CENTER FOR THE STUDY OF DEMOCRACY

A ROADMAP FOR THE DEVELOPMENT OF THE BULGARIAN ELECTRICITY SECTOR WITHIN THE EU UNTIL 2050: FOCUS ON FUNDAMENTALS

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Introduction: Bulgaria's Energy Security Priorities

The Bulgarian energy security position has been steadily improving since the country joined the European Union a decade ago. The country's Energy Security Risk Index declined further in the past two years, placing it at 58th position among the 75 largest energy consumers in the world.[1] The key contributing factors have been the steady reduction of energy intensity and the greening of Bulgaria's energy and economy. Bulgaria was among the first EU members to meet its 2020s energy goal on consumption from renewable sources. It has also started explorations for oil and gas in its Black Sea shelf and has vowed to build gas interconnectors with Turkey and Greece in a bid to wean the country off its dependence on Russian gas.

The Bulgarian government needs to build carefully on this progress focusing on its EU-related priorities and heeding **the country's long-term energy risk factors**, the top four of which remain:

- **Energy poverty**: Bulgarian households and micro and small consumers are the most vulnerable in the EU, which rising energy prices have pushed back to coal and wood consumption or out of business, further worsening air and living quality;
- **Energy intensity**: Despite continuous improvements the Bulgarian economy remains on average more energy intensive than its EU peers, hurting resilience to external shocks and productivity;

[1] CSD, 2016, Energy Security Risks and the Case for Gas Diversification, Policy Brief 62, July 2016, Center for the Study of Democracy, Sofia.

KEY POINTS

- Based on data and modelling used by the European Commission, three scenarios for the decarbonisation of the Bulgarian electricity sector until 2050 have been developed. These scenarios provide the model framework for policy decision-making for Bulgaria in all energy domains. The results suggest the necessity for active policy-making on a number of sensitive energy issues, often linked to entrenched special interests.
- The least costly way to decarbonize the electricity sector in Bulgaria would be by replacing coal-fired power plants with renewable energy sources.
- By 2050, the country's decarbonised electricity mix would include 53-54 % renewable generation.
- The rising carbon, coal and natural gas prices would lead to an increase of Bulgarian wholesale electricity prices from an average of EUR 34/MWh in 2016 to over EUR 74/MWh in the decarbonisation scenario in 2050.
- At the average expected wholesale power price in 2050, new nuclear capacity would not be financially viable as its breakeven costs are over EUR 80/MWh.
- Due to steeply rising carbon prices, coal and lignite based generation capacities would be priced out of the market before the end of their lifetime in all scenarios.
- The best-case decarbonisation scenario would require investment of around EUR 16.5 billion but only around EUR 4 billion in state support over the next three decades.
- In all scenarios, the households electricity expenditures to income would double to around 8.5 % by 2050.
- Natural gas would play a transition role in all scenarios, which requires the speeding up of efforts to fully liberalise the natural gas market and achieve source diversification.

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- **Diversification**: Bulgaria has suffered the worst external energy security shocks in gas, the energy sector, which is the least diversified outside and inside the country;
- **Bad governance**: Thus far, corruption and waste in the public sector and within energy policies has cost Bulgarian consumers at least a third of the energy price increases they have experienced, excluding the long-term effects of bad policy choices and monopoly rents.[2]

Failing to focus on these critical issues within the wider framework of EU energy priorities and regulations has already cost the country dearly, not just in monetary terms, as it continues to be embroiled in multi-billion long-term negotiations with its dominant energy supplier Russia. The Bulgarian government has continuously been unable to define, publicly defend, and implement its energy priorities, policies and actions in a clear-cut framework, outlining the effects on consumers, producers, tax-payers, the public and private sector. It is thus caught between the rock of EU obligations and popular demands for affordable energy, and the hard place of alluring, large-scale contracting projects such as NPP Belene and the South Stream gas pipeline.[3] It seems that successive Bulgarian governments have chosen the latter at the expense of officially proclaimed government policies and without decision-making matrix. Continuing this stubborn path of self-entrapment, based solely on the desire to offset sunk costs and win big business would be a grave mistake. The Bulgarian government and public energy sector need to focus on defining the country's national priorities within the EU Energy Union framework, and only engage in projects commensurate to its limited capacity. Critically, Bulgaria should focus on analyzing and choosing its preferred scenario and roadmap for the development of the electricity sector within this framework.

