Development of Roadmap for the Introduction of a National Carbon Tax in North Macedonia

Project implemented by the Center for Clean Air Policy

Deliverable 1

Carbon Tax Assessment Report

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Acronyms

BAU	Business-as-Usual
BC	British Columbia
CHP	Combined Heat and Power
EU	European Union
EUETS	European Union Emissions Trading Scheme
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HPP	Hydro Power Plant
LPG	Liquefied Petroleum Gas
MEMO	Electricity Imports and Aviation Sector
MKD	Macedonian Denar
MW	Megawatt
NECP	National Energy and Climate Plan
NDC	Enhanced Nationally Determined Contribution
PV	Photovoltaic
RES	Renewable Energy Sources
RGGI	Regional Greenhouse Gas Initiative
UNFCCC	United Nations Framework Convention on Climate Change

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1. Rationale for carbon tax in Macedonia. The twin goals of NDC attainment and alignment with EU climate policies

The Republic of North Macedonia has updated its Nationally Determined Contribution (referred to as the Enhanced NDC or NDC), a key interim step to meeting its goal of reducing net emissions by 82 percent below 1990 levels by 2030 (a 51% reduction in GHG emissions compared to 1990 levels), and its anticipated goal of carbon neutrality (in alignment with the EU) by 2050. In March 2020 the European Council opened accession negotiations with North Macedonia to enter into the European Union, and in July 2020 the European Commission presented the draft negotiating framework to the Member States—an important milestone on the path to EU membership. There is an expectation that North Macedonia would progressively advance its climate agenda to match the EU commitments such that the country could adopt the EUETS by the time of accession.

Macedonia has already made important progress towards defining a low-carbon agenda, including adoption of the Energy Strategy at the end of 2019, the preparation of the Energy and Climate Plan which is now in the process of receiving stakeholder comments, and adoption of the Third Biennial Update Report (TBUR) and Enhanced NDC. A transition towards renewable energy sources, energy efficiency, and reduction of coal electricity production is high on the nation's agenda.

There are a number of measures that can directly or indirectly contribute to reducing GHG emissions in Macedonia. Macedonia's Enhanced NDC proposes 63 measures, mainly energy sector measures defined in the "green scenario" from the Energy Strategy until 2040. In fact, the NDC and TBUR, based on assessments of various mitigation measures, conclude that the introduction of a CO2 tax has the potential to have the greatest overall impact on reducing greenhouse gas emissions in Macedonia. At CO2 tax levels in line with EU carbon pricing projections, the CO2 tax would cut emissions nearly in half. By increasing the cost of carbon intensive fuels, a CO2 tax could induce decisions that would transform the energy sector, leading to shifts away from coal and towards low- and zero-carbon energy sources. Therefore, the introduction of a carbon tax presents an opportunity for Macedonia to meet its dual climate change mitigation objectives: 1) to support realization of its forthcoming enhanced UNFCCC commitments, and 2) with respect to its EU accession negotiating strategy.

1.1 An introduction to a carbon tax and how it can be used to meet those goals

What is a carbon tax?

A carbon tax offers a way to induce the Macedonian industry, business community and households alike to shift their investments away from fossil fuels and towards low- and zero-GHG alternatives in a cost-effective manner. It does this both by starting to incorporate the external costs of GHGs into the price of GHG-intensive fuels and activities, and also, potentially, in the way the tax revenues are deployed.

A carbon tax works by setting a pre-determined price for every ton of greenhouse gases. Depending on decisions made in designing the carbon tax, the tax can be applied to the GHG emissions from a given source or to the carbon content of fuels purchased or sold. In the latter case, the tax is typically passed down to fuel consumers through higher fuel prices that reflect (part or all of) the value of the tax. Affected entities have two primary choices: 1) they can pay the per-unit tax, or 2) they can reduce emissions or sales of taxed fuels to limit their exposure to the tax. Likewise, downstream consumers seeing a higher fuel price that includes the price of carbon can continue to purchase the fuel at the higher price, or reduce their consumption, whether through increased efficiency or shifts in consumption. Rational actors will choose to reduce emissions, enhance efficiency, or shift to lower-carbon alternatives when these actions cost less than paying the tax. The emissions reductions achieved from covered sources and downstream consumers will depend on the level of the tax and the availability of mitigation options that cost less than the tax.

