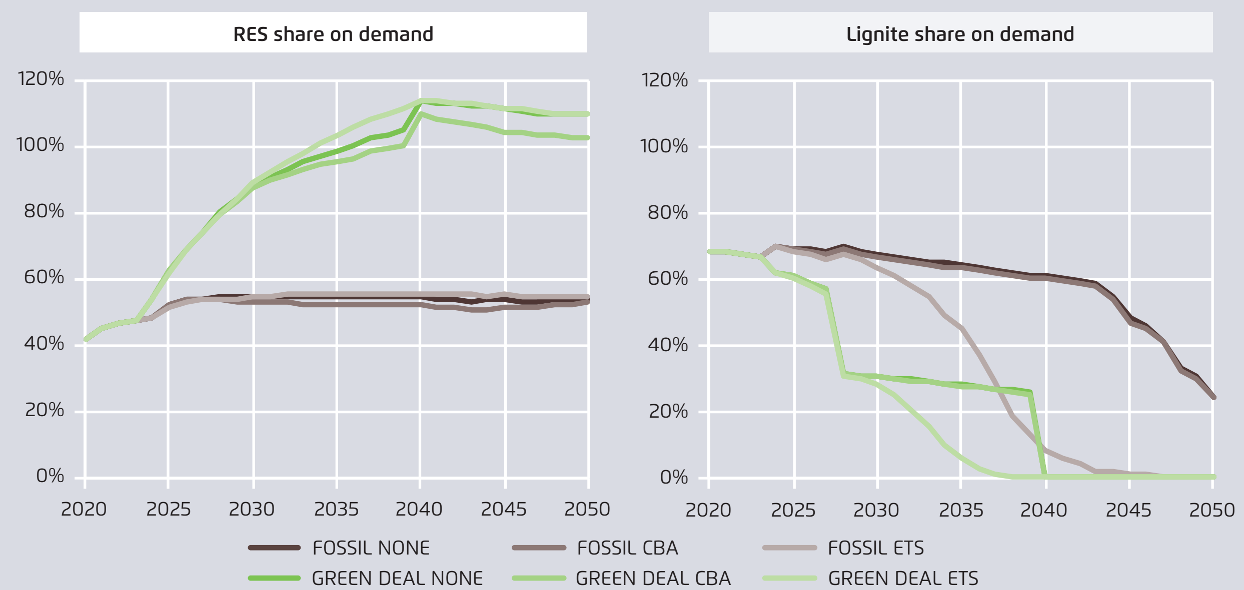
25 RES shares over 100 per cent indicate net exports from the power system.

The decline in lignite shares in demand is more pronounced and takes place earlier in the Green Deal scenarios. The phase-out occurs in two steps. First, reduced modernization activity leads to a significant drop in lignite generation around 2027–2028. This is followed by a second strong reduction by 2040 in the scenario without CO_2 pricing and in the scenario with CBA mechanism. By contrast, the introduction of an ETS leads to a smoother lignite phase-out after 2028. This effect can also be observed in the Fossil ETS scenario and results in a more even RES distribution.

4.1.2 CO_2 emissions in the Western Balkan region

The overall trends in annual CO_2 emissions primarily follow the lignite generation patterns, as Figure 33 illustrated. Carbon emissions in the Fossil scenarios amount to 1.9 bn tons (no carbon pricing), 1.8 bn tons (CBA), and 1.2 bn tons (ETS) by 2050. These emissions are significantly higher than in the Green Deal scenarios, which amount to 1 bn tons (no carbon pricing), 0.9 bn tons (CBA), and 0.8 bn tons (ETS).

Demand development of RES shares (left) and lignite shares (right) in the WB-6 Figure 32



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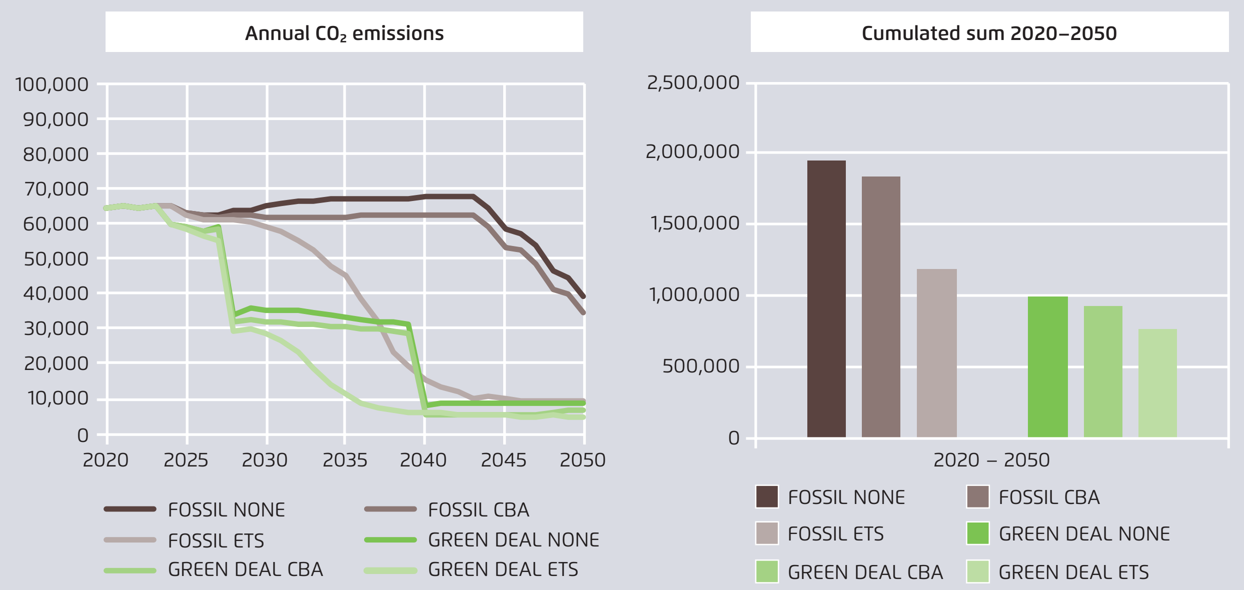
Development of annual CO_2 emissions (left) and the cumulated sum 2020–2050 (right) Figure 33



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Compared with the scenarios without CO_2 pricing, the CBA reduces incentives for export-oriented gas generation ("carbon arbitrage") and thus lowers CO_2 emission levels. But the overall effect of the CBA mechanism on total CO_2 emissions remains rather small: it reduces total CO_2 emissions by 5 per cent in the Fossil scenario and by 7 per cent in the Green Deal scenario. Furthermore, the residual gas-based generation releases carbon emissions in the Green Deal scenarios. Introducing an ETS leads to a substantial and steady reduction of carbon emissions in both the Green Deal and the Fossil scenarios. Measured against the CBA mechanism, it yields a 36 per cent reduction in the Fossil pathway and an 18 per cent reduction in the Green Deal pathway. Compared with a set-up without CO_2 pricing, an ETS phase-in reduces accumulated carbon emissions over the 2020–2050 period by 39 per cent in the Fossil pathway and by 24 per cent in the Green Deal projection.

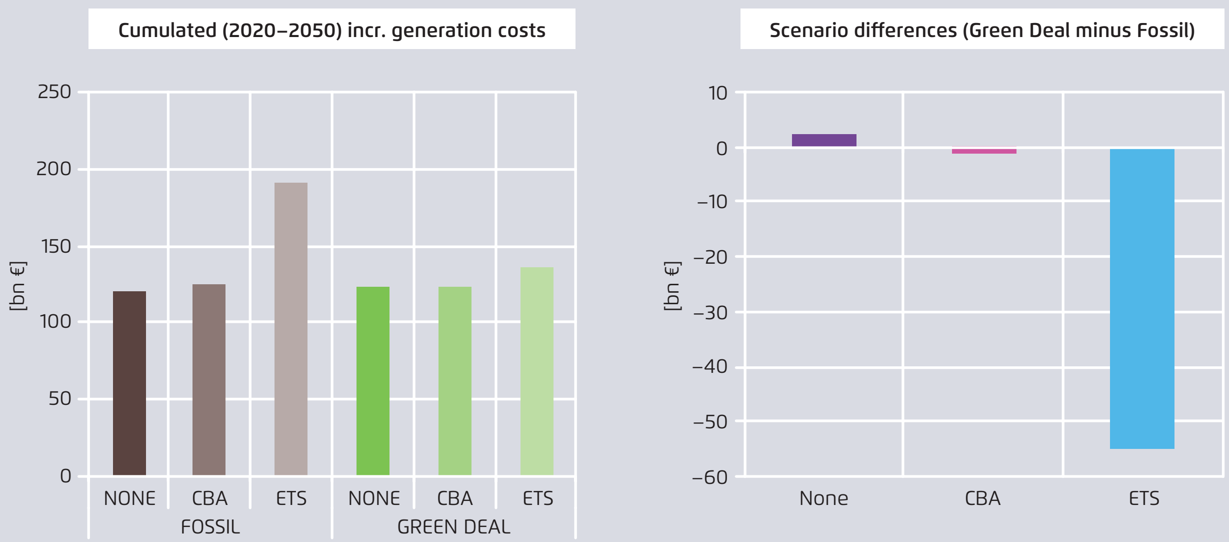
4.1.3 Incremental generation costs

Figure 34 shows the sum of incremental generation costs over time and the scenario differences for the WB-6 region. In absence of CO_2 pricing, differences in incremental generation costs remain in a relatively tight range between the Fossil scenarios (121 bn €) and the Green Deal scenarios (123 bn €). Introducing a CBA mechanism has a rather modest impact on generation cost (Fossil: 125 bn €, Green Deal: 124 bn €). However, the Green Deal scenario reduces costs by 55 bn € when an ETS phase-in is assumed. This is because of the significant reduction in emissions and the costs for CO_2 certificates.

For an economic comparison of the scenarios, the differences in generation costs are key because they indicate which pathway is more cost-efficient. The scenario differences reveal that the incremental generation costs are lower in the Green Deal scenarios with carbon pricing schemes (CBA and ETS) than in their Fossil counterparts. This means that power in the Green Deal scenarios is generated more cost efficiently, which can either reduce end-consumer costs, increase the rents ("profits") of power producers, or result in a combination of both.

Cumulated (2020–2050) incremental generation costs (left) and scenario differences (Green Deal minus Fossil) (right) in the WB-6 region

Figure 34



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The main drivers behind these cost developments are illustrated in Figure 35. The costs components of conventional capacities – CAPEX and OPEX – decrease significantly in the Green Deal scenarios. Furthermore, the lower amount of lignite in the system reduces the costs of external effects. This applies to all costs related to lignite mining. Compared with the Fossil projections, higher RES costs arise in the Green Deal scenarios because of the strongly enforced RES commissioning.

A CBA mechanism has a major impact on variable OPEX because it reduces the export-oriented gas commissioning and the fuel costs. Accordingly, net export revenues fall significantly but are not eliminated. Introducing an ETS results in rising net import costs over time. The rising costs are partially compensated in the Green Deal scenario by the reduced conventional generation costs. By contrast, the introduction of an ETS in the Fossil scenario risks a major increase in generation costs that are not offset elsewhere.

4.1.4 Investment needs and consumer costs

The annual investment volumes for the WB-6 region are illustrated in Figure 36. The bars represent the annual investment needs for each technology, whereas the blue line represents the cumulated investment volume. The investment needs in the Fossil projections amount to 21.7 bn € (None), 19.3 bn € (CBA), and 20 bn € (ETS) by 2050, with a strong concentration on lignite and gas-based generating capacities. Investments in the Balkan Green Deal scenarios mainly concentrate on RES and total 39.9 bn € (None), 38 bn € (CBA), and 39.3 bn € (ETS) by 2050.

Therefore, the Green Deal scenarios require significant additional investments but also provide additional business and growth opportunities. For the investment volumes in the Green Deal scenarios, EU and IFI funding would likely be available, which is not considered in the numbers analyzed here. EU and IFI funding would effectively reduce the residual investment need from a national point of view and would make these scenarios more attractive than their Fossil counterparts.

Main drivers of incremental generation costs for the WB-6 region across the scenarios

Figure 35

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Investment needs for the WB-6 region across the scenarios

Figure 36

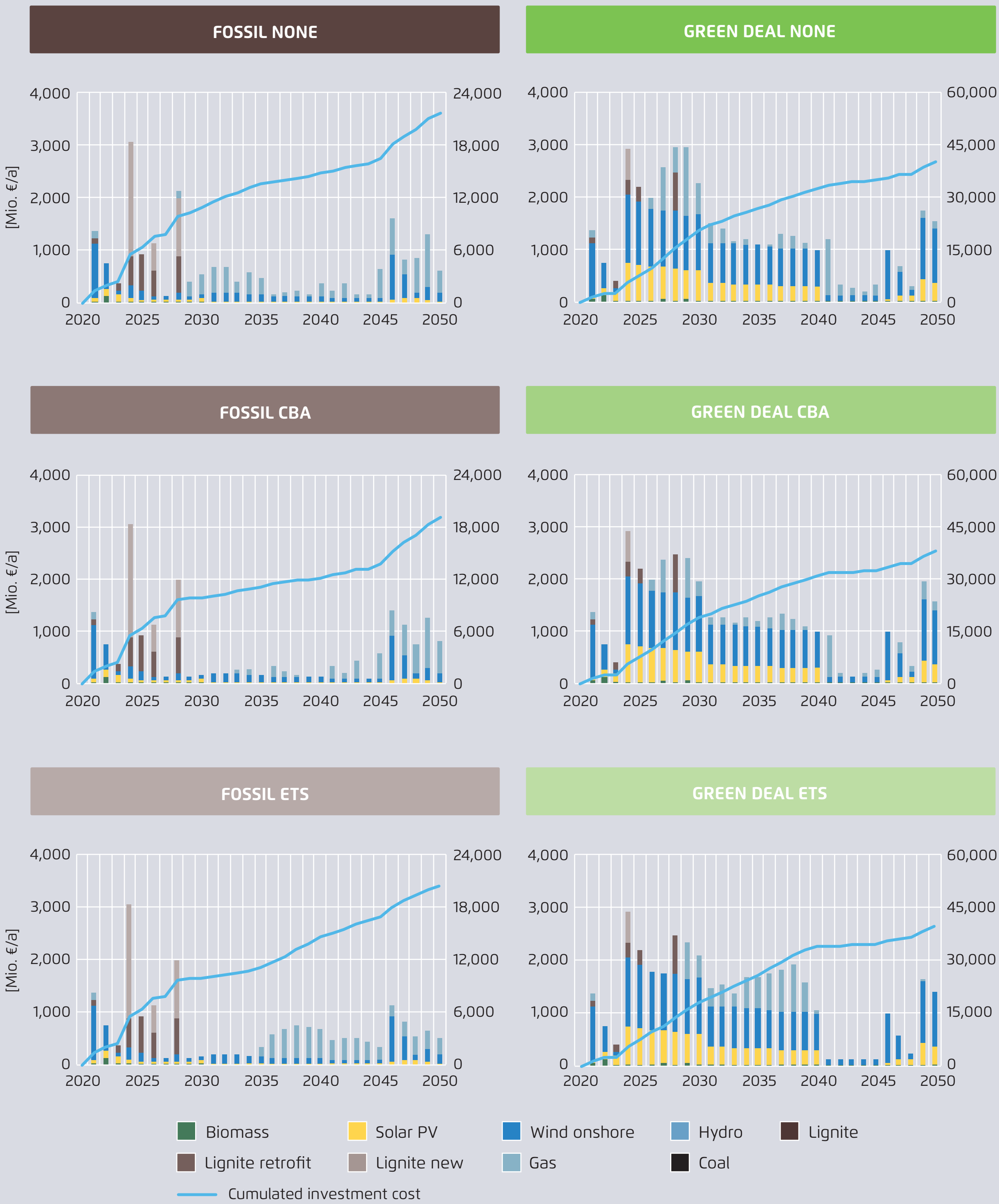

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Figure 37 shows the consumer costs for the WB-6 region across the scenarios. These costs reflect wholesale base volume, RES support needs, and strategic reserves.[26] Most can be allocated to wholesale base volumes; RES support needs and costs for strategic reserves remain limited. Because demand and wholesale base prices increase in each scenario, annual consumer costs tend to rise.

In the Fossil scenarios, annual consumer costs rise to 7.7 bn € (None), 7.3 bn € (CBA), and 11.3 bn € (ETS) in 2050. The modeling clearly shows that the introduction of an ETS to a fossil energy system can significantly impact power consumers. More RES in the system can mitigate wholesale base volumes significantly, regardless of the CO_2 regime in the Green Deal scenarios. Thus, in the Green Deal, annual consumer costs add up to 5.6 bn € (None), 5.3 bn € (CBA), and 7.6 bn € (ETS) in 2050. The need for RES support and the costs for strategic reserve capacities remain limited compared with wholesale base volumes. It is important to note that with wholesale power prices rising, the subsidy needs for RES are quite limited. Depending on the CO_2 pricing scheme, total RES support costs represent on average of only 0.7 per cent to 1.2 per cent of annual consumer costs in the Fossil scenarios and 1.0 per cent to 4.8 per cent in the Green Deal scenarios.