The EU Energy Union Framework

The Energy Union Framework Strategy, embraces **a long-term commitment to the full decarbonisation of the electricity sector**. Resting on five pillars (Energy security, solidarity and trust; A fully integrated European energy market; Energy efficiency contributing to moderation of demand; Decarbonising the economy; and Research, innovation and competitiveness),[4] it aims at easing the achievement of the **EU energy-climate objectives**:

- reduce EU territorial greenhouse gas emissions (by 20 % by 2020, and by 40 % by 2030);
- increase the share of energy coming from renewable sources (to 20 % by 2020 and to 27 % by 2030); and
- improve energy efficiency (by 20 % by 2020, by 27 % by 2030).

The **Bulgarian government has been successful in reaching the 2020 target** of at least 16 % of the energy consumption of the country to come from renewable energy sources. As early as 2015, close to 19 % of the Bulgarian final energy consumption came from renewable energy sources. However, the attainment of the goal has been partially driven by the large share of renewable energy in the heating and cooling sector due to the widespread use of biomass (wood), especially in rural areas and small towns, which has caused worsening in air quality.[5] Even before the 2009 – 2013 expansion of solar and wind capacity, close to one-quarter of the power generation capacity was held by the hydro-power sector.[6] Expanding the share of the RES in the country's power generation to the levels ensuring **more than 90 % decarbonisation of the electricity sector would be a much greater challenge**.

[2] CSD, 2013, Why Electricity Bills Spoiled the Party, Media Note, February 2013, Center for the Study of Democracy, Sofia.

[3] CSD, 2016, State Capture Unplugged: Countering Administrative and Political Corruption in Bulgaria, Center for the Study of Democracy, Sofia, pp. 29-34.

[4] COM/2015/080 final Communication from the Commission to the European Parliament, the Council, the European Economic And Social Committee, the Committee of the Regions and the European Investment Bank A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy.

[5] CSD, 2011, Green Energy Governance in Bulgaria at a Crossroads, Center for the Study of Democracy, Sofia.

[6] CSD, 2011, Energy and Good Governance in Bulgaria. Trends and Policy Options, Center for the Study of Democracy, Sofia.

Long-term Scenarios for Electricity Sector Decarbonisation

Under a scenario-building exercise using European Commission approved modelling techniques and assumptions, part of the development of a South-East Europe Regional Electricity Roadmap (SEERMAP) for the almost complete decarbonisation of electricity generation in Serbia, Macedonia, Albania, Kosovo, Bosnia & Herzegovina, Bulgaria, Romania and Greece by 2050, **three scenarios for the future development of Bulgaria's electricity sector** can be proposed:[7]

- **'No target' scenario**. It reflects the implementation of existing energy policies (including implementation of renewable energy targets for 2020 and construction of all power plants included in official planning documents) combined with a rising CO_2 price, but no CO_2 emissions reduction target for 2050 in the EU or non-EU countries;
- '**Decarbonisation' scenario**. It reflects a long-term strategy to reduce CO_2 emissions by 96.7 % (in the case of Bulgaria), in line with EU emission reduction goals for the electricity sector as a whole by 2050, driven by a rising CO_2 price and strong, consistent RES support;
- **'Delayed' scenario**. It involves an initial implementation of current national investment plans followed by a change in policy direction from 2035 onwards, resulting in the realisation of almost the same emission reduction target in 2050 as the 'decarbonisation' scenario. The transformation is again driven by rising CO_2 price and increased RES support from 2035 onwards.