A carbon tax can create additional emissions impacts if revenues are used to pay for emissions reductions within and/or outside of the covered sectors. However, there will be other competing uses for carbon tax revenues that will need to be weighed. It is also possible to allow covered sources to comply with the carbon tax through use of domestic offsets. This offers another avenue to encourage low-cost emissions reductions towards national climate goals.

Benefits of a carbon tax

The main benefit of a carbon tax is its ability to encourage the most cost-effective mitigation actions across the affected sectors—all mitigation actions that cost less than the tax—towards national mitigation goals. This ensures the country is able to take advantage of the lowest cost measures first, supporting compliance at the lowest cost to the economy. Strategic use of carbon revenues can also help minimize adverse impacts to the GDP of meeting climate goals.

A carbon tax offers certain advantages over other types of mandatory carbon pricing programs. First, a carbon tax offers a high degree of certainty to the covered entities on the level of the carbon price over time, informing planning and investment decisions in mitigation measures estimated to cost less than the tax. Second, a carbon tax is relatively easy to implement from an administrative standpoint. There is no need to establish an auction mechanism or decide on a methodology to distribute allowances. Further, a carbon tax can often build on existing tax infrastructure.

Considerations in implementing a carbon tax

The transparent nature of a carbon tax also contributes to one of its challenges: public acceptance. Many businesses and consumers may feel the costs are not affordable, particularly in challenging economic times when many are hard-hit by the direct and indirect impacts of a global pandemic. To mitigate concerns with public acceptance of a new tax, responsible authorities will need to engage stakeholders in the development of the policy and clearly communicate the advantages.

The process of designing the carbon tax should include meaningful engagement of key stakeholders—potential regulated sources, business interests, energy consumers, environmental groups, and national and local governments. Such engagements offer an opportunity for the government to introduce the policy instrument, how it works and the rationale for its use; understand stakeholder concerns; build a shared understanding of the expected implications of different designs, including through sharing modeling scenarios; and gather feedback on the different options. The subsequent design of the carbon tax should consider this feedback.

Public communications, in turn, would highlight the win-win attributes of the program in ways that will foster understanding and build and sustain political support. Such communications would aim to clearly articulate the rationale for the tax and emphasize how it will be effective and fair in its implementation, including through use of revenues to improve lives and mitigate disproportionate harms.

Further, while a carbon tax provides certainty on the cost of the policy, it will not guarantee a fixed level of emissions will be reduced. Regular assessments can be used to determine whether or not the country is on track to meeting its emission reduction goals. While one of the main benefits of a carbon tax, as noted above, is the certainty on price, there are ways to design a carbon tax that builds in some amount of flexibility to adjust the price path. The pros and cons of such flexibility options could be considered as part of the process to design a carbon tax. Short of adjusting the tax rate, if there is a desire to increase the emissions impact of the carbon tax, it could be possible to adjust the use of revenues.

1.2 A review of the key design issues for a carbon tax—coverage, tax rates over time, revenue recycling choice—and various considerations for selecting particular designs and scenario choices

The role of the carbon tax

A first critical consideration in defining the tax is the role it is intended to play in reaching the nation’s climate goals. Does the tax aim to achieve the full level of effort required from the affected sectors or for the economy as a whole? Does it aim to “backstop” other policies and measures, encouraging actions that might otherwise fall through the cracks? Is the main goal to facilitate future alignment with EU carbon pricing policies? Or is a key goal to raise a particular amount of revenues? Each of these objectives might imply different design characteristics.

For example, if the goal is to achieve the full level of effort required from the affected sectors, the carbon price would need to be set high enough to compel sufficient emissions reductions to realize this mitigation objective. This could be estimated by setting the applicable emissions goal in the model, and letting the model solve for the carbon price needed over time to reach that goal. The carbon price generated by the model could be considered to be a starting point for the carbon tax.[1] If the tax is intended to serve as a backstop, the tax level could be somewhat lower, recognizing that other policy mandates may achieve a bigger share of the overall emissions reductions. If the goal is to demonstrate the country is willing and able to assume the obligations of EU membership through participation in the EUETS (these goals are not mutually exclusive), this would impact decisions on which sectors are subject to the tax and the level of the tax; both the coverage and tax levels should be on track to match the EU’s plans and forecasts by the expected date of accession.