4.2 Results at the country level

4.2.1 Bosnia and Herzegovina

4.2.1.1 Installed capacity and power generation

As can be seen in Figure 38, the installed net capacity in the Fossil scenarios increases from 4.2 GW to 7.4 GW (None), 6.6 GW (CBA), and 7.5 GW (ETS) by 2050 depending on the CO_2 pricing scheme.[27] Since the trajectories of lignite and RES are set by scenario design, the main difference lies in the model's deployed gas capacities. The Green Deal scenarios consider no new lignite investment and only a partial modernization of exiting units. The resulting gap is covered by PV and wind onshore capacities. Total installed capacity increases to 13.7 GW (None), 13 GW (CBA), and 13.8 GW (ETS) by 2050.

The increase in demand to 16.3 TWh by 2050 remains constant across the scenarios. The changes in installed capacity and the modelled CO_2 pricing schemes lead to different power mixes over time. Compared with the Fossil scenarios, which show even more lignite than today due to retrofits and the realization of new projects, lignite generation in the Green Deal scenarios ceases by no later than 2040 and RES dominates the power mixes by the late 2020s. Because of the ETS phase-in, lignite generation falls significantly, as does total export from Bosnia and Herzegovina to neighboring countries. A CBA mechanism reduces lignite generation to a much lower extent, but it also diminishes incentives for export-oriented gas generation. The shift in Green Deal scenarios from lignite to wind onshore and PV, complemented by gas-based generation, leads to higher exports from Bosnia and Herzegovina. Bosnia and Herzegovina will stay a significant net exporter in the Green Deal scenario.

4.2.1.2 Incremental generation costs

The impact of the aforementioned changes in the power system on incremental generation costs is illustrated in Figure 39. The graphs show the cumulated incremental generation costs and the scenario deltas for Bosnia and Herzegovina.

In absence of CO_2 pricing, the differences in incremental generation costs remain in a relatively tight range between scenarios, with 22.9 bn € in the Fossil pathway and 22 bn € in the Green Deal pathway. Introducing a CBA mechanism has a modest impact, with 25.0 bn € in Fossil and 22.3 bn € in the Green Deal. However, if an ETS phase-in is assumed, the

26 For methodological reasons, we have excluded costs and support needs for existing capacities (mostly RES and lignite).

27 This excludes "out-of-market reserves" necessary in case peak demand is covered at the national level.

Consumer costs for the WB-6 region across the scenarios

Figure 37

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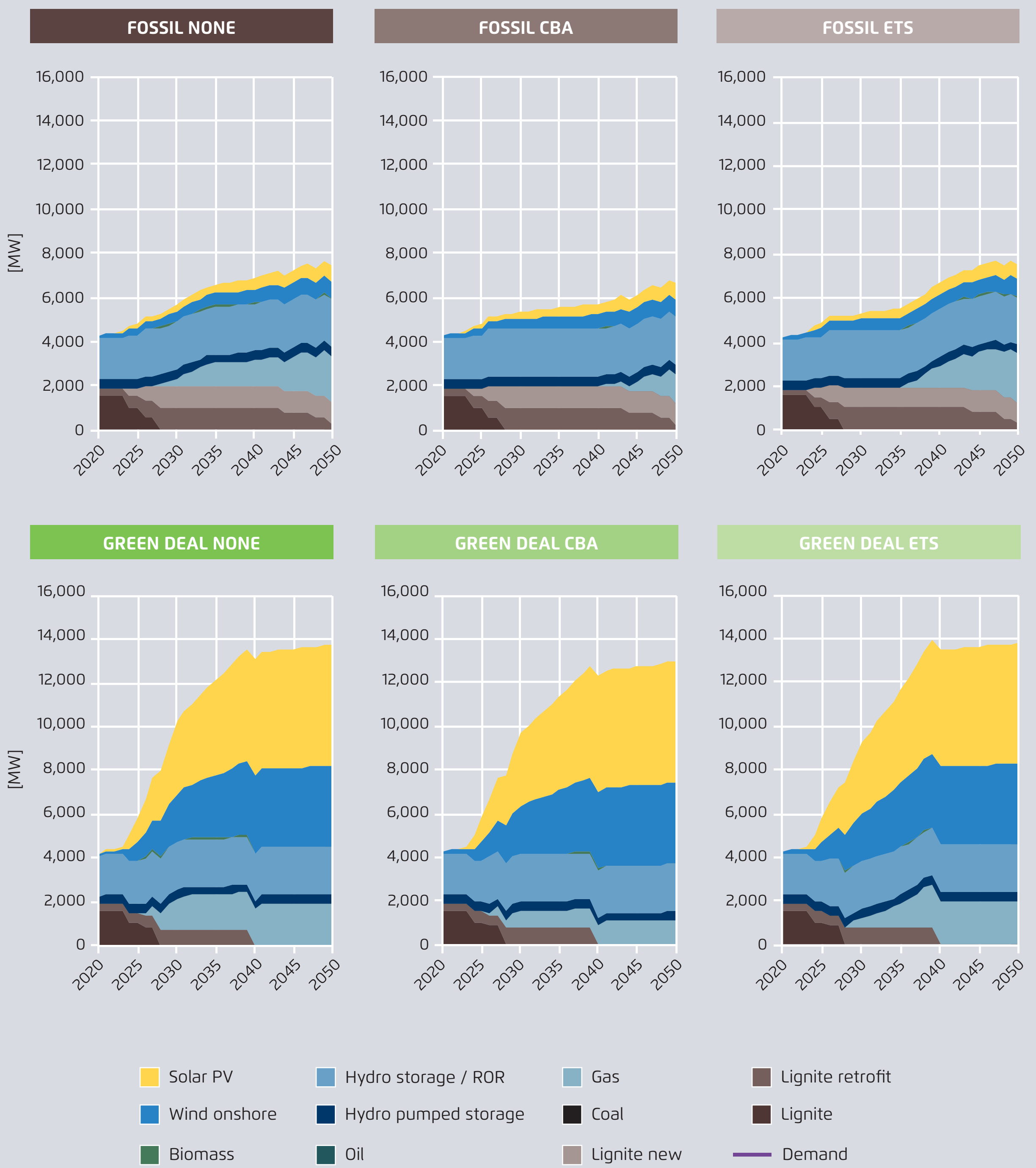
Development of the power market structure across the scenarios – Bosnia and Herzegovina Figure 38 a

CAPACITY



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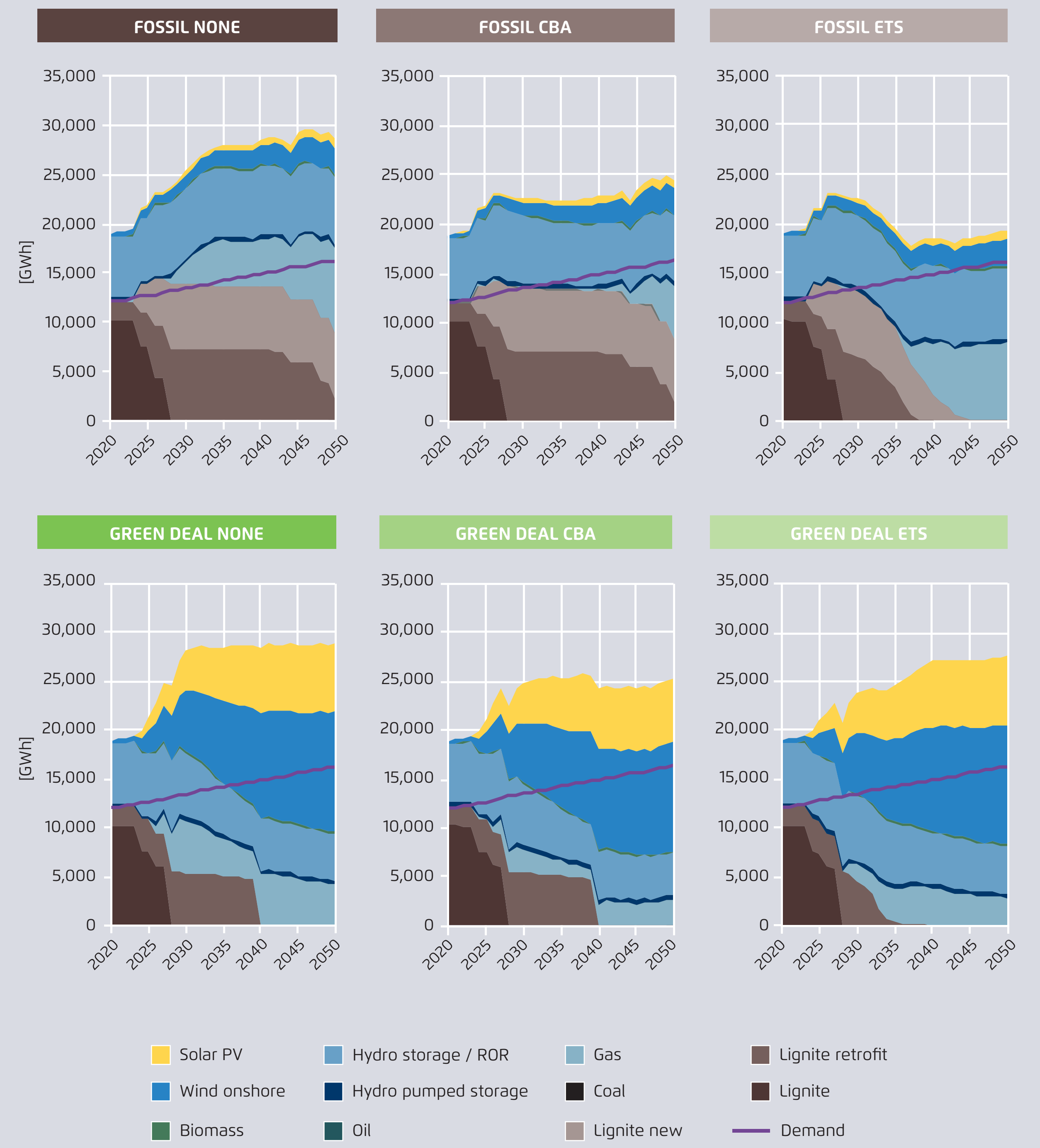
Development of the power market structure across the scenarios – Bosnia and Herzegovina Figure 38 b

GENERATION



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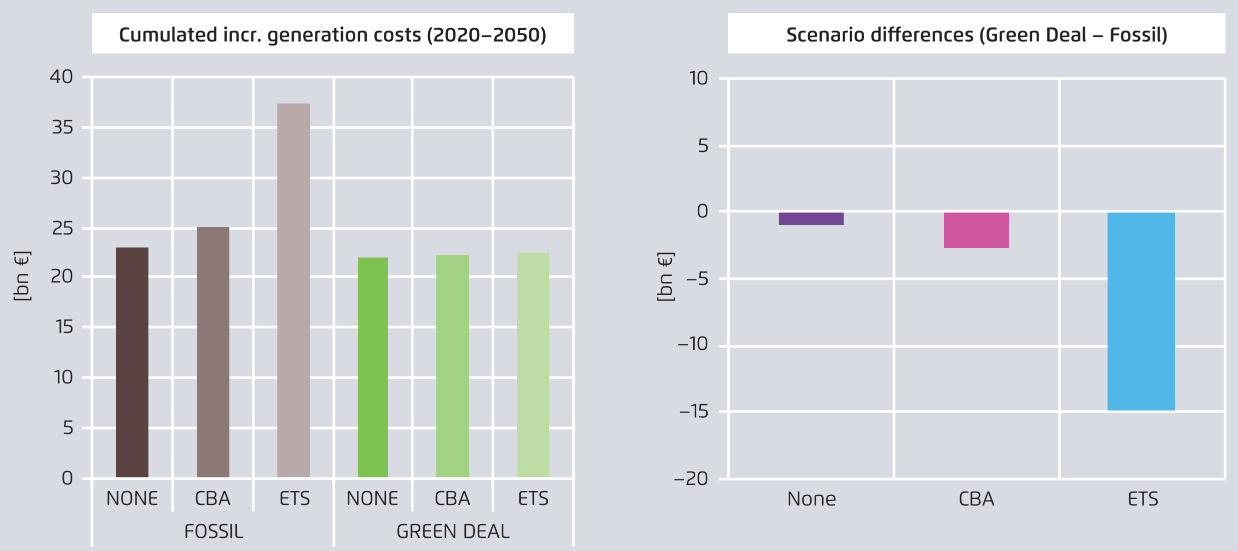
Cumulated incremental generation costs (2020–2050) (left) and scenario differences (Green Deal – Fossil) (right) – Bosnia and Herzegovina

Figure 39



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Green Deal scenario significantly reduces costs, from 37.1 bn € to 22.4 bn €. As the comparison of incremental generation costs shows, the Green Deal pathway is cheaper for Bosnia and Herzegovina regardless of the modelled CO_2 regime.

4.2.1.3 Wholesale base prices and consumer costs

Figure 40 shows average wholesale base prices per modelled decade for Bosnia and Herzegovina. The wholesale price level increases moderately across most scenarios. This is due in part to the increase in power demand and the rising fuel costs. The Green Deal mitigates the resulting price increases significantly, while the Fossil scenarios result in higher wholesale prices for each CO_2 regime.

The price level rises more significantly if an ETS phase-in is assumed. The cushioning effect of the Green Deal on the wholesale base price level is strongest (2040–2050: by -37 per cent) when comparing the Green Deal to the Fossil scenario. Remarkably, export-oriented gas deployment in the Fossil scenario without CO_2 pricing leads to higher wholesale base price levels than with the CBA.

Figure 41 shows the resulting consumer costs for Bosnia and Herzegovina in each scenario considering wholesale base volume, RES support needs, and the costs for strategic reserves.[28] Most can be allocated to wholesale base volumes; RES support needs and costs for strategic reserves remain limited. As power demand and wholesale base prices increase across the scenarios, consumer costs rise as well.

The increase in consumer costs is mitigated significantly by more RES in the Green Deal scenarios, regardless of the modelled CO_2 regime. Comparing the different cost components, the need for RES support and the strategic reserves remain negligible: wholesale base volumes represent 92.6 per cent (Green Deal

28 For methodological reasons, the costs and support needs for existing capacities (mostly RES and lignite) are excluded.

Average wholesale base prices per modelled decade – Bosnia and Herzegovina

Figure 40

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CBA) and 99.6 per cent (Fossil ETS) of overall consumer cost.

4.2.1.4 Investment needs and subsidies

Figure 42 shows annual investment volumes for Bosnia and Herzegovina in each scenario. The investment needs in the Fossil projections amount to 5.5 bn € (None), 4.9 bn € (CBA), and 5.6 bn € (ETS) by 2050, with a strong concentration on new lignite and gas-based generating capacities. By comparison, investments in the Green Deal scenarios concentrate on RES, mostly wind onshore, and amount to 9.1 bn € (None), 8.4 bn € (CBA), and 9.2 bn € (ETS) by 2050. The investment needs in the Green Deal scenarios are higher than in the Fossil scenarios.

Due to the strong commissioning of wind onshore and PV, the Green Deal scenarios have higher RES generation costs than the Fossil scenarios: 274 million € in 2030, 442.3 million € in 2040, and 429.2 million € in 2050. However, most is financed by market revenues and thus does not increase the support needs. Figure 43 shows the scenario differences of annual RES costs (bars) and RES support (lines) for Bosnia and Herzegovina.

Additional annual RES support in the Green Deal scenarios represents on average only 0.9 to 9.3 per cent of total additional costs. Especially in the ETS scenario (0.9 per cent), most of the additional RES generation costs are financed by market revenues. Accordingly, only minor out-of-market payments for RES investments are needed.