The results of the modelling work on Bulgaria showed that under the scenarios with an ambitious decarbonisation target and corresponding RES support schemes, the country would have an electricity mix with 53-54 % renewable generation, mostly solar and wind, and some hydro by 2050. In contrast, if no CO_2 emissions target is set and the phasing-out of the state support for RES is complete and irreversible, the share of RES in electricity consumption will reach only around 33 % in 2050. While this represents a significant increase compared to current levels, it is insufficient compared with decarbonisation levels targeted by the EU by 2050.

The model shows that whether or not Bulgaria pursues an active policy to support renewable electricity generation, **a significant replacement of fossil fuel generation capacity would take place**. Coal and lignite capacities would be almost completely phased out under all scenarios by 2050, accounting for less than 3 % of today's level. The decrease in the share of these fuels would begin early, by 2030 around 45 % of these capacities would be already closed driven by the rising price of carbon and of natural gas which would result in unprofitable utilisation rates.

The modelled **increase of the carbon price** follows the EU 2016 Reference Scenario showing that the price of a ton of CO_2 emissions jumps from EUR 33 in 2030 to EUR 88 in 2050. This Reference Scenario reflects the impacts of the full implementation of existing legally binding 2020 targets and EU legislation, but does not result in the ambitious emission reduction targeted by the EU as a whole by 2050.[8] The **increase of natural gas prices** is derived from the European Gas Market Model (EGMM),[9] which forecasts that the natural gas price in Bulgaria doubles to EUR 32.37/MWh by 2050 driven by a 15 % expected increase in oil prices, and a tightening market amid rising demand. New potential discoveries in the offshore Black Sea area and diversification of the gas supply via LNG gas could change the situation but due to the high uncertainty of many of the projects, the model has not considered a significant change of the gas supply structure.

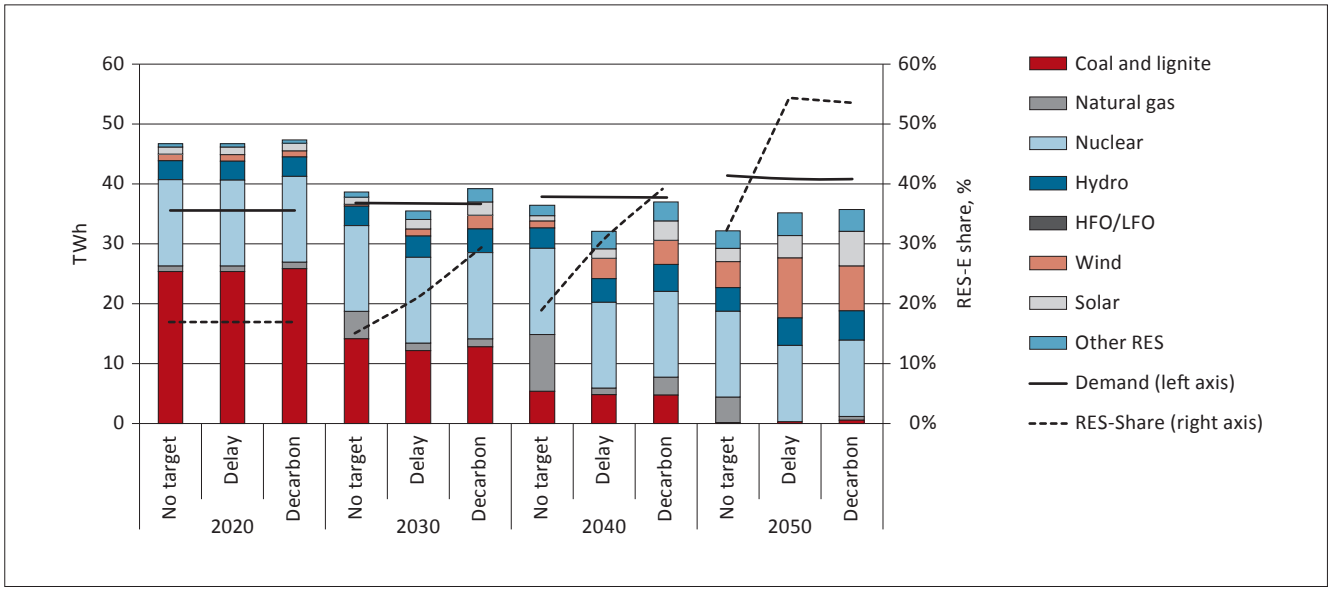
Nonetheless, **natural gas gains critical importance in all scenarios** in the coming decades as its utilization expands in order to replace the phased-out coal-fired generation capacity. The role of natural gas is though