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[1] The actual tax level could be higher or lower than this estimate. A higher carbon tax could be needed if there are barriers to implementing some of the low-cost mitigation measures. The carbon tax could be set at a lower level in the case that affected sources are able to innovate more than expected. It should also be recognized that the modeling relied on to set the carbon tax relies on assumptions about population growth, GDP growth, weather and other factors. Significant changes in these assumptions could mean that the tax level would need to be higher or lower to reach the modeled level of impact.

The level of the tax

Informed in part by the intended role of the tax in meeting national climate goals, the next main decision is the level of the carbon tax. This includes the initial level of the tax, and whether/how it ramps up over time. There could also be predetermined procedures for making adjustments to future tax levels (up or down), considering environmental and economic impacts[2].

Initial carbon price levels are often intentionally set fairly low. In cap-and-trade programs, it is common for countries to set caps that are only just below business-as-usual levels in the first years of the program to build experience with the new pricing regime. Likewise, many countries that have adopted a carbon tax also set prices quite low in the beginning. In fact, there are a number of tax programs (Argentina, Chile, Colombia, South Africa), where the tax falls below $10 per ton. This can make sense in the first years of a program where sources may have had limited time to plan for the carbon price, so have a limited set of mitigation options.

Some countries set their carbon prices to adjust over time. Some countries (e.g., Mexico) tie the carbon tax rate increases to inflation,[3] essentially maintaining a constant level of ambition. In other cases (e.g., Portugal), tax levels are tied to a benchmark, such as EUETS price levels in the year prior.[4] This has the effect of ensuring that sectors subject to the tax are treated roughly on par with those under the EUETS. However, under this scenario, the carbon prices can go up or down, and do not provide the same level of certainty as a price path. Still others (e.g., British Colombia) set periodic increases in the tax rate to increase ambition. The BC tax started at C$10/ton in 2008 and in 2020 is at C$40/ton. Sweden's carbon tax, the highest in the world, started at roughly USD $26/ton in 1991 and now stands at about USD $126/ton.

A starting point for considering a price path for Macedonia considers the gradual and full price paths used in the Energy Community Study (see Table 1, below). This study used a gradual price path for Macedonia (Euros/ton CO2) that assumed moderate flexibility of the power sector to respond to a carbon price relative to other countries in the study. The full price path assumed the carbon price starts at higher levels, approximating EUETS prices at the time of the study and ramping up over time.

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[2] For example, British Colombia's carbon tax will remain constant at its current level of C$40/ton (rather than the planned increase) due to the economic effects of COVID-19. https://www2.gov.bc.ca/gov/content/environment/climate-change/planning-and-action/carbon-tax

[3] https://www.thepmr.org/system/files/documents/5.%20Carlos%20Munoz%20Pina.pdf or https://www.sciencedirect.com/science/article/abs/pii/S0301421517306341 (check)

[4] https://taxfoundation.org/carbon-taxes-in-europe-2019/

Table 1. Gradual and Full Price Paths Assumed in the Energy Community Study for Macedonia (MK)(Euros/ton)

	2025	2030	2035	2040
Gradual price path for Macedonia (MK)	7.95	20.80	45.05	80.00
Full price path (assumed EUETS price path)	26.50	32.00	53.00	80.00

Another benchmark to consider is the auction price floor (starting at 24 Euros/ton) in Montenegro's cap-and-trade program, which entered into force on February 21, 2020. This program covers industrial and energy plants and reduces emissions from covered sources by 1.5 percent per year between 2020 and 2030.[5,6]

Finally, we note there are various methods that can be used to adjust the level of the carbon tax price path over time for environmental or economic reasons. Such approaches could be automated or based on periodic reviews and benchmarks, potentially subject to price corridors to maintain a degree of price certainty. Such mechanisms can allow the responsible authorities to take advantage of (some of) the price certainty of a carbon tax while gaining (some of) the environmental certainty of cap-and-trade.

Regardless of the chosen carbon price or path, policymakers should aim to set the tax levels as far in advance as possible. Certainty on the level of the tax level over time allows affected sources to align low-carbon investment decisions with planning processes and timelines.

Coverage and points of regulation

The next decision is which sectors should be covered by the tax, and the point at which they are regulated (e.g., upstream, midstream or downstream).