Development of consumer costs across the scenarios – Bosnia and Herzegovina

Figure 41

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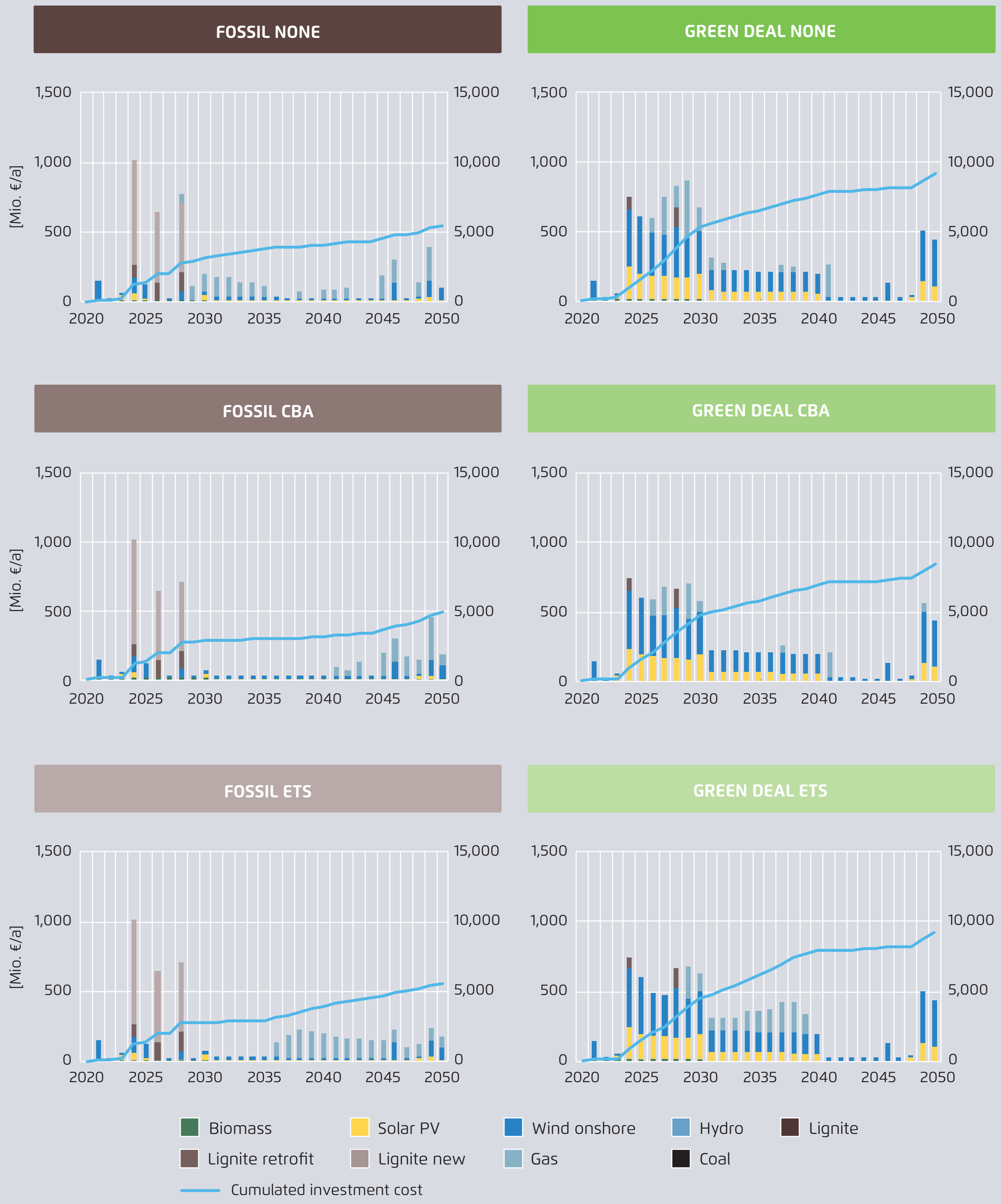
Investment needs across the scenarios – Bosnia and Herzegovina

Figure 42



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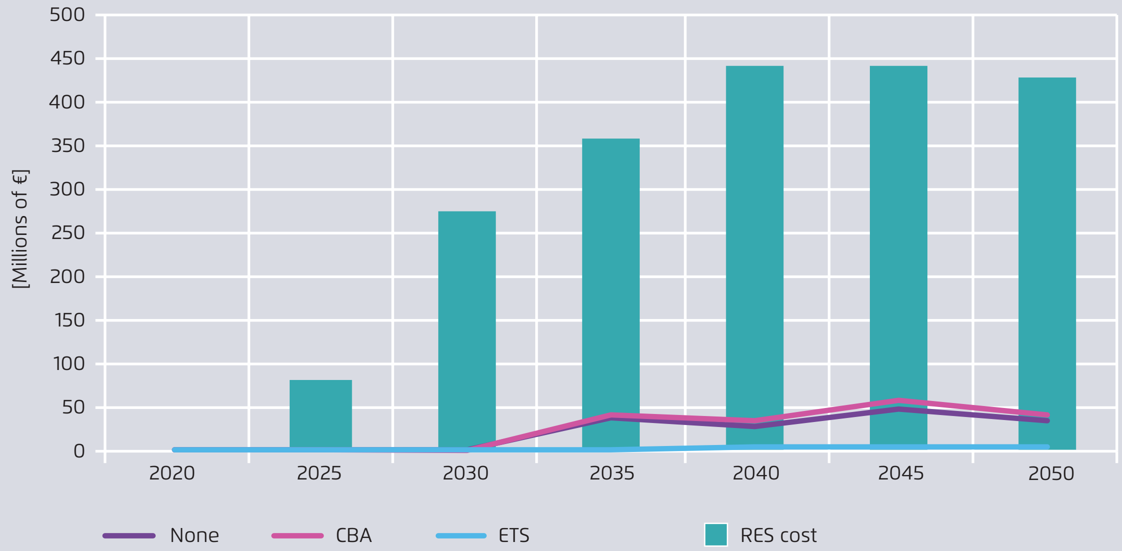
Annual RES support (lines) vs. RES generation costs (bars) – Bosnia and Herzegovina

Figure 43



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4.2.2 Kosovo

4.2.2.1 Installed capacity and power generation

In the following section, we present the modelled power market outlook for Kosovo. As Figure 44 shows, the installed net capacity increases slightly in the Fossil scenarios by 2050 depending on the CO_2 pricing scheme, from 1.2 GW to 1.3 GW (None and CBA) or from 1.2 GW to 1.4 GW (ETS).[29] Since the trajectories of lignite and RES are set by the scenario design, the main difference lies again in the gas capacities deployed by the model. The Green Deal scenarios consider no new lignite investment. The resulting gap is covered by PV and wind onshore capacities. In total, installed capacity increases significantly to 5 GW (None), 4.9 GW (CBA), and 5.4 GW (ETS) by 2050, depending on the modelled CO_2 regime.

The increase in power demand is kept constant across all scenarios. In 2050, 6.8 TWh of electricity are assumed to be consumed in the Kosovo power system. Today, Kosovo's power generation mix relies almost exclusively on lignite. In the Fossil scenario, the lignite generation level is maintained in absence of CO_2 pricing or the introduction of a CBA mechanism. However, the phase-in of an ETS scheme can severely reduce power generation output and total exports from Kosovo. In the Green Deal scenarios, lignite's share in power generation decreases by 2025 and is eliminated by no later than 2040. Increasing power generation from RES leads to a substantial transformation of the power mix in Kosovo. In view of the different mechanisms for CO_2 pricing, the CBA does not significantly reduce lignite generation – Kosovo does not share a border with the EU – but it diminishes incentives for gas generation. The introduction of ETS leads to reduced generation from lignite and an earlier phase-out.

4.2.2.2 Incremental generation costs

The resulting impact on incremental generation costs for Kosovo is illustrated in Figure 45. In a setting without carbon pricing or a CBA, the scenario differences in incremental generation costs remain in a narrow range, from 8.1 bn € in the Fossil scenario to 9.8 bn € in the Green Deal scenario (None) and from 8.8 bn € to 9.9 bn € (CBA). When an ETS phase-in is considered, however, the Green Deal scenario reduces incremental generation costs by 4.5 bn €.

4.2.2.3 Wholesale base prices and consumer costs

Figure 46 shows the average wholesale base prices per modelled decade for Kosovo. The price level increases moderately across most scenarios, due in part to rising power demand and increasing fuel costs. Price level rises more significantly when an ETS is introduced. The Green Deal scenario mitigates the resulting price increase. In the long run, the Fossil scenarios lead to higher wholesale base prices in Kosovo for each CO_2 regime.

Figure 47 shows the consumer costs for Kosovo across the scenarios when considering wholesale base volume, RES support needs, and costs for strategic reserves.[30] Most can be allocated to wholesale base volumes, while RES support needs and strategic reserve costs remain limited.

A generally rising trend in consumer costs can be observed across all the scenarios as demand and base prices increase.. However, more RES in the system mitigates wholesale base volume regardless of the modelled CO_2 regime in the Green Deal scenarios. A comparison of the cost components shows that the need for RES support remains limited.

As for the strategic reserves needed to cover national peak load, the green deal scenarios trigger some

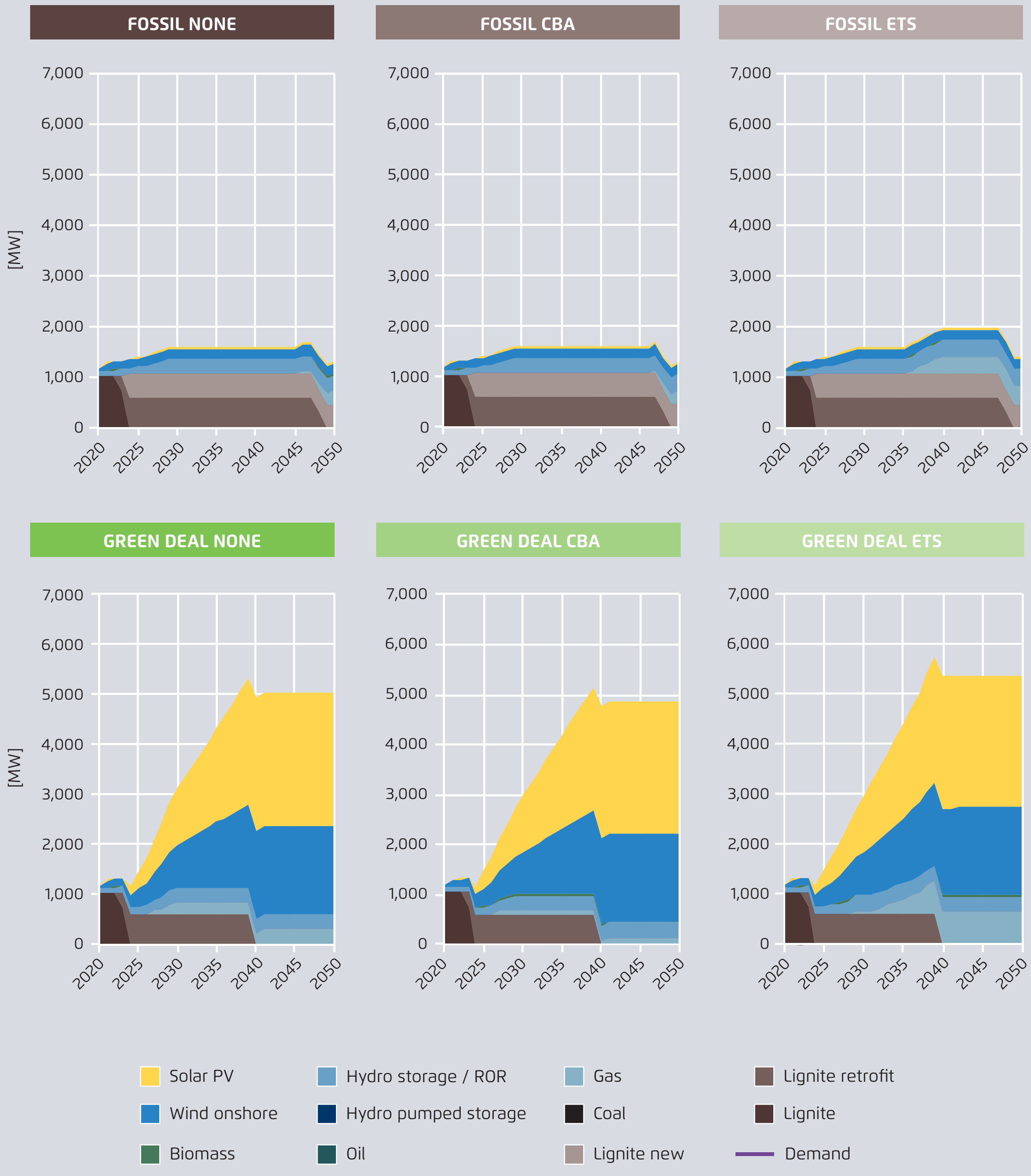
29 This excludes "out-of-market reserves" necessary in case peak demand is covered at the national level.

30 For methodological reasons, costs and support needs for existing capacities (mostly RES and lignite) are excluded.

Development of the power market structure across the scenarios – Kosovo

Figure 44 a

CAPACITY



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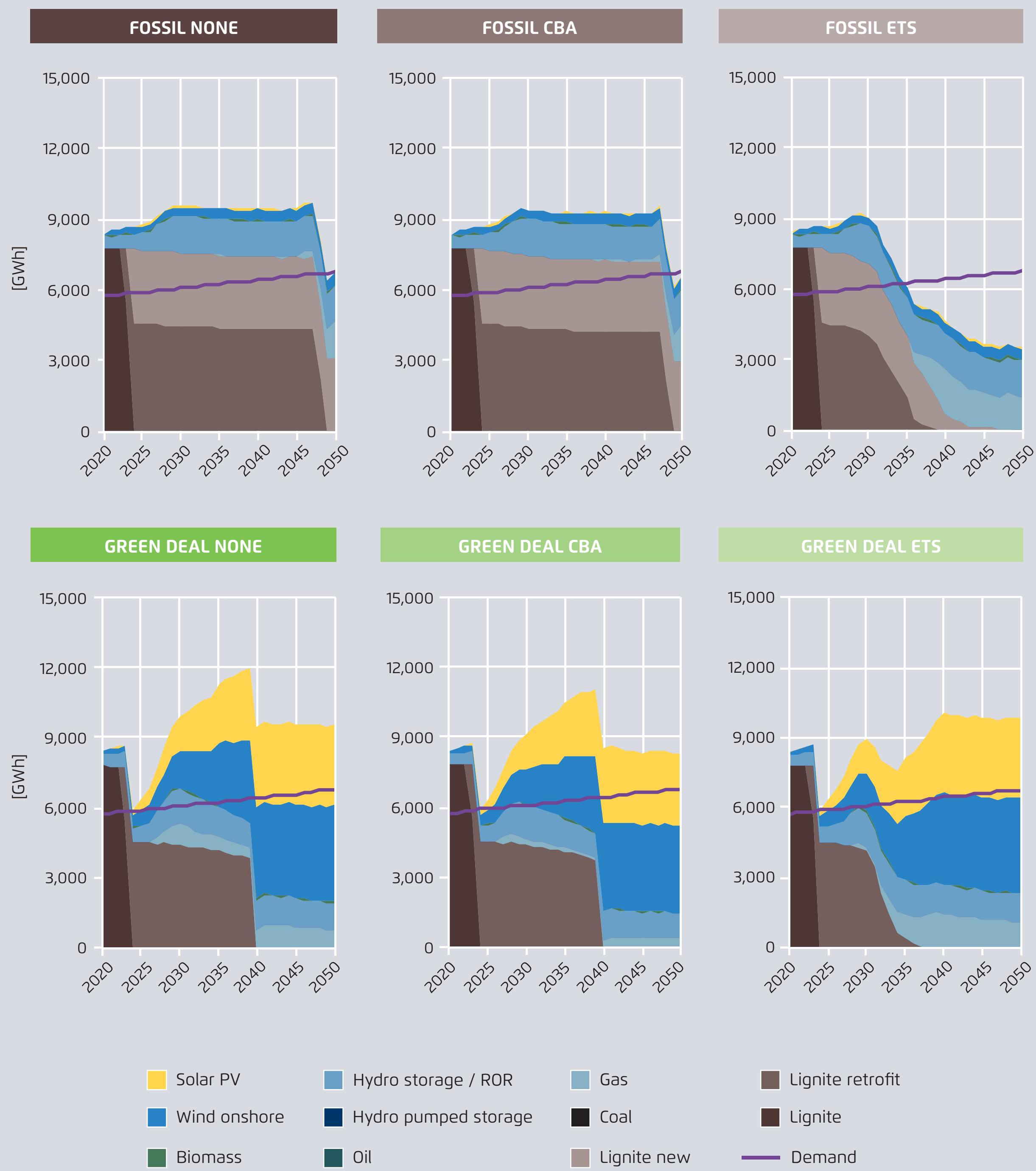
Development of the power market structure across the scenarios – Kosovo