[7] The modelling and scenarios have been developed by the Budapest-based Regional Center for Energy Policy Research (REKK), the Technical University in Vienna, the Belgrade-based Electricity Coordination Centre (EKC) and the Hungarian consultancy, OG Research in partnership with the Center for the Study of Democracy, Sofia. The study has been financed by the Austrian Ministry for Agriculture, Forestry, Environment and Water Management and the European Climate Foundation.

[8] Szabo, Laszlo et. al. SEERMAP: South East Europe Electricity Roadmap South East Europe Regional report 2017. September, 2017.

[9] Developed by REKK in 2010, and implemented in a number of cost/benefit studies of future gas infrastructure projects including Nord Stream, the Slovakia-Hungary interconnector and the Interconnector Greece-Bulgaria.

Figure 1. Electricity generation and demand (TWh) and RES share (% of demand) in Bulgaria, 2020 – 2050



Source: *SEERMAP Bulgaria Report.*

deemed as transitory as in both the delayed and the decarbonisation scenarios, gas-fired power plants are also phased out of the system by the end of the 2040s. In the *'no target' scenario* however, the contribution of gas to the electricity mix in 2050 will be still sizable, over 13 % of total generation. This trend means that Bulgaria might rely more heavily on gas import in the mid-term horizon, raising security of supply concerns, if no domestic gas resources are added to the resource pool.

The impact of rising carbon, coal and natural gas prices leads to **an overall jump of electricity prices in Bulgaria in the decarbonisation scenario from an average of EUR 34/MWh in 2016 to over EUR 74/MWh in 2050**, a price level in South East Europe (SEE) close to the one before the global economic crisis. The electricity price increase would allow the expansion of the share of renewable energy sources in the power mix even in the '*no-target' scenario*, where a business-as-usual RES policy is considered. Decarbonisation of the electricity sector does not drive up wholesale electricity prices compared to a scenario where no emission reduction target is set. In fact, electricity prices fall slightly after 2045 in scenarios with higher levels of RES in the mix due to the low marginal cost of RES electricity production.

Despite the fact that the high-power prices would be the main driver behind market-based investment in new RES capacity, **decarbonisation would still require continued RES state support** for around a half of all new renewable generation capacity. New wind-based generation would be the main technology to drive the transformation of the electricity sector. Yet increases in solar and biomass capacity would also be visible by the end of the observed period. RES in the power mix rises from around 20 % in 2015 to around 55 % by 2050 in both the *'delayed'* and *'decarbonisation' scenarios*.

Since the *'delayed' scenario* expects a slower shift in policies directed at boosting RES capacity, it is in this scenario that the state support would be most critical for the attainment of carbon emission reduction targets. The total public and private **investment cost estimated for the renewable energy investments in Bulgaria needed in this scenario could reach EUR 13.23 billion**, ¾ of which would have to be spent after 2035, and with more than half of it coming from state support mechanisms. The *'decarbonisation' scenario* assumes even higher investment of around EUR 16.5 billion but only around EUR 4 billion in state support over three decades due to the more immediate closing of coal-fired generation.