Key factors to consider in deciding which sectors are subject to the carbon tax include the degree to which these entities would:

- capture a large share of the total economy-wide emissions with a carbon price;
- encompass cost-effective opportunities to reduce greenhouse gas emissions;
- be able to pass through costs to consumers;
- be able to accurately measure fuel carbon content, emissions or emissions reductions;
- correspond with the sectors covered by the EUETS.

The Energy Community Study was limited to the electricity and heat production sector, which comprise nearly 60 percent of energy sector emissions in Macedonia, but just 39 percent of total emissions. Limiting the carbon tax to these sectors misses opportunities to

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[5] https://seenews.com/news/montenegro-approves-trade-system-for-major-greenhouse-gas-emitters-688352

[6] https://balkangreenenergynews.com/montenegro-adopts-bylaw-to-introduce-emission-credits-system/

reduce emissions in the transportation and manufacturing sectors, which contribute about 20 and 14 percent of energy sector emissions, respectively, as well as significant mitigation opportunities in the waste, agriculture and industrial process sectors.

While there can be political or practical reasons for taxing only some sectors of the economy, it should be noted that doing so can create distortions and inefficiencies. For example, taxing emissions from just the electricity and heat production sector would make it relatively more costly to operate electric cars as compared to diesel- or gasoline-fueled cars. Likewise, taxing just power and heat production could lead more industries to shift from power and heat purchases to self-generation.[7] Another possible market distortion is the possibility that taxing emissions from electricity and heat production but not taxing firewood could lead some consumers to produce more heat from wood-burning stoves in their homes. This issue is considered in the MARKAL-Macedonia model and addressed in the results.

The cost curve presented in the Enhanced NDC as well as in the TBUR, shows substantial very low (negative) cost mitigation opportunities in the electricity and heat production sector, related both to energy supply (various clean energy alternatives) and energy demand (e.g., phasing out incandescent lighting, reduced distribution system losses, increased building efficiency, appliance labelling). Moreover, some of the measures with the biggest cost savings are in the transportation sector (e.g., increased use of railways and bicycles, and updates to the car fleet). While there are fewer low-cost mitigation opportunities in the industrial sector, covering these emissions would encourage enhanced energy management in manufacturing and encourage research and development into lower-carbon methods. There are also meaningful low-cost opportunities in waste (closing landfills) and forestry (reduced wildfires).

Considering that the EUETS covers electricity production stations, other large (>20 MW thermal rated input) combustion sources, various industry sectors and domestic aviation (using a downstream point of regulation), Macedonia should likewise aim to cover these sectors in preparation for EU accession. There could be options for the carbon tax to realize emissions reductions in other sectors as well, either through use of domestic offsets (as used in Colombia) or by investing carbon tax revenues in such mitigation measures.

As far as the point of regulation, the main choices are to regulate emissions “upstream,” “midstream” or “downstream.”

- Regulating upstream often means the point at which the regulated fuels enter the national economy, either the fuel importers or fuel producers. Such regulations support broad coverage of carbon emissions across the economy, and where there are few domestic fuel producers, would involve few regulated sources. Some countries using this approach include Colombia and Sweden.
- Regulating midstream can mean, for example, electricity generators and natural gas pipelines. The EU, Mexico, Montenegro and South Africa are examples of jurisdictions that regulate at this point for electricity and/or heat.
- Regulating downstream would mean the point where energy is used. This could mean industrial emitters, commercial and residential electricity customers, and vehicle owners/drivers. Many systems (e.g., EUETS, Mexico, Montenegro, South Africa) apply the carbon price directly to large industrial sources that exceed a given emissions threshold. For other downstream sectors, regulating at this point can mean

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very large numbers of regulated entities. However, governments may already have experience regulating at this point and can build on existing requirements. As an example, excise taxes are often applied at the fuel pump.