Figure 44 b

GENERATION



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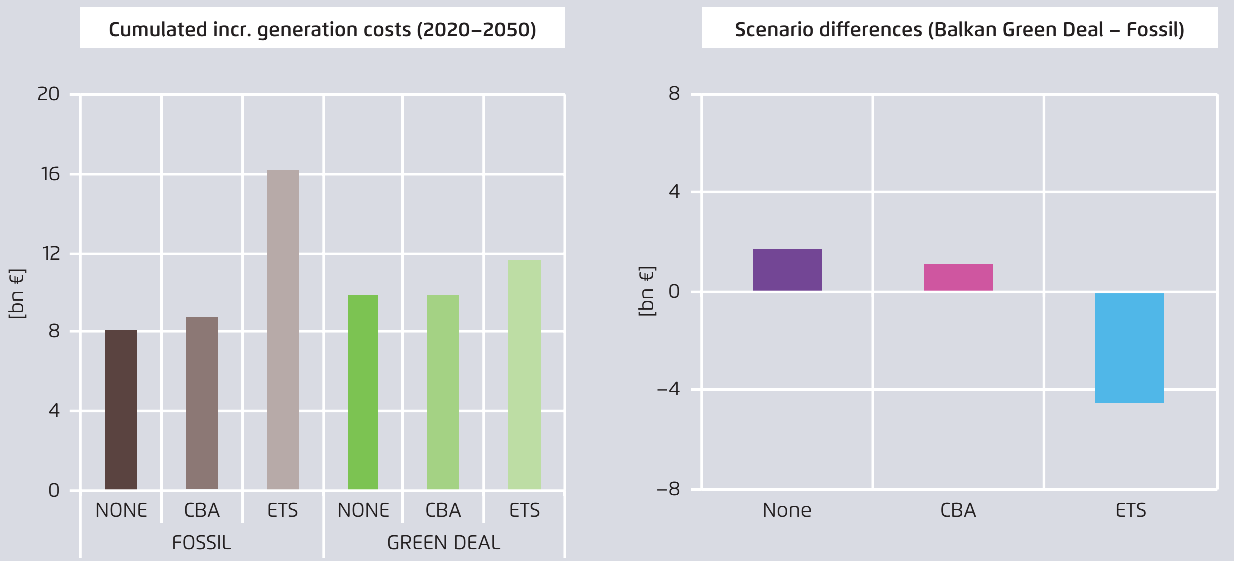
Cumulated incremental generation costs (2020–2050) (left) and scenario differences (Balkan Green Deal – Fossil) (right) – Kosovo

Figure 45



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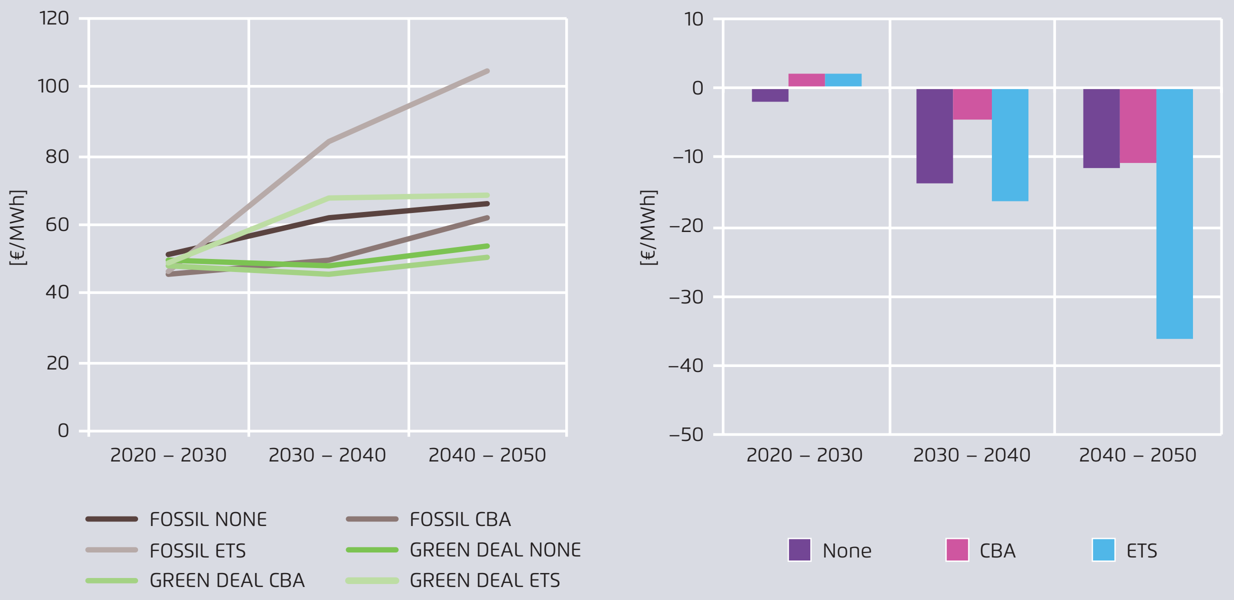
Average wholesale base prices per modelled decade – Kosovo

Figure 46



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Development of consumer costs across the scenarios – Kosovo

Figure 47

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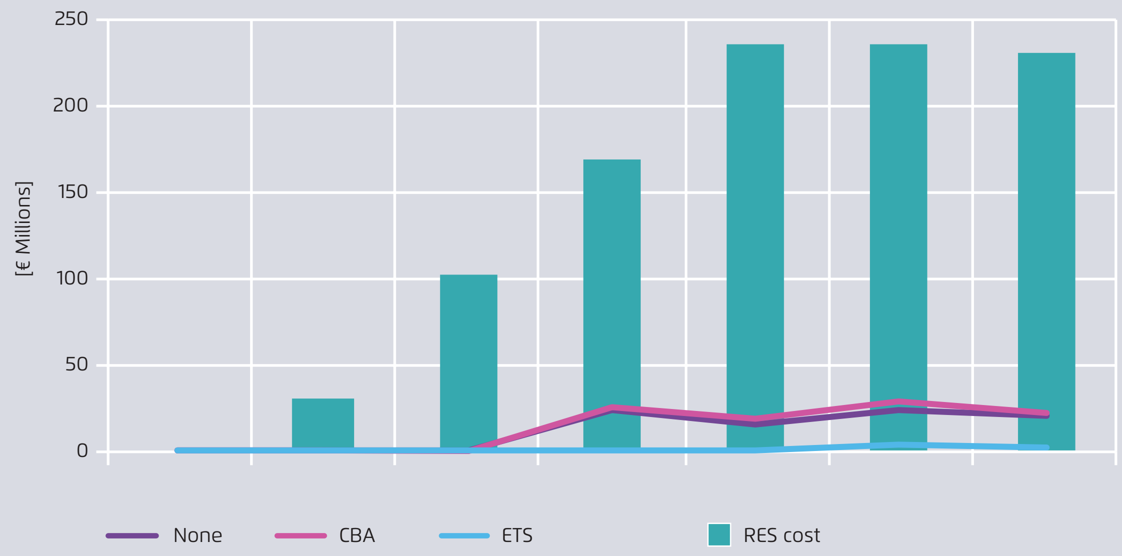
Investment needs across the scenarios – Kosovo

Figure 48

enervis (2021)

Annual RES support (lines) vs. RES system costs (bars) – Kosovo

Figure 49



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additional investment needs for Kosovo, though they remain low.

4.2.2.4 Investment needs and subsidies

Figure 48 shows annual investment volumes for Kosovo across the scenarios.

The investment needs in the Fossil projections amount to 1.8 bn € (None, CBA) and to 1.9 bn € (ETS) by 2050, with a strong concentration on lignite- and gas-based generating capacities. Investments in the Green Deal scenarios mainly concentrate on RES and add up to 3.8 bn € (None), 3.7 bn € (CBA), and 4.2 bn € (ETS) by 2050.

Figure 49 shows the scenario differences regarding annual RES costs (bars) and RES support (lines) for Kosovo. Compared with the Fossil scenarios, the Green Deal scenarios have additional annual RES generation costs of 102.2 million € in 2030, 235.6 million € in 2040, and 230.7 million € in 2050. But additional annual RES support costs represent on average only 1 per cent (ETS), 9.3 per cent (None), and 10.1 per cent (CBA) of total additional costs. Most of the additional RES generation costs are financed by market revenues and do not increase support needs.

4.2.3 Serbia

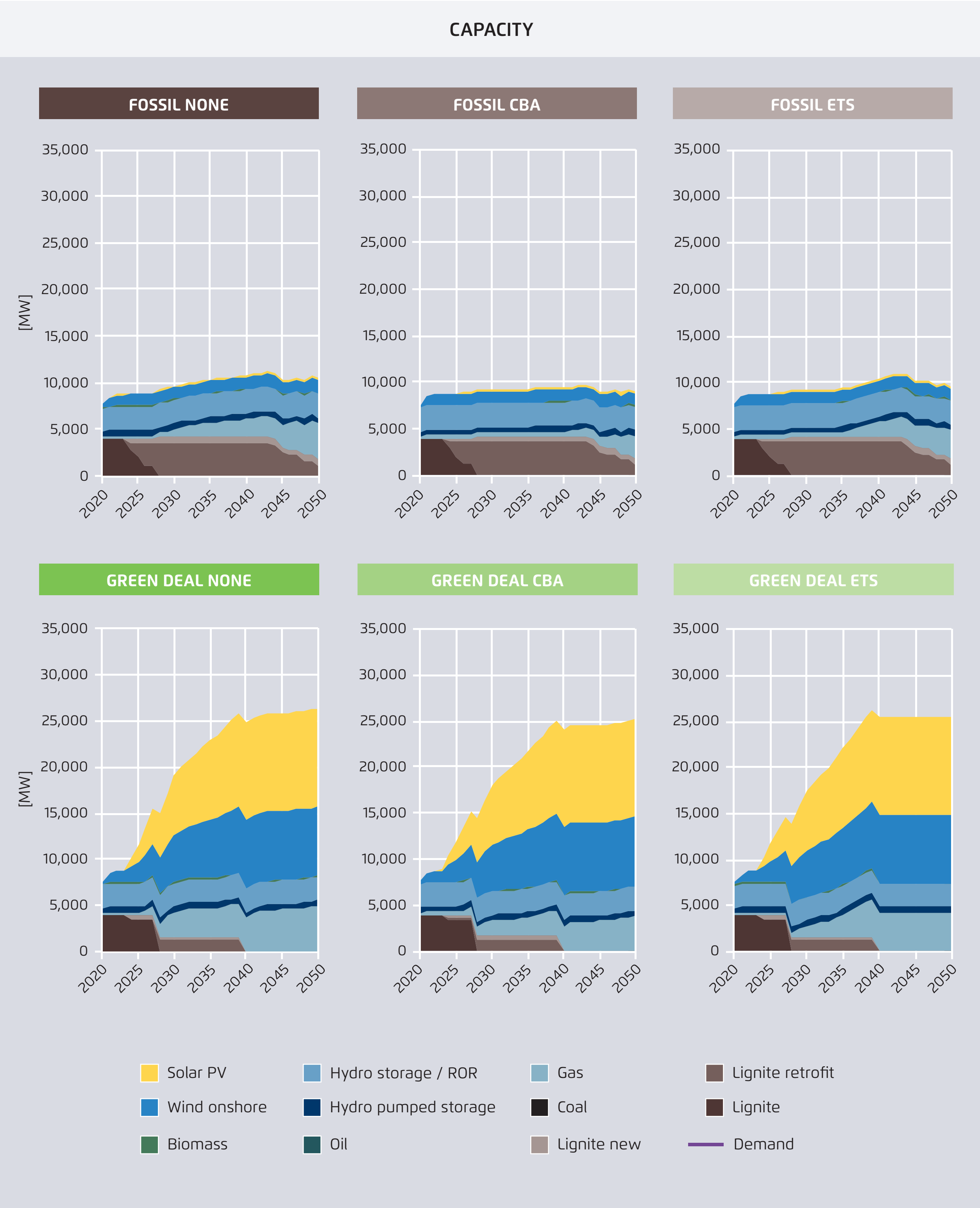
4.2.3.1 Installed capacity and power generation

In the following section, we present the modelled power market outlook for Serbia. As can be observed by Figure 50, the installed net capacity in the Fossil scenarios increases from 7.6 GW to 10.4 GW (None), to 9 GW (CBA), and to 9.6 GW (ETS) by 2050, depending on the CO_2 pricing scheme.[31] The trajectories of lignite and RES follow the scenario design; the main difference lies in the gas capacities deployed by the model. The Green Deal scenarios consider no new lignite investment and only a partial modernization of exiting units. The resulting gap is covered by PV and wind onshore capacities. Total installed capacity increases to 26.3 GW (None), to 25.2 GW (CBA), and to 25.5 GW (ETS) by 2050.

31 This excludes "out-of-market reserves" necessary in case peak demand is covered at the national level.

Development of the power market structure across the scenarios – Serbia

Figure 50 a



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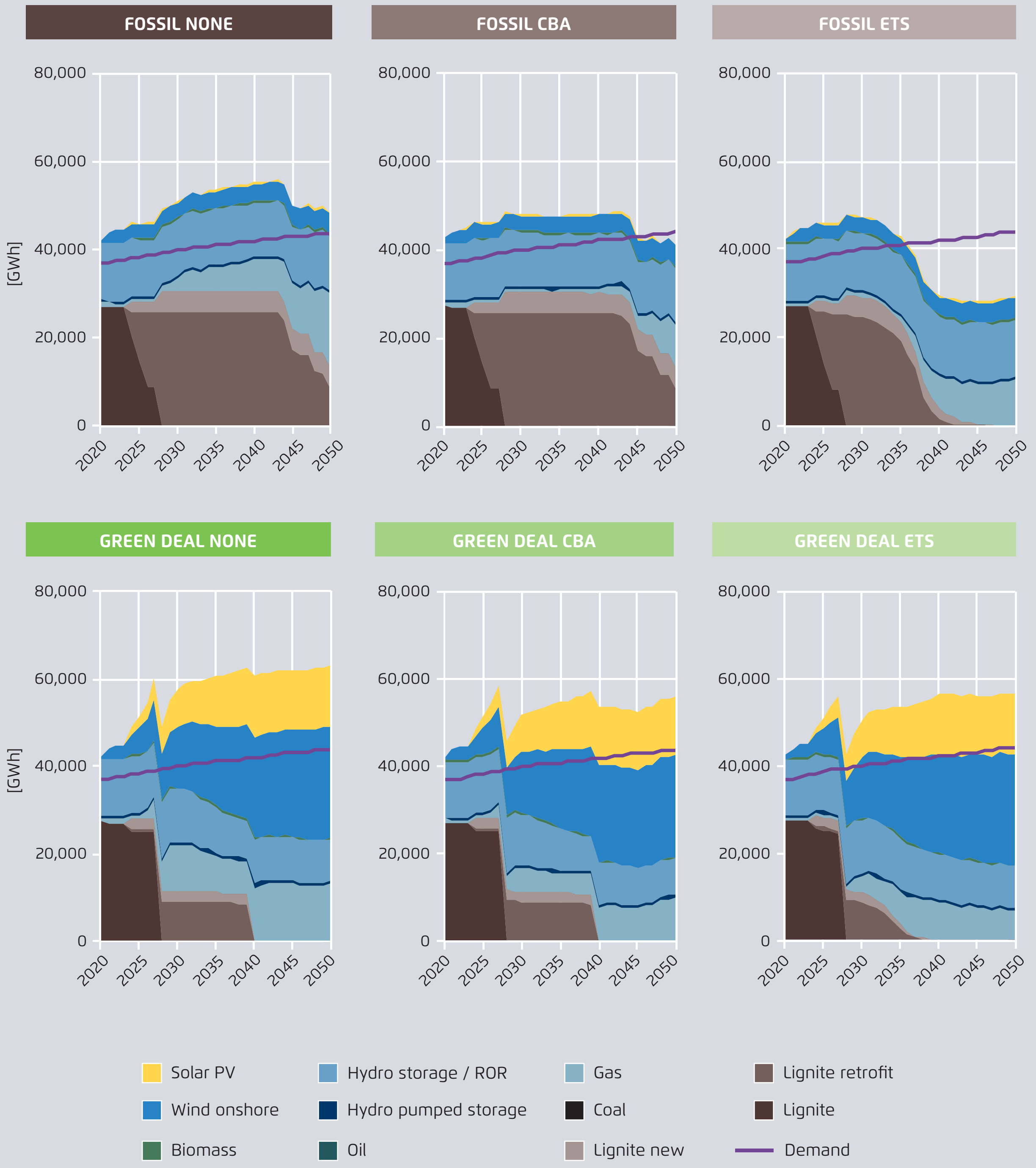
Development of the power market structure across the scenarios – Serbia

Figure 50 b

GENERATION



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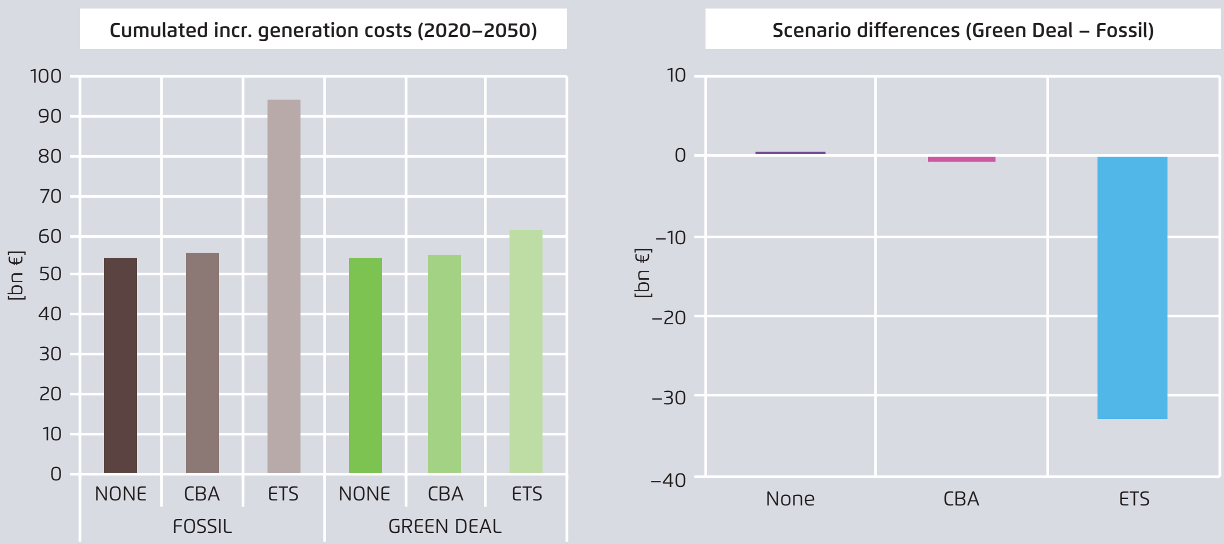
Cumulated incremental generation costs (2020–2050) (left) and scenario differences (Green Deal – Fossil) (right) – Serbia

Figure 51



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While the increase of demand is kept constant across the scenarios (around 44 TWh in 2050), the capacity developments and the modelled CO_2 pricing schemes lead to different power mixes over time. In the Fossil scenario, the retrofit of existing and commissioning of additional (modern) lignite units lead to more lignite generation than today. By contrast, in the Green Deal scenarios, lignite generation is phased out earlier and power mixes are shaped more by rising RES shares. The introduction of an ETS scheme in the Fossil scenario severely reduces generation and total power export from Serbia. (This is less so with the CBA.) By contrast, the shift from lignite to wind onshore and PV in the Green Deal scenario can manifest itself in exports. A CBA mechanism reduces incentives for export-oriented gas generation ("carbon arbitrage").