High investments in RES generation capacity flow into wind and solar, due to a combination of good technical potential, decreasing cost of technology and the rising price of carbon. A **significant portion of the new solar capacity comes from the installation of small PV roof-top capacity** amid increasing decentralisation of the electricity supply that becomes more attractive due to the rising final electricity prices. Hydro

Table 1. Development of support expenditures (for RES total) in Bulgaria over time (5-year time periods)

Support expenditures in M€	2016 – 2020	2021 – 2025	2026 – 2030	2031 – 2035	2036 – 2040	2041 – 2045	2046 – 2050	Total
No target scenario	1,451	466	142	77	9	-	-	**2,144**
Central PV	580	107	-	-	-	-	-	**687**
Decentralised PV	353	105	-	-	-	-	-	**458**
Wind onshore	325	62	-	-	-	-	-	**386**
Delayed scenario	1,451	786	187	174	382	582	3,909	**7,472**
Central PV	580	134	3	7	36	54	345	**1,159**
Decentralised PV	353	125	2	6	29	46	340	**902**
Wind onshore	325	221	20	43	193	328	2,341	**3,470**
Decarbonisation scenario	1,448	702	568	575	329	47	298	**3,967**
Central PV	580	138	55	82	85	29	170	**1,138**
Decentralised PV	353	126	46	69	48	4	70	**716**
Wind onshore	323	245	322	346	188	14	58	**1,495**

Source: *SEERMAP Bulgaria Report.*

and biomass capacity expansion remain limited due to the smaller technical potential and the relatively higher fixed investment costs.

One of the most interesting conclusions from the three modelling scenarios is that no new nuclear capacity is constructed in the period under consideration. The outcome of the modelling work is in stark contrast to the official government policy focused on the construction of two new 1,000-MW reactors at the Belene site or alternative solutions at Kozloduy. The information about the total cost of construction that has been published in 2012 showed that the Belene project would be unprofitable[10] at Bulgarian wholesale power tariffs of EUR 74/MWh in the decarbonisation scenario in 2050. Estimates show that the unit cost of electricity *(Levelised Cost of Electricity – LCOE),* which would allow Belene project to break even would be at least EUR 80/MWh. In addition, the results showed that in the *'delayed'* and *'decarbonisation' scenarios*, the utilisation rate of the nuclear power plant in Kozloduy falls by around 10 % in the 2040 – 2050 decade signalling the competitive nature of RES generation facilities in certain hours of the day. The latter observation could have an important policy impact. With a projected LCOE at least three times the current production costs of the Kozloduy plant, a new nuclear capacity could potentially remain severely underutilised in all scenarios leading to stranded assets with enormous fiscal and environmental implications.

Policy Implications for Energy Security

The modelling results show that **the least costly way to decarbonize** (with a target of CO_2 emission reductions of over 96 %) the electricity sector in Bulgaria **would be by replacing currently outdated coal-fired power plants with renewable energy sources** (mostly wind and solar). Under a *'no-target' scenario*, a mixture of new RES and natural gas capacity is the most economically efficient option, considering that 97 % of the current fossil-based generation capacity would be decommissioned by 2050. This transformation of the electricity sector carries significant consequences for the Bulgarian energy security profoundly affecting the security of supply and affordability long-term policy framework.

Security of supply

In all scenarios, **Bulgaria becomes a net importer of electricity** between 2030 and 2040 and remains so. By 2050, 22 % of consumption will be covered by import in the *'no target' scenario*, while in the *'decarbonisation' scenario* imports stay at 12 % of the total needs. The generation adequacy indicator, referring to the ability of a country to satisfy its demand using only domestic power production, drops to almost zero. Considering the extended interconnection capacities

[10] CSD, 2014, Energy Sector Governance and Energy (In)Security in Bulgaria, Center for the Study of Democracy, Sofia.

of the Bulgarian TSO in the region, the country is still able to cover its power needs meaning that the system adequacy level remains favourable. The *'decarbonisation'* and *'delayed' scenarios* reveal that Bulgaria would have to **increase its reliance on the imports of fossil-fuel-based electricity**, mainly from gas-fired power plants.

In order to **address the intermittency of the significant share of the installed RES generation capacity**, the government should work on introducing large-scale demand-side measures such as state support for energy efficiency investment in the residential infrastructure, the coordination of the production cycles of large energy consumers and the development of expanded domestic network connections.