Use of tax revenues

The final policy decision to be made in establishing a carbon tax involves determining how to use the tax revenues. While the options for such revenue recycling are limitless, some of the main options (not mutually exclusive) used in other systems include the following:

- **Use revenues to replace other taxes.** Sweden, British Colombia and Argentina, among others, have used carbon tax revenues to reduce marginal income tax rates and/or corporate tax rates. In this way, taxes are increased on activities the government seeks to discourage (carbon pollution) and decreased on activities it wishes to encourage (income). Accordingly, like the taxes being replaced, carbon tax revenues support the overall government budget. An advantage of this approach is that it minimizes the overall impact on the economy of the carbon tax, and in some cases, has been shown to modestly increase GDP.[8]

- **Use revenues to achieve additional emissions reductions.** The RGGI states in the US and Montenegro are examples of authorities using this approach. RGGI states have invested significant amounts of auction revenues in energy efficiency and renewable energy, supporting compliance with their cap-and-trade program and lowering the effective carbon price. Montenegro’s cap-and-trade system similarly calls for proceeds to be used for environmental protection measures, including production of energy from renewable sources and innovations.

  Using carbon tax revenues to invest in more emissions reductions can be helpful in making the tax more effective in reducing emissions, particularly if used to overcome barriers to investment. Doing so would also lower compliance costs for covered entities, helping to ease the burden of the tax. However, it should be noted that using carbon tax revenues to pay for mitigation investments would not have a direct impact on the level of the carbon tax. Moreover, to the extent that tax revenues are used to motivate emissions reductions in the sectors covered by the tax, this revenue recycling could reduce the revenues generated from the tax.[9] In contrast, using revenues to reduce emissions in sectors that are not covered by the tax (e.g., potentially agriculture, forestry or waste) would not impact the expected tax revenues.

- **Use revenues to reduce the adverse impact of the carbon tax to disproportionately impacted groups.** Low income consumers, workers and communities reliant on fossil fuel industries for their livelihoods, and carbon-intensive, trade-exposed industries unable to pass through the value of the carbon tax to customers might be most adversely impacted by the program. Accordingly, the government could opt to dedicate a portion of tax revenues to mitigate these impacts. This could entail, for example:
  - Rebating the estimated value of the tax in a lump sum on low income consumer electric bills (e.g., to the bottom quintile of households). Providing

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[8] https://www.brookings.edu/wp-content/uploads/2019/03/Metcalf_web.pdf

[9] As affected sources lower their emissions (the desired outcome), there are fewer emissions subject to the tax.

the rebate as a lump sum makes it possible for the consumers to respond to the marginal tax incentives by shifting demand or fuel source, while providing compensation to those least able to afford the energy price increase.

- Paying for (temporary) job training and redevelopment support for workers and communities impacted by a plant closure.
- Providing some amount of compensation, potentially considering a benchmark reflecting best practice carbon intensity, to industries that are determined to be both carbon-intensive and trade-exposed. As examples, Macedonia could look to free allocation approaches used in the EUETS and in and Montenegro’s cap-and-trade program.

2. Introduction to the MARKAL model. Principles of the MARKAL economic analysis of energy related systems at the country level

To help decision-makers more fully understand the implications of a CO2 tax on the Macedonian economy and how it can support the NDC, the TBUR recommended additional analysis that would be specific to Macedonia. Accordingly, the present study offers an assessment of several carbon tax scenarios. Various types of models can be useful in examining the impact of the introduction of a CO2 tax on the energy sector. This analysis uses the MARKAL-Macedonia model, a very detailed energy system model that captures local conditions, such as the assumed availability of new and existing energy resources and mitigation measures (such as renewable energy, energy efficiency and fuel switching) capable of replacing CO2-intensive emissions sources and details of the local context. This is the same model that was used in the NDC development process, making it possible to directly compare scenario results across the two initiatives.