4.2.3.2 Incremental generation costs

Figure 51 shows the overall incremental generation costs over time and the scenario differences for Serbia. In a situation without CO_2 pricing, incremental generation costs rise somewhat. A CBA mechanism reduces generation costs slightly. But the effects remain in a relatively tight range between the scenarios. The Green Deal scenario reduces costs by over 30 bn € when an ETS phase-in is considered.

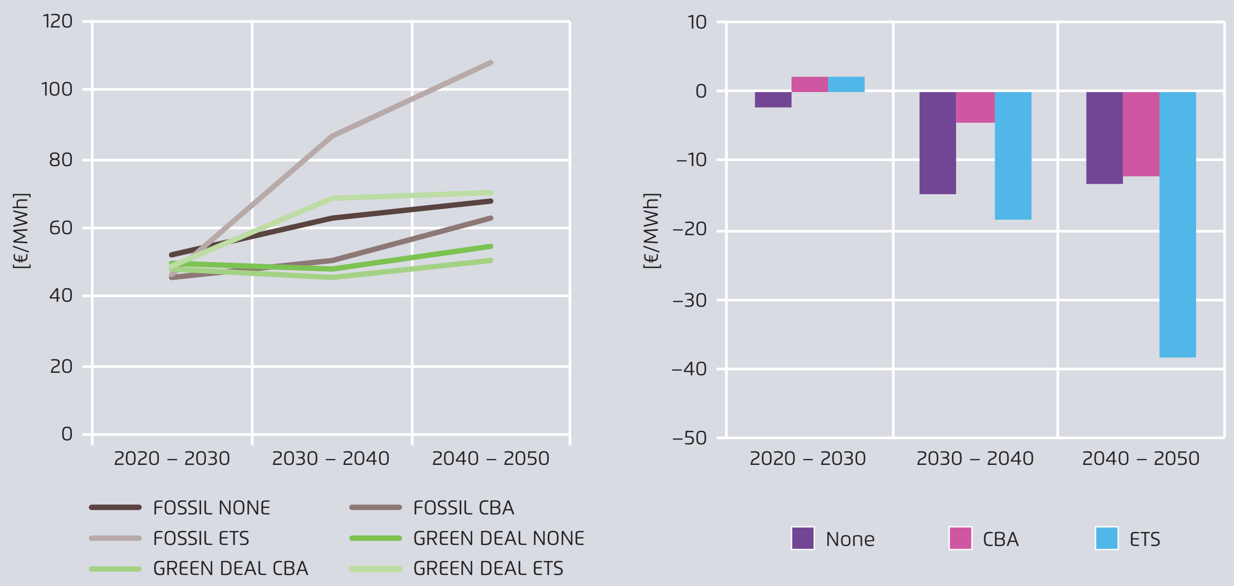
4.2.3.3 Wholesale base prices and consumer costs

Figure 52 shows the average wholesale base prices per modelled decade for Serbia. The wholesale price level increases moderately across the scenarios, due in part to the increase in power demand and fuel costs. Prices rise more significantly when an ETS is introduced. The Green Deal scenario noticeably mitigates the resulting price increase. In the long run, the Fossil scenarios result in higher wholesale base prices for Serbia for each CO_2 regime.

Figure 53 shows the consumer costs for Serbia across the scenarios when considering wholesale base volume, RES support needs, and the costs for strategic

Average wholesale base prices per modelled decade – Serbia

Figure 52



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reserves.[32] Most can be attributed to wholesale base volumes, while the costs for RES support needs and strategic reserves remain limited.

A generally rising trend in consumer costs can be observed across all the scenarios as demand and base prices increase. However, more RES in the system mitigates wholesale base volume regardless of the CO_2 regime modelled in the Green Deal scenarios. A comparison of the cost components shows that the need for RES support is negligible.

As for the strategic reserves needed to cover national peak load, the green deal scenarios trigger some additional investment needs for Serbia, though they remain low.

4.2.3.4 Investment needs and subsidies

Figure 54 shows the annual investment volumes in the Fossil projections for Serbia across the scenarios.

32 For methodological reasons, costs and support needs for existing capacities (mostly RES and lignite) are excluded.

The investment needs amount to 8.9 bn € (None), 7.7 bn € (CBA), and 8.1 bn € (ETS) by 2050, with a strong concentration on lignite- and gas-based generating capacities. By contrast, investments in the Green Deal scenarios mainly concentrate on RES and add up to 20.2 bn € (None), 19.3 bn € (CBA), and 19.6 bn € (ETS) by 2050.

Figure 55 shows the scenario differences for annual RES costs (bars) and RES support (lines). While significant RES costs occur in the Green Deal scenarios, most of it is financed by market revenues and hence does not increase support needs. The Green Deal scenarios produce additional annual RES generation costs of 587.7 million € in 2030, 941.5 million € in 2040, and 913.4 million € in 2050. But additional annual RES support costs represent on average only 0.9 per cent (ETS), 8.7 per cent (None), and 10 per cent (CBA) of total additional costs. Especially in the ETS scenario, most of the additional RES cost are financed by market revenues. The out-of-market payments needed for RES investments are relatively minor.

Development of consumer costs across the scenarios – Serbia

Figure 53

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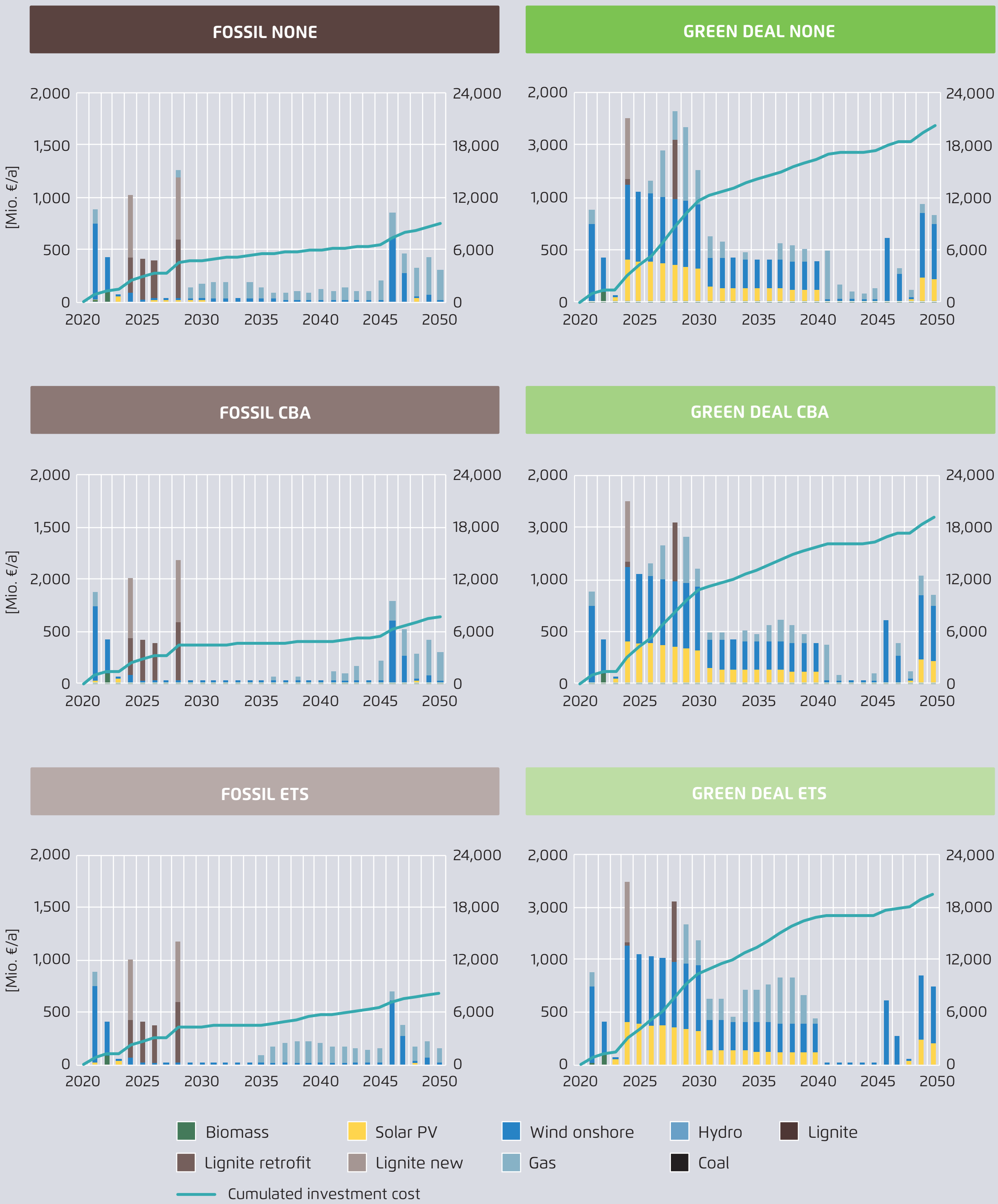
Investment needs across the scenarios – Serbia

Figure 54



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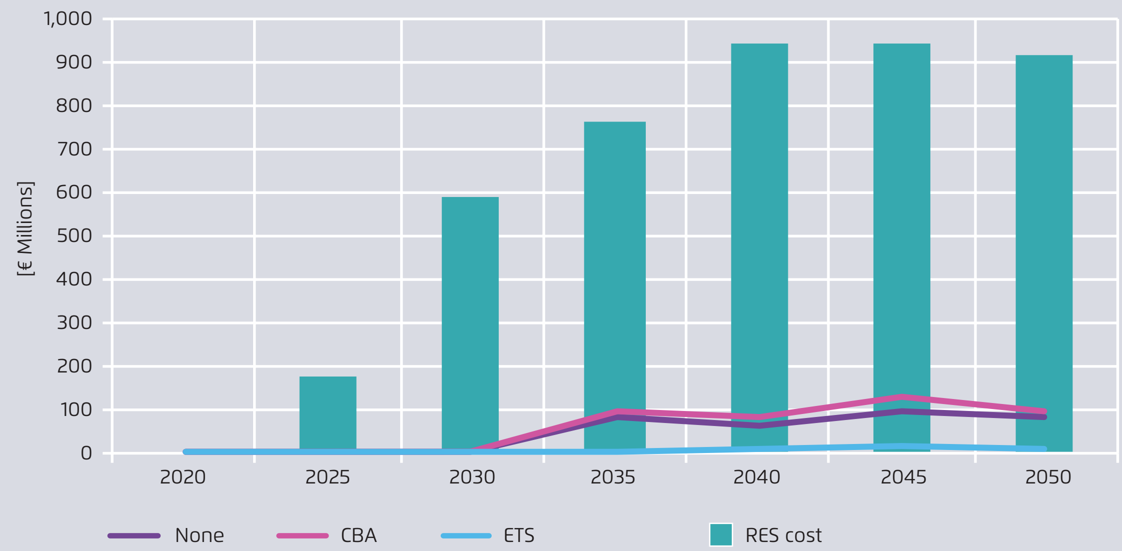
Annual RES support (lines) vs. RES system costs (bars) Figure 55



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4.3 Economic assessment of planned lignite projects

All across the region, heated discussions are taking place about the economic viability of the planned lignite plants. In response, the study analyzed their potential economic performance.

In order to assess economic viability of the proposed lignite projects in the region, we calculated the net present values for the newly planned units. We considered the following drivers: income based on wholesale prices, lignite and carbon costs (if applicable), fixed operational costs, and investment costs. We assumed capital costs of 6 per cent in real terms for discounting purposes. The costs of surface mining were provided by WISE. The resulting net present value represents the economic viability of a specific new lignite planned from an investment point of view, excluding subsidies. If the calculated net present values are positive, then the asset represents an investment whose profits exceeding the capital costs. If the net present values are negative, the profits do not exceed the capital costs and the investment project should be abandoned.

Figure 56 illustrates the results of the economic assessment of the proposed lignite projects in the region. Notably, Kakanj G8 and Gacko 2 have a negative NPV in all scenarios. Both Serbian projects and Kosovo C1 have positive NPVs in the Fossil scenario without CO_2 pricing. Differences between the different plants are mostly due to different power price levels and lignite costs.

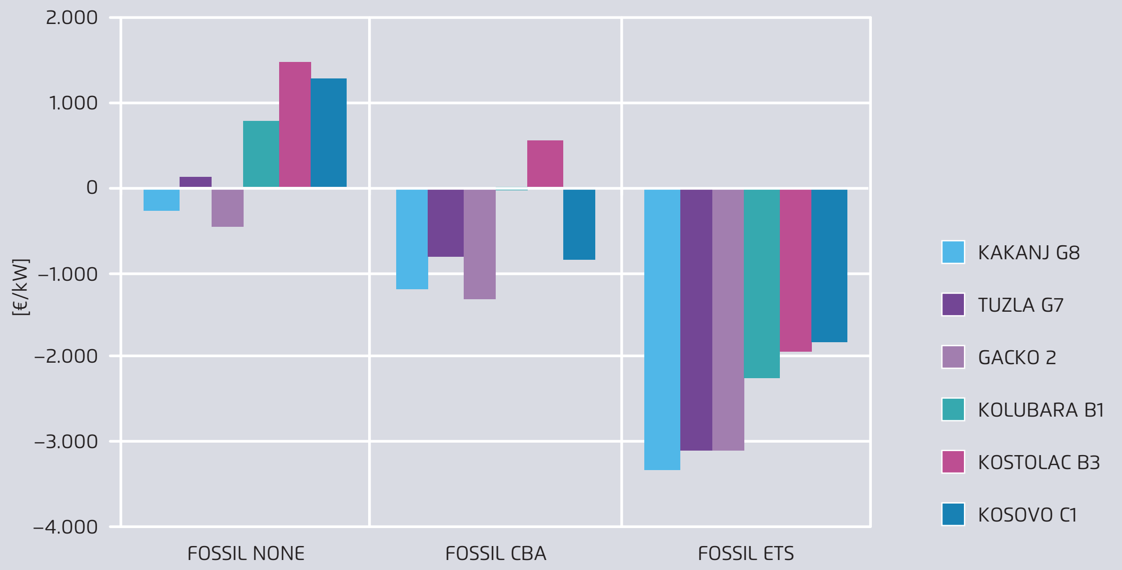
Therefore, even without a carbon pricing mechanism, some planned lignite plants are not profitable. With a CBA, the economic situation for plants gets worse; if the ETS is phased in, all planned lignite power plants turn net negative and hence are unprofitable. Consequently, any form of carbon pricing (at the border via a CBA or through an ETS phase-in) poses a major risk for the economics of new lignite plants in the region.

Accordingly, the 2 GW of additional lignite capacity currently planned in the region will, if built, generate a cumulative loss by 2040. The main factors are the low efficiency of lignite mining, the costs of complying with air pollution regulation and, most importantly, the limited export opportunities in view of the carbon border adjustment at the EU border. The phase-in of an ETS in the Energy Community countries would make new lignite an even riskier investment.