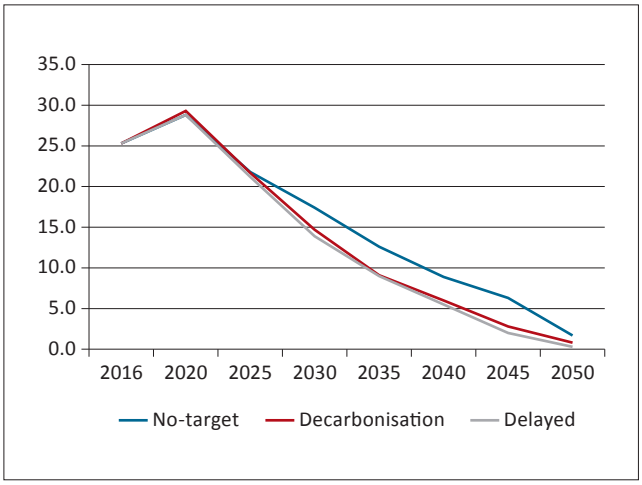
Investment is needed in the Bulgarian network system – estimated to be in the range of EUR 92 million. The recorded peak load for Bulgaria in 2016 was 7015 MW,[11] while it is projected to be 8017 MW in 2030[12] and 8935 MW in 2050. Consequently, there will be a need for further investment in domestic high and medium voltage transmission and distribution lines. Analysis of the network constraints anticipates contingencies at the Dobruja region and at the Serbian and Romanian border.

Transmission network losses would probably increase on the back of higher levels of electricity trade to be observed in 2050. The rise of decentralised power supply, especially in PV, could alleviate some of the pressures on the network but as the Bulgarian power network is underfunded and the investment program of the TSO is rarely fulfilled, **the large deployment of renewable energy sources could undermine the stability of the Bulgarian power system.**

Sustainability

By 2050 **CO_2 emissions from the electricity sector in Bulgaria compared to 1990 levels are reduced by from 93 %** (*'no-target' scenario*) to 98.6 % in the other two scenarios, where besides the increasing RES generation, nuclear production also contributes to the CO_2 reductions.[13]

Figure 2. CO_2 emissions under the 3 core scenarios, 2020 – 2050 (mt)



Source: *SEERMAP Bulgaria Report.*

The **share of renewable generation as a percentage of gross domestic consumption in 2050** is 32 % in the *'no target' scenario*, 54 % in the *'delayed' scenario* and 53 % in the *'decarbonisation' scenario*. Compared to other countries in the region, the results for Bulgaria present lower shares of RES generation, mainly due to the existing 2000 MW nuclear capacity, and smaller potential in certain RES technologies, e.g. in hydro. In the scenario with the highest RES share in 2050 (the *'delayed' scenario*) long term RES potential utilisation reaches 63 %, 64 % and 33 % for hydro, wind and solar respectively. This means that approximately two thirds of Bulgarian hydro and wind potential will be utilised by the end of the modelled period, if this scenario is implemented. These high utilisation rates in wind and hydro reflects the relatively lower potential of Bulgaria, rather than an exceptionally dynamic investment pattern in RES compared to its neighbours.

Affordability

The **modelled significant increase of power prices** is independent from the level of decarbonisation and follow a very similar trajectory in all scenarios. This price development has significant impact on energy affordability and presents a difficult dilemma for policy-makers. The increase of wholesale power prices is

[11] According to the database of the European Association Electricity System Operators – ENTSO-E.