4.4 Summary and conclusions

- → In contrast to the Fossil scenarios, the Green Deal scenarios consider no new lignite investments and only a partial modernization of exiting lignite units. In the latter scenarios, the generation gap is covered by PV and wind onshore capacities, yielding a higher installed net capacity of these technologies by 2050. In the Fossil pathway, the majority of capacity development takes place before 2028 via the refurbishment of existing lignite and the commissioning of new units. In the Green Deal scenarios, there is less lignite retrofitting and an earlier and much more significant expansion of RES.
- → RES shares in demand remain low in the Fossil scenarios and increase significantly in the Green Deal scenarios. The resulting level of carbon emissions is significantly lower in the Green Deal scenarios than in the Fossil scenarios. In the Fossil scenarios, the introduction of ETS pricing would reduce lignite volumes significantly and consequently cut regional CO_2 emissions.
- → Without any form of carbon pricing in the Western Balkans, gas capacity in the region has a competitive advantage ("carbon leakage") over new gas units in the European Union. Introducing a CBA mechanism would prevent those investments.
- → Investments in Fossil scenarios reach a cumulated maximum of 19–22 bn €, with a strong concentration on lignite and gas, while investments in the Green Deal scenarios amount to around 38–40 bn €, most of which go to RES. These investments could be reduced through funding

Calculated net present values for proposed lignite projects in the region — Figure 56



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from the European Union and IFIs. Investment activity is an indicator of increased business activity and employment potential.

→ Looking at incremental generation costs, an ETS introduction poses a significant risk for the Fossil scenarios. By contrast, the Green Deal scenario hedges against an ETS phase-I,.and a CBA has rather modest impact on overall cost differences. Generally, a Green Deal scenario significantly reduces fuel costs and the costs related to external effects, which is currently estimated to be in the range of 6.1–11.5 bn € (Health and Environment Alliance (HEAL), 2019) per year.
→ As demand and wholesale base prices increase across the scenarios, consumer costs tend to rise. The modeling clearly shows that introduction of an ETS to a fossil energy system has the potential to significantly impact power consumers. However, more RES in the system mitigates wholesale base volumes regardless of the CO_2 regime in the Green Deal scenarios. Hence, it is important to note that as wholesale power prices rise, the subsidies needed for RES are fairly low. The financial RES support needs are comparable to current estimates of direct subsidies provided to lignite electricity producers. In 2019, the latter amounted to 22.71 million EUR in Bosnia and Herzegovina, 6.59 million EUR in Kosovo and 41.36 million EUR in Serbia[33].
→ A business case calculation finds that new lignite plants in the Western Balkans are not financially viable with any form of carbon pricing. Some plants are not even feasible *without* carbon pricing.
→ Any carbon pricing (at the border via a CBA or through an ETS phase-in) poses a major risk for the economics of new lignite in the region. The 2 GW of lignite capacity currently planned in the region will, if built, generate a cumulative loss by 2040.

33 See footnote 1.

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Annex A Detailed results

A. 1 Bosnia and Herzegovina

The annual development of capacity for Bosnia and Herzegovina across the scenarios is shown in Figure 57. Positive bars represent the commissioning of capacities; the negative bars represent the decommissioning of capacities.

As can be observed, the majority of capacity development in the Fossil scenarios takes place up to 2024 and consists of renewals in the existing lignite capacity and the commissioning of new units. By contrast, the Green Deal scenarios see less lignite retrofitting and an earlier and more significant RES expansion.

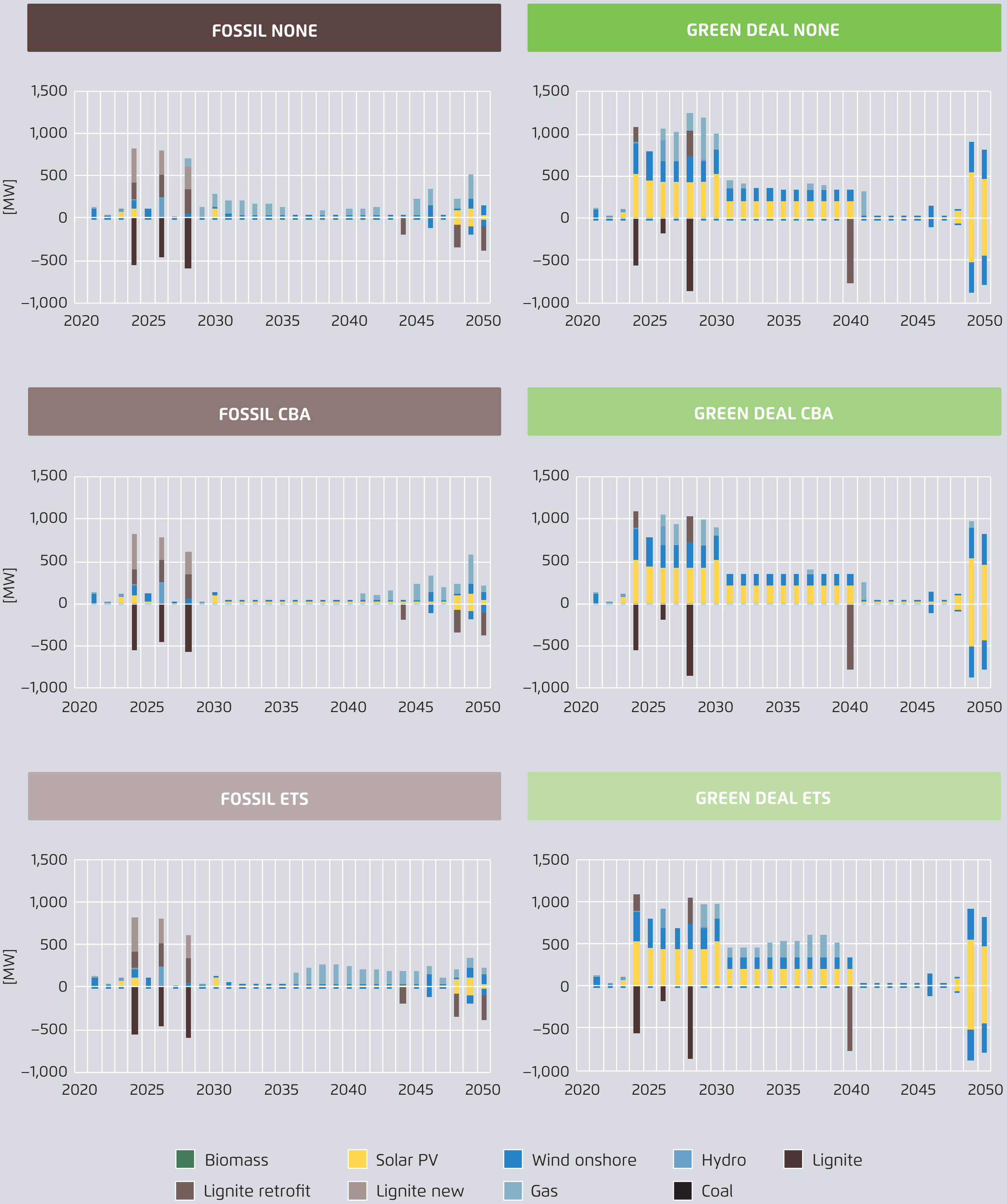
Figure 58 shows the development of RES and lignite shares in demand for Bosnia and Herzegovina. RES shares in generation increase slightly and remain between 60 per cent and 70 per cent in the Fossil scenarios, while the share of RES in the Green Deal scenarios increases significantly as a result of the "coal to green" approach for lignite replacement. Due to the excess of lignite generation today, the "coal to green" approach for the Green Deal results in RES shares exceeding 100 per cent (implying exports).

Figure 59 shows the development of CO_2 emissions for Bosnia and Herzegovina. The overall trends in annual CO_2 emissions primarily follow the corresponding lignite generation pattern combined with the endogenous expansion of gas capacity (as was shown in section 4.2). The remaining plateau of emissions observed beyond 2040 in the Green Deal scenarios can thus be attributed exclusively to gas-based generation and illustrates the need for further action to achieve a "deep decarbonization" scenario.

Compared with the scenarios without CO_2 pricing, the CBA reduces incentives for export-oriented gas generation ("carbon arbitrage") and thus averts rising CO_2 emission levels. However, the overall effect of the CBA mechanism on total CO_2 emissions remains limited. The introduction of an ETS leads to a substantial and steady reduction of carbon emissions in both the Green Deal and the Fossil scenarios.

Development of capacity across the scenarios – Bosnia and Herzegovina

Figure 57



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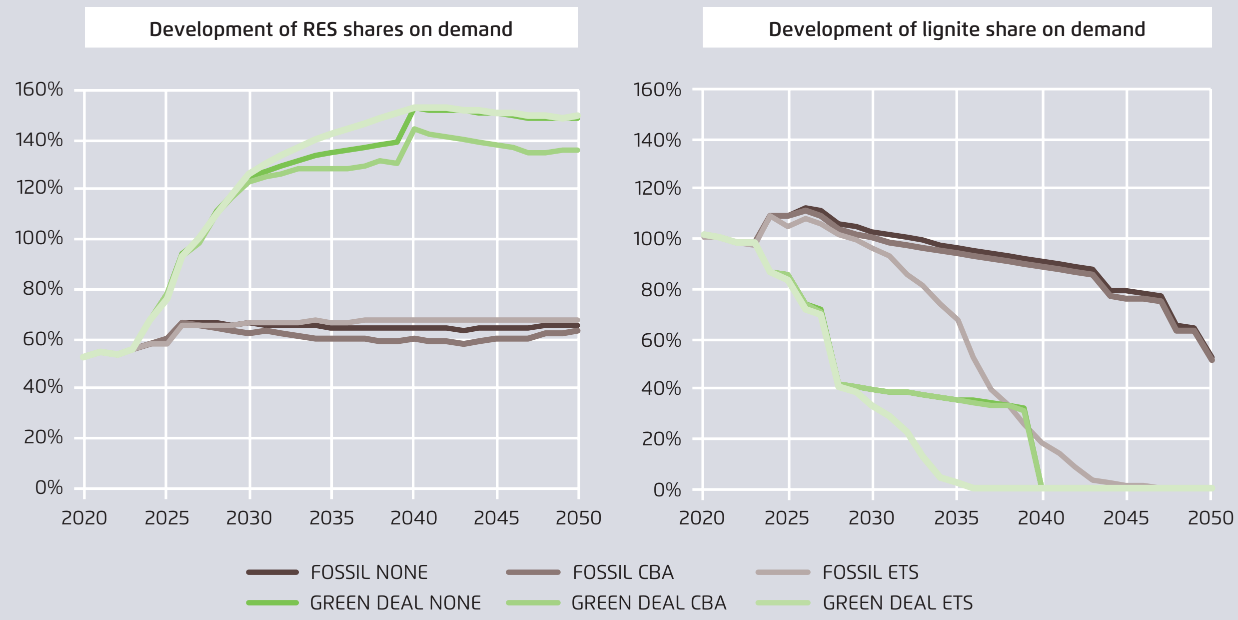
Development of RES shares (left) and lignite shares (right) in demand – Bosnia and Herzegovina Figure 58



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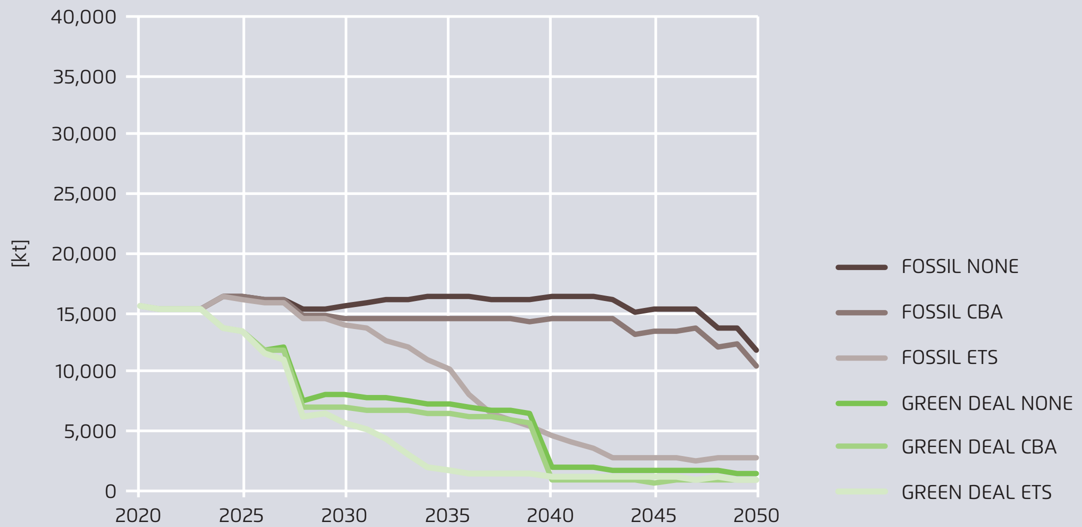
Development of CO_2 emissions – Bosnia and Herzegovina Figure 59



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A. 2 Kosovo

Figure 60 shows annual capacity for Kosovo across the scenarios. Most of the capacity increase in the Fossil scenarios takes place in the period up to 2024 and consists of renewals of existing lignite capacity and the commissioning of new units. By contrast, the Green Deal scenarios have less lignite retrofitting and an earlier and more significant RES expansion.

Figure 61 shows the development of RES and lignite shares in demand for Kosovo. RES shares remain unambitious in the Fossil scenarios. rising just over 30 per cent, while in the Green Deal scenarios, the share of RES increases significantly. Due to the excess of lignite generation today, the “coal to green” approach for the Green Deal renewable expansion results in RES shares exceeding 100 per cent (implying exports).

Figure 62 shows the development of CO_2 emissions for Kosovo. The overall trends in annual CO_2 emissions primarily follow lignite generation combined with the endogenous expansion of gas capacity (as presented in section 4.2). The remaining plateau of emissions observed beyond 2040 in the Green Deal scenarios can thus be attributed exclusively to gas-based generation.

Compared with the scenarios with CO_2 pricing, the CBA reduces CO_2 emission levels slightly, but the overall effect of the CBA mechanism on total CO_2 emissions remains fairly limited. An introduction of ETS leads to a substantial and steady reduction of carbon emissions in both the Green Deal and the Fossil scenarios.

Development of capacity across the scenarios – Kosovo

Figure 60

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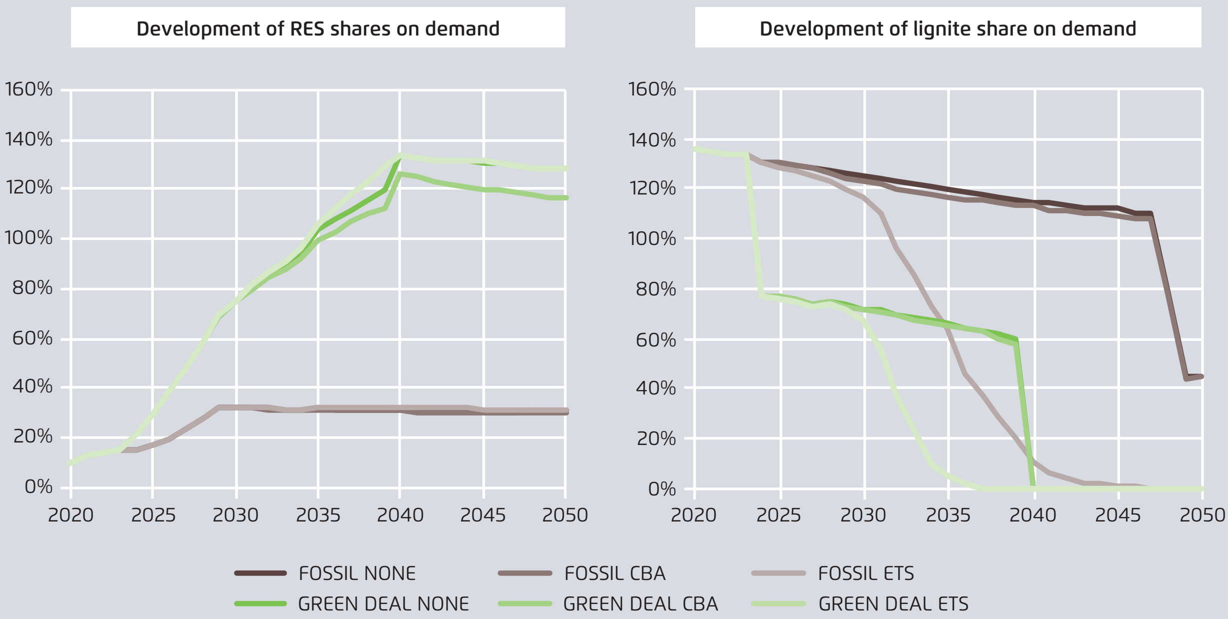
Development of RES shares (left) and lignite shares (right) in demand – Kosovo

Figure 61



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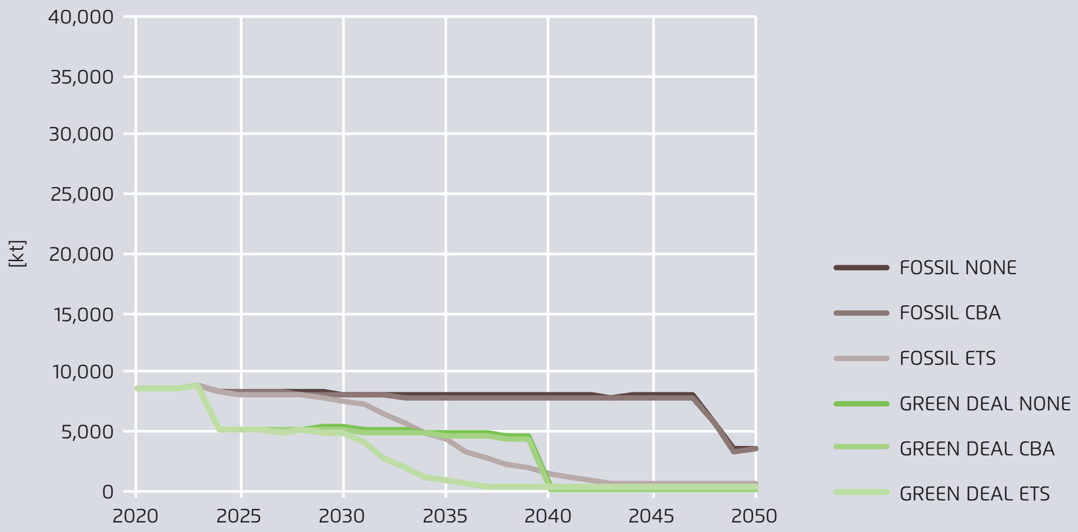
Development of CO_2 emissions – Kosovo

Figure 62



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A. 3 Serbia

Figure 63 shows the annual development of capacity for Serbia across the scenarios. The majority of capacity development in the Fossil scenarios takes place prior to 2028 via the refurbishment of existing lignite capacity and the commissioning of new units. By contrast, the Green Deal scenarios see less lignite retrofitting and an earlier and more significant RES expansion.