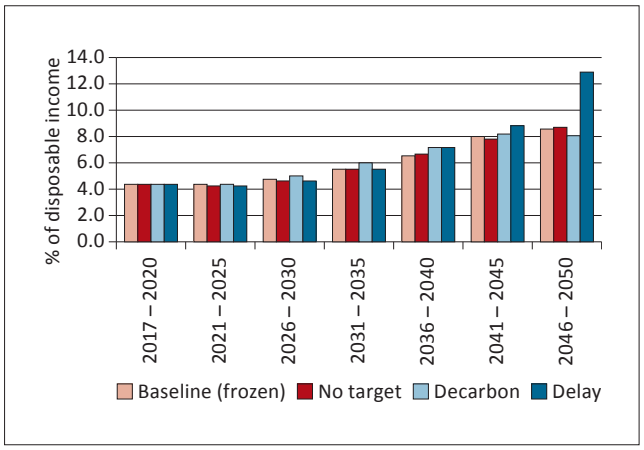
[12] According to the database of the Southeast Europe Cooperation Initiative Transmission System Planning Project (SECI).

[13] The CO_2 emissions of the three core scenarios were calculated based on the modelled utilisation of fossil fuel plants. Due to data limitations, the CO_2 calculations for the three core scenarios did not account for other forms of greenhouse gases and only considered direct emissions of electricity production, not including emissions related to heat production from cogeneration. The calculations were based on representative emission factors for the region.

passed through to the final retail prices paid by households and businesses. Hence, the expected doubling of wholesale power prices is **likely to contribute to more energy poverty in the country**. If affordability is measured in household electricity expenditure as a share of disposable income, Bulgarian consumers would have to face increasing costs for heating, which has become electrified in many urban centres.

At 4.3 % the share of household electricity expenditure to income in Bulgaria stood roughly at the regional average in 2016. The baseline scenario foresees the electricity expenditure to income increasing significantly to around 8.5 % by 2050 as a result of several opposing factors. First, real wholesale energy prices are foreseen to grow by over 80 % by 2050. Second, the phasing out of RES support schemes reduces the retail price level by over 28 %. Third, energy intensity is projected to increase over 10 % until 2050.

Figure 3. Household electricity expenditures



Source: *SEERMAP Bulgaria Report.*

The **affordability of electricity consumption declines substantially in the *'delayed' decarbonisation*** scenario, as household electricity expenditures as share of disposable income reach almost 14 % in 2050. The reason is the more intensive state renewable support to compensate for the delayed policy shift towards decarbonisation. The situation, on the other hand, improves in the *'decarbonisation' scenario*, where the fall of wholesale prices in the 2040s on the back of an even more aggressive renewable generation deployment reduces the share of household expenditures to around 8 %.

The recent history has shown that policy-makers find it very hard to explain sharp increases of power prices in Europe. In Bulgaria increases have led to social unrest and even to government instability. The implication could be that governments would have to address citizens' complaints, sometimes reaching out to populist measures such as administrative regulation of household tariffs at below-cost levels or unpopular taxes for power producers and large business consumers or embarking on large scale investment projects with delayed impact on prices in the hope of gaining in the short-term. Nonetheless, the **price increase also has two positive implications**. It would incentivise investment in new capacities and reduce the need for direct RES support from the state.

For the macro perspective of the affordability factor, affecting the overall competitiveness of the economy, the results suggest small gains vis-à-vis a baseline scenario for the economic development trajectory. **In the *'decarbonisation' scenario*, the GDP level is on average around 2 % higher until 2050 compared to the baseline scenario**. The long-term GDP effect is somewhat higher at 4 %. Gains are more moderate in the *'delayed' scenario*, at around 1 % on average and at 2.5 % in the long term, while practically zero in the *'no target' scenario*. **Employment effects are marginally positive**, at around 0.2-0.3 % on average.

It is important to stress that long term GDP gains are present in the *'decarbonisation'* and *'delayed' scenarios* due to the **higher level of productive capacities in the economy**. These long-term gains come from two sources. First, the extra investment efforts raise the level of productive capital in the economy. Second, the newly installed, mainly EU technologies increase overall productivity. The **lower employment gains** compared to GDP effect is explained by two factors: (i) the energy investments are relatively capital intensive, and (ii) the initial employment gains are translated to higher wages in the longer term, as labour supply remains the same across all scenarios.

Policy Conclusions and Recommendations

The laid-out scenarios provide **an example for an effective policy decision-making mechanism**. Their conclusions imply hard choices, which would strain social relations to the limits, and require an extraordinary level of transparency and informed public debate. The Bulgarian government will have to rise to the challenge and focus on the one variable of energy security it can best control – improving the governance of public policy and the public energy sector.

If Bulgaria is to achieve the ambitious EU 2050 goal of 100 % electricity generation from zero-carbon energy sources, the country's enormous potential for renewable energy facilities needs to be unlocked. The SEERMAP results show that this transformation would be driven by **an unprecedented increase of investment in generation capacity**. Although, the assumption is that it would be financed by private actors, **the state would need to create an enabling tax and regulatory environment** to incentivize companies to risk high upfront costs in exchange for low operation and maintenance costs in the future. **Decarbonisation does not drive up power prices. Carbon emissions quota do**. Understanding this EU policy logic makes it more understandable how RES-based capacity would become more competitive than existing coal and gas-fired power plants. The analysis has developed several robust **policy options** that should become part of the country's upcoming long-term energy strategy debates including:

- RES capacity increases would depend on **de-risking the investment environment for private actors** by removing arbitrary taxes on revenues, easing the issuing of operational and construction licenses, introducing auctions for RES support mechanisms to last until 2030 when RES technology is expected to become fully competitive.
- The **pressure from the increased state support for new RES capacity** at least in the *'delayed' scenario* should not be imposed on the state-owned electricity companies but should be absorbed by a liquid, fully liberalised power market without long-term power purchase contracts.
- **Decarbonisation in Bulgaria will require a significant increase in aggregated investment needs** from about 8.5 bn EUR to about 15-18 bn EUR over the 35-year period. Depending on which policy direction, the government chooses, it would need to finance between one-third and 50 % of these investment needs. A large portion of this would be financed by the Emissions Trading Schemes-based revenue in the scenario of steeply rising carbon price.
- Since **natural gas would play a transition role in all scenarios** (the strongest in the *'no-target'* one), the government would have to speed up its efforts to fully liberalise the natural gas market, complete all interconnections with neighbouring countries and renegotiate its long-term contracts on better terms dependent on the level of supply diversification.
- In order to ensure that the modelled least cost energy system can be translated into reality, it is necessary to **base renewable energy policies on sound analysis**, take into account the interests of consumers and avoid institutional capture. This is particularly important as the vulnerability of consumers in Bulgaria is high, and ineffective implementation of policies may result in significant price increases, producing a backlash against renewable energy.
- **Co-benefits of investing in renewable electricity generation can strengthen the case for increased RES investment**, including a boost to GDP as a result of increased investment in generation capacity, an improved external balance due to reduced gas imports, and lower wholesale energy price which can result from very high penetration of RES. Additional co-benefits, not assessed here, are health and environmental ones from reduced emissions of air pollutants.
- In order to enable Bulgaria to decarbonise its electricity sector to the level suggested by the 2016 reference scenario for the development of the energy sector by 2050, an active, **long-term and stable renewable energy support framework is needed**.
- **Delayed action on renewables is feasible, but has two disadvantages** compared with a long term planned effort. It results in stranded fossil fuel power generation assets, including currently planned power plants. Translated into a price increase equivalent over a 10-year period, the cost of stranded assets is on par with the size of long term RES support needed for decarbonising the electricity sector.
- **Coal and lignite based generation capacities are expected to be priced out of the market before the end of their lifetime in all scenarios**; this is also true for gas generation capacities under scenarios with an ambitious decarbonisation target, resulting in stranded assets. These long-term costs need to be weighed against any short-term benefits, particularly associated with gas that temporarily bridges the transition from coal and lignite to renewables.
- As one of the biggest net power exporters in the region**, Bulgaria needs to work closely with its neighbors to complete the coupling of markets** and create regional power exchange benchmark that would allocate electricity exchanges more efficiently.
- The **TSO needs to increase investment in high-voltage, cross-border power interconnections and the modernization of distribution networks** to ensure the smooth uptake of large volumes of RES-based power generation and prevent intermittency problems in certain hours of the day.