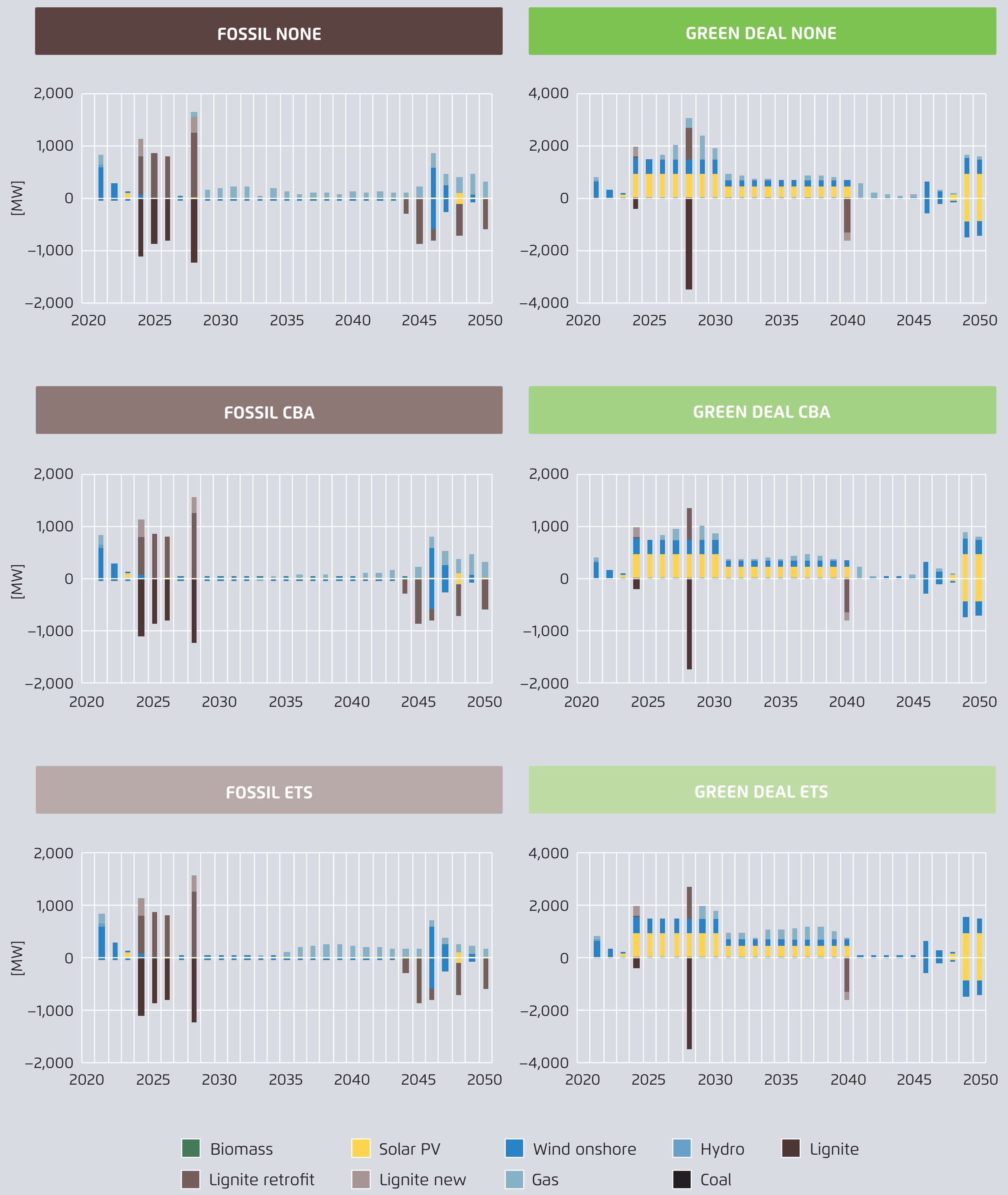
The development of RES and lignite shares in demand for Serbia is illustrated in Figure 64. In line with the scenario design, RES shares remain at around 40 per cent in the Fossil scenarios, while the share of RES increases significantly in the Green Deal scenarios due to the "coal to green" approach. Because of the excess of lignite generation today, the "coal to green" approach for the Green Deal renewable expansion results in RES shares exceeding 100 per cent (implying exports).

Figure 65 shows the development of CO_2 emissions for Serbia. The overall trends in annual CO_2 emissions primarily follow the lignite generation pattern combined with the endogenous expansion of gas capacity as illustrated in section 4.2. The remaining plateau of emissions observed beyond 2040 in the Green Deal scenarios can thus be exclusively attributed to gas-based generation. This stresses the need for further action in a "deep decarbonization" scenario.

Also for Serbia, the CBA reduces incentives for export-oriented gas generation ("carbon arbitrage") and thus averts rising CO_2 emission levels, unlike the scenarios without CO_2 pricing. But the overall effect of the CBA mechanism on total CO_2 emissions remains limited. The introduction of an ETS leads to a substantial and steady reduction of carbon emissions in both the Green Deal and the Fossil scenarios.

Development of capacity across the scenarios – Serbia

Figure 63



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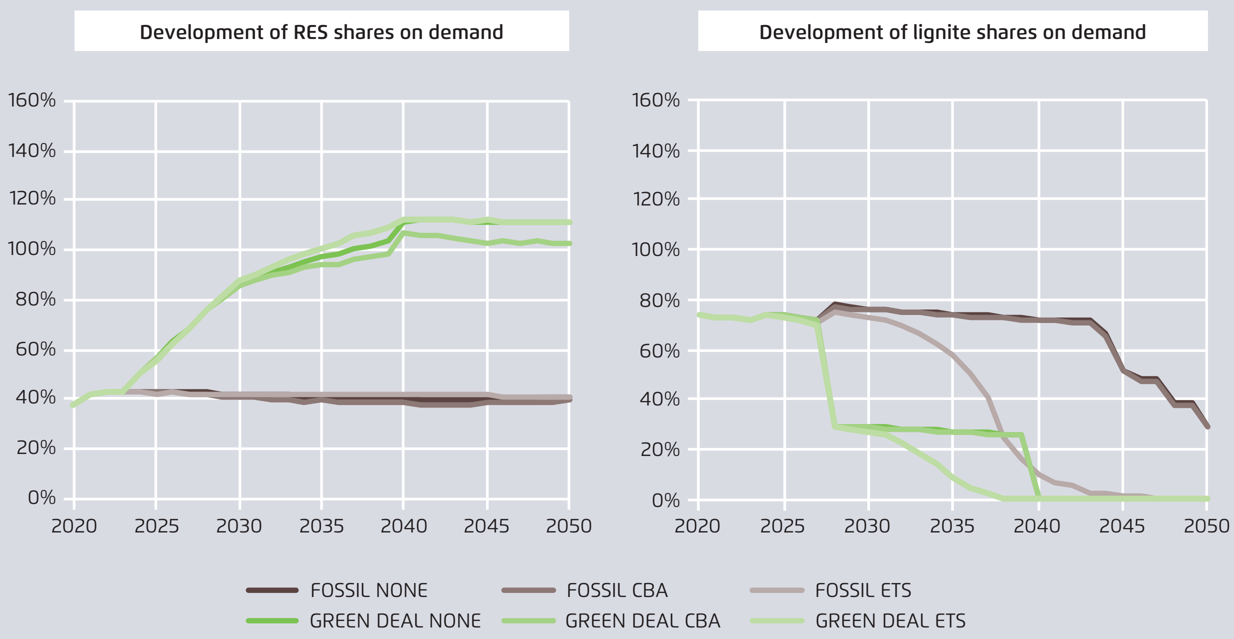
Development of RES shares (left) and lignite shares (right) in demand – Serbia Figure 64



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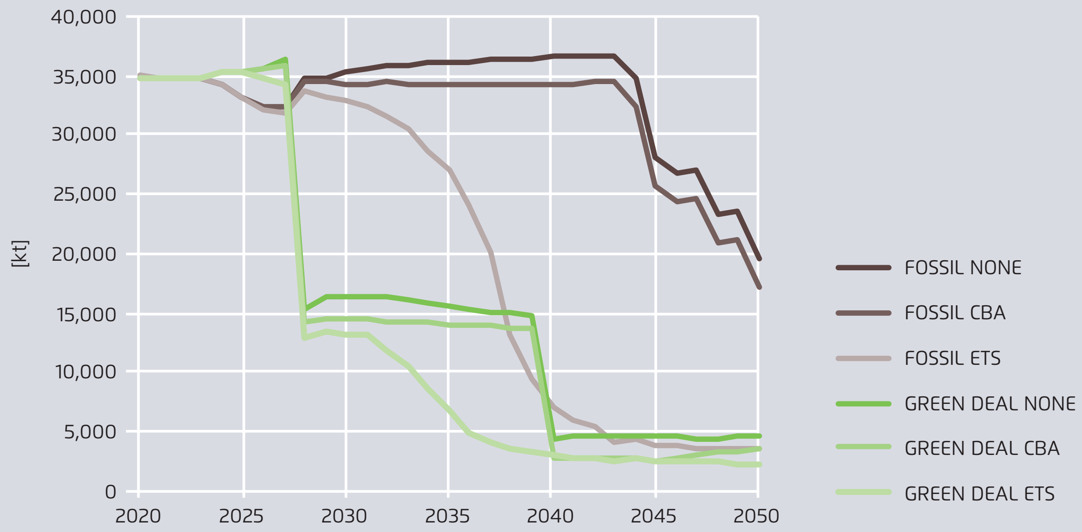
Development of CO_2 emissions – Serbia Figure 65



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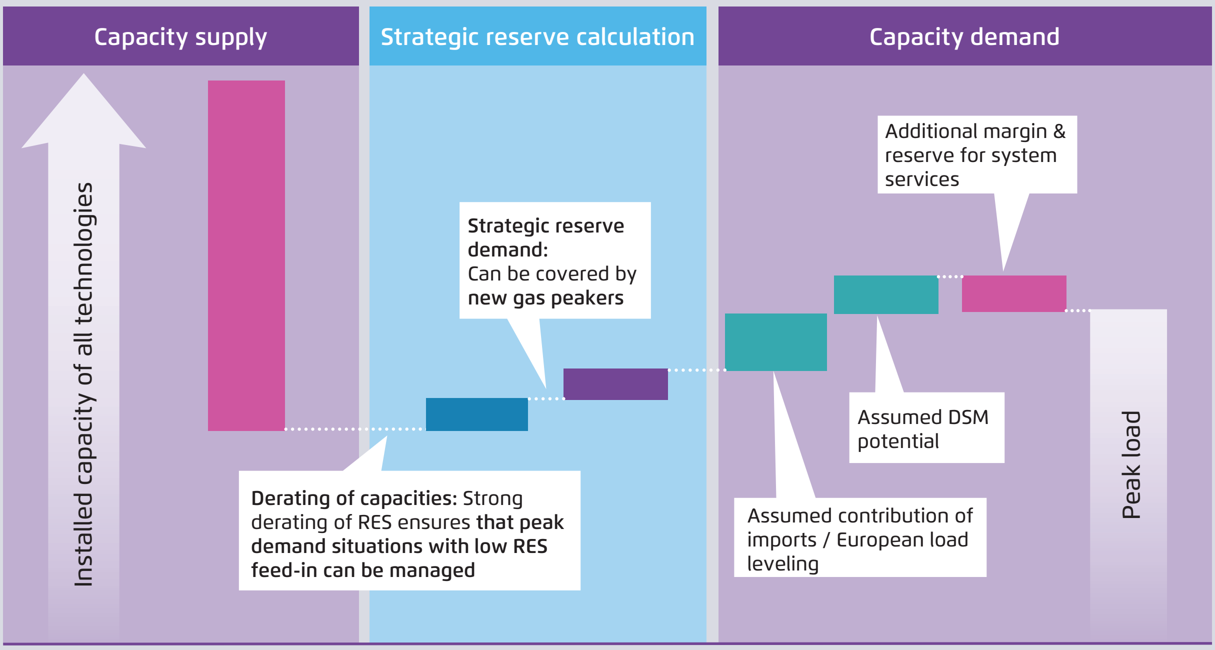
Annex B Security of supply: Strategic reserves

B. 1 Methodology for calculating strategic reserves

The energy-only market does not necessarily provide enough incentives to deploy sufficient capacities for covering peak load at the national level. Rather, an energy market left to its own devices will consider levelling effects within a region and and beyond (via imports and exports) and deploy capacities so that demand can be met at the regional level. Generally, the energy industry does not worry about the energy-only market providing capacities in line with national considerations. It does debate the extent to which the energy-only market efficiently ensures the security of supply at the regional level, but this discussion goes beyond the scope of this study. Each country within the region will, on average, have less capacity than necessary to meet its peak load. This is positive from an efficiency point of view, but is sometimes less desirable from a political point of view.

Therefore, we performed calculations to assess the costs if each country was to ensure a certain minimum capacity level within its borders. The additional capacity could be provided by different mechanisms and capacities. In this instance, we assumed a strategic reserve mechanism with mostly open gas turbines. We used a “capacity balancing approach” to calculate strategic reserve demand at the national level. The use of strategic reserves makes situations with inadequate solar and/or wind supply manageable. The following figure provides an overview of the approach we applied.

Capacity balancing approach (schematic) Figure 66



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The aforementioned calculations were conducted based on the following, additional assumptions regarding capacity credit:

→ Required margin on peak load = 9 per cent
→ DSM can reduce peak load by 5 per cent
→ Leveling effects can reduce peak load (pro rata) by 7.5 per cent
→ Capacity credit of RES: PV = 0 per cent; onshore = 4 per cent, offshore = 7 per cent

B. 2 Strategic reserve capacities and costs

The following graphs show the results for the "out of market" strategic reserves needed to cover national peak demand. General developments differ from country to country. Most countries have low overall demand for strategic reserves. A minor increase in strategic reserve demand is triggered in the Green Deal scenarios, most noticeably in Serbia and Kosovo.

The following graphs show the cumulative investment volumes over time needed to cover national peak loads. Investment needs are generally quite low and to a significant level already necessary in the Fossil scenarios. It can be concluded, therefore, that the Green Deal would require additional investment, though the total volume would be limited.

Development of strategic reserve needs Figure 67

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Investment needs for strategic reserves

Figure 68

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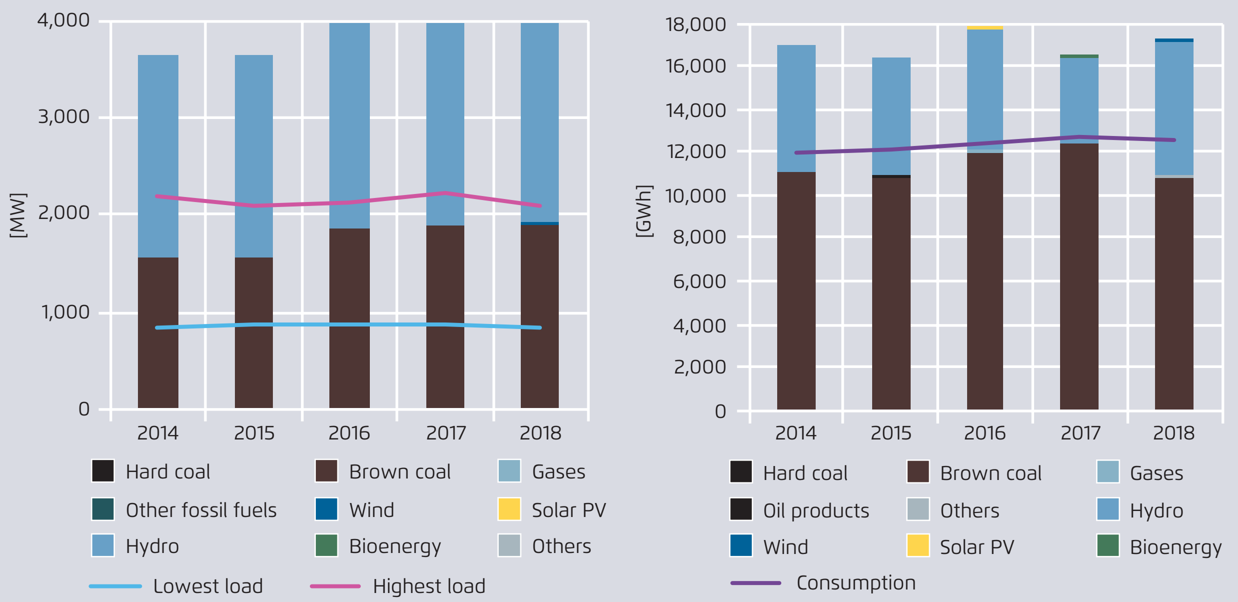
Annex C Status quo: Country-level perspective

Power capacity and generation mix for 2014–2018 in Bosnia and Herzegovina

Figure 69



enervis based on (ENTSO-E, 2020)

C. 1 Bosnia and Herzegovina

Bosnia and Herzegovina's lignite share amounts to two-thirds of domestic production and almost 100 per cent of domestic consumption. Combined with the country's relevant hydro output, Bosnia and Herzegovina sees consistent net exports.

→ Bosnia and Herzegovina's dominant technologies in capacity terms are hydro and lignite-
→ Peak load is significantly exceeded.
→ Domestic consumption is almost entirely met by lignite generation in the annual balance.

Bosnia and Herzegovina has a constant annual net exporting position.

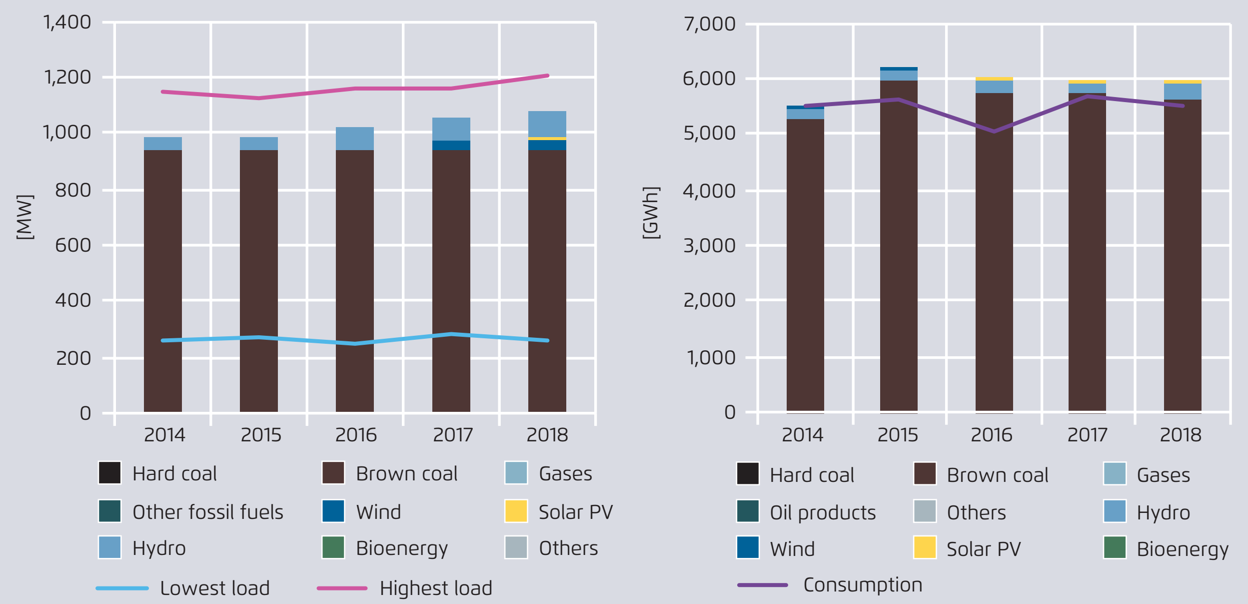
Imports, exports and trade balance for 2014–2018 in Bosnia and Herzegovina

Figure 70

enervis based on (ENTSO-E, 2020)

Power capacity and generation mix 2014–2018 in Kosovo

Figure 71



enervis based on (ENTSO-E, 2020)

C. 2 Kosovo

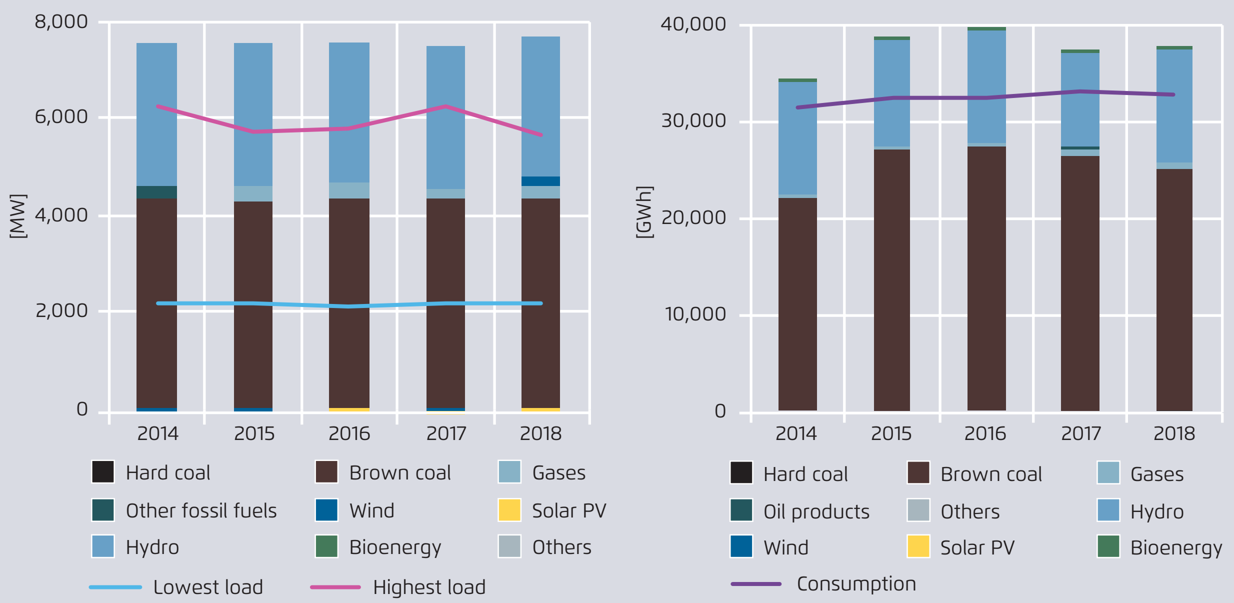
- → Kosovo relies almost exclusively on lignite capacity.
- → Some RES installation occurred for 2016–2018.
- → Kosovo's electricity demand can almost entirely be met by the country's lignite generation.
- → Kosovo's trade balance varies with consumption more than with power output.

Imports, exports and trade balance for 2014–2018 in Kosovo

Figure 72

enervis based on (ENTSO-E, 2020)

Power capacity and generation mix for 2014–2018 in Serbia — Figure 73



enervis based on (ENTSO-E, 2020)

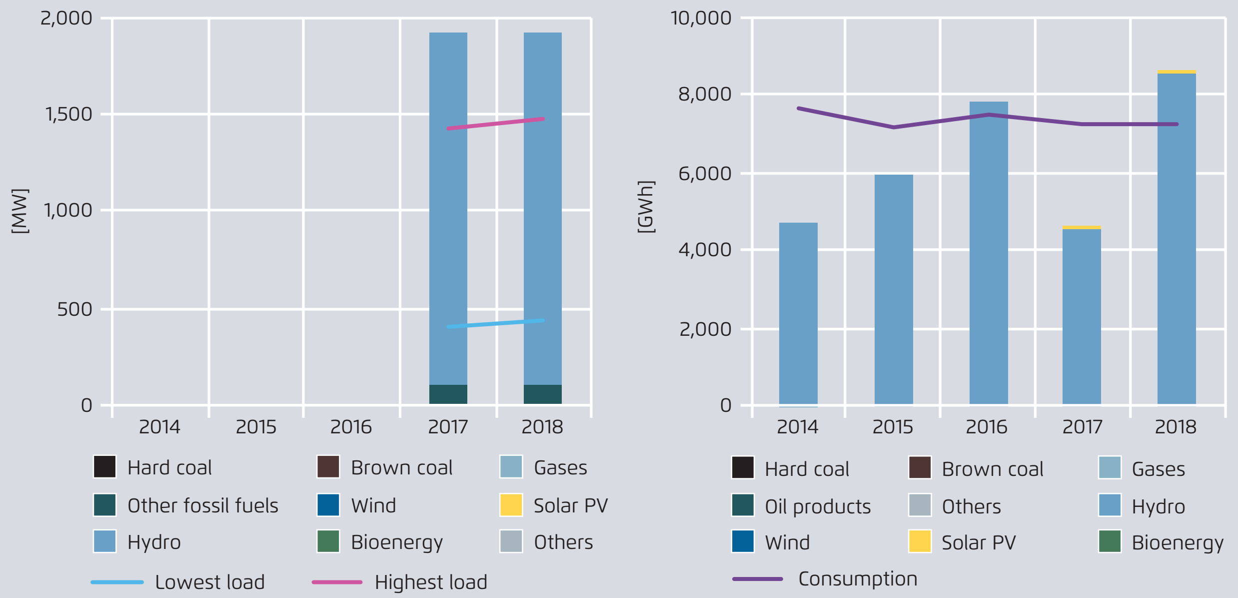
C. 3 Serbia

- → Serbia's capacity mix is made up by more than 50 per cent lignite.
- → The second dominant technology is hydro.
- → Lignite dominates generation, contributing around three-quarters of the domestic power mix.
- → Serbia's trade position is nearly balanced on an annual basis.

Imports, exports and trade balance for 2014–2018 in Serbia — Figure 74

enervis based on (ENTSO-E, 2020)

Power capacity and generation mix for 2014–2018 in Albania — Figure 75



enervis based on (ENTSO-E, 2020)

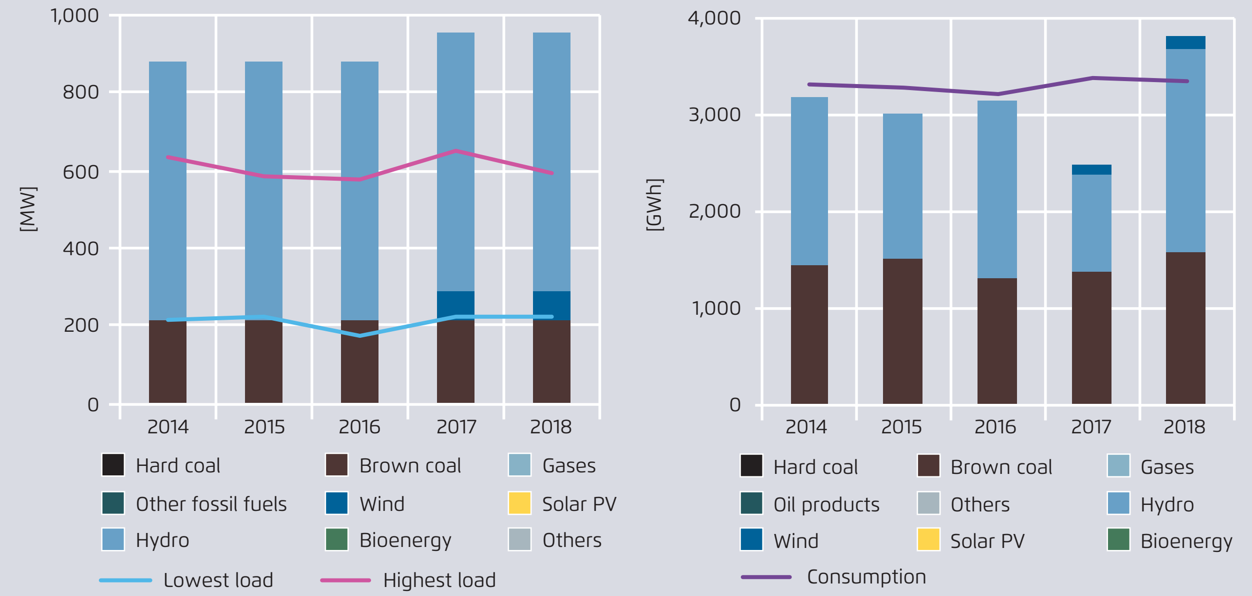
C. 4 Albania

→ Albania's power mix is almost exclusively made up of hydro capacities.
→ Domestic generation fluctuates with hydro availability.
→ As with hydro availability, Albania's trade balance has been volatile in the past.

Imports, exports and trade balance for 2014–2018 in Albania — Figure 76

enervis based on (ENTSO-E, 2020)

Power capacity and generation mix for 2014–2018 in Montenegro — Figure 77



enervis based on (ENTSO-E, 2020)

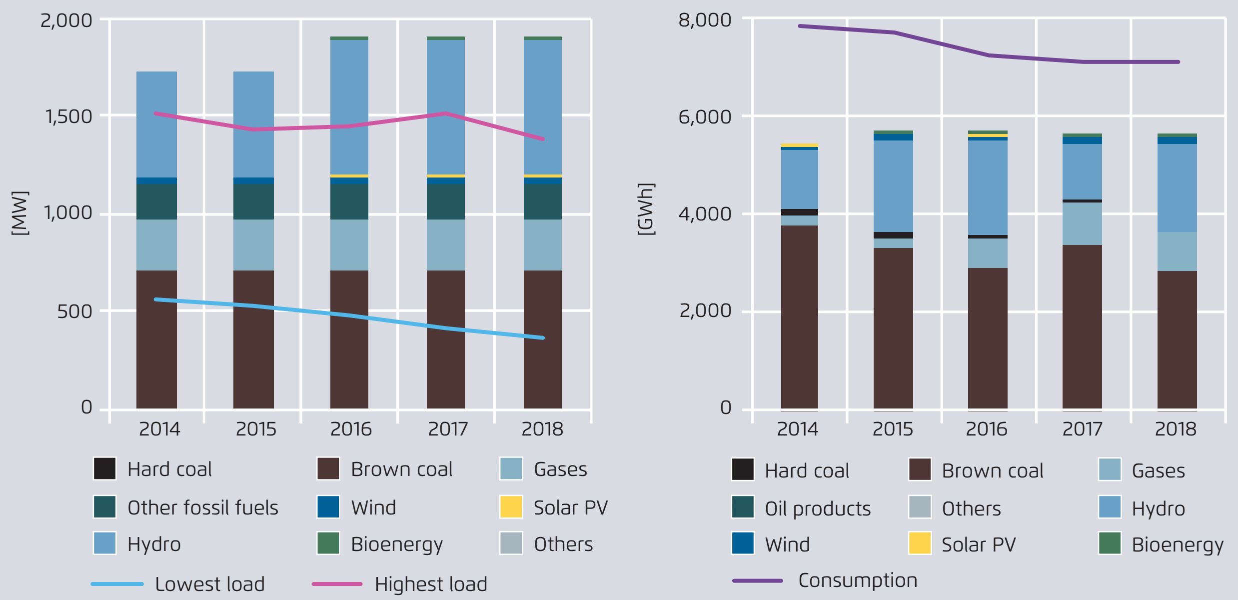
C. 5 Montenegro

→ Capacity mix is dominated by hydro and lignite.
→ Wind capacity was first introduced in 2017.
→ On average, generation consists of half lignite and half hydro.
→ After substantial net imports in the past, strong hydro resulted in net exports in 2018.

Imports, exports and trade balance for 2014–2018 in Montenegro — Figure 78

enervis based on (ENTSO-E, 2020)

Power capacity and generation mix for 2014–2018 in North Macedonia — Figure 79



enervis based on (ENTSO-E, 2020)

C. 6 North Macedonia

→ Beyond lignite and hydro, gas-based capacities play a role.
→ Some installations of PV and wind exist.
→ Bitola's generation (lignite) fell in recent years.
→ The country's net importing position was eased somewhat in recent years due to weaker demand.

Imports, exports and trade balance for 2014–2018 North Macedonia — Figure 80

enervis based on (ENTSO-E, 2020)

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