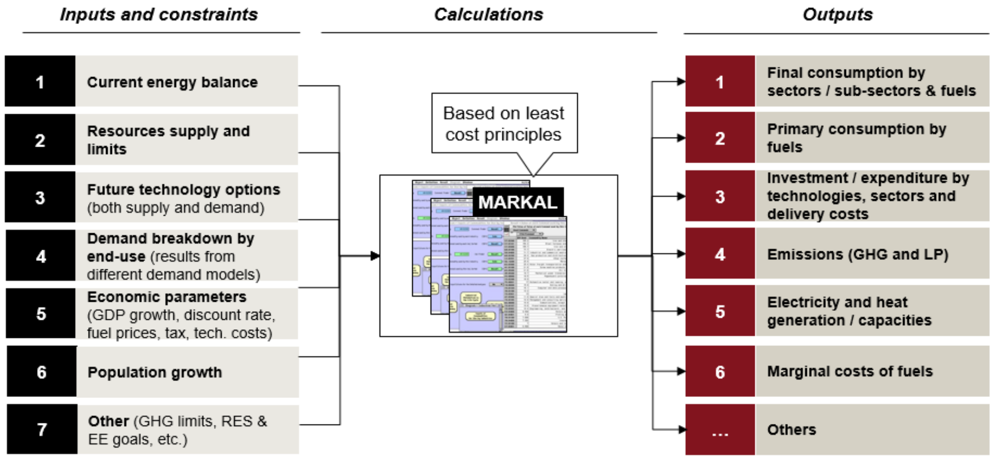
MARKAL is a widely used, commercially available, linear programming energy systems modeling framework that is well suited to examining the complexities of the energy market through a systematic approach. Using the MARKAL model and the associated software tools, the energy model for North Macedonia was developed to support policy making and analysis of future energy system development options. The MARKAL-North Macedonia model includes the whole energy system starting from resources through conversion technologies to end use sectors. The base year in the model is 2012 and it is run to 2040 on yearly basis.

It should be emphasized that, like a lot of other energy planning models, MARKAL Macedonia is a tool that is used to understand the directional and relative implications of different policy scenarios. Based on the findings, policy makers can then decide whether a given scenario, say, using a carbon tax to achieve the full NDC ambition, is a good idea. In this report different scenarios are created and considered, but there is a possibility to evaluate others. Note that the model has already been well-tested, as presented elsewhere (e.g., Strategy for Energy Development up to 2040, BURs etc.) so this report is able to make use of the model to evaluate policy scenarios.

For any given modeling scenario, the MARKAL model’s objective is to meet the forecasted energy needs while minimizing the total cost of the energy system, adequately discounted over the planning horizon. To meet this objective, the MARKAL model takes into account large amount of input data (assumptions) as well as potential constraints (e.g. a CO2 tax, limits on GHG emissions and/or renewable energy standards).

MARKAL finds the lowest cost way to meet the various constraints considering the availability and costs of existing and new energy technologies. The results include forecasts of new energy investments, including the types, amounts and timing, as well as utilization of existing energy resources. Based on the engineering and economic representations of energy supply, energy conversion technologies (e.g., power plants and fuel conversion plants) and end-use devices in each country, MARKAL solves for the least cost energy supply and demand balance that can satisfy the physical and policy requirements. Examples of inputs to the model and the resulting outputs are shown in Figure 1.

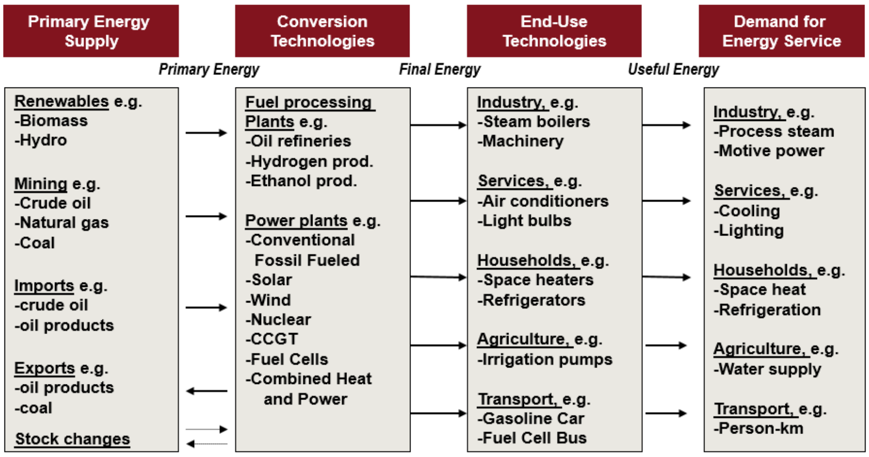
Figure 1. MARKAL model energy structure



Source: MARKAL model

The demand side of the MARKAL North Macedonia model is divided into five sectors: residential, commercial, industry, transport and agriculture. Each of these sectors, except agriculture, is divided into sub-sectors in order to calculate useful energy demand more precisely. Furthermore, for each of the subsectors, end-use services are defined (Figure 2).

Figure 2 MARKAL model key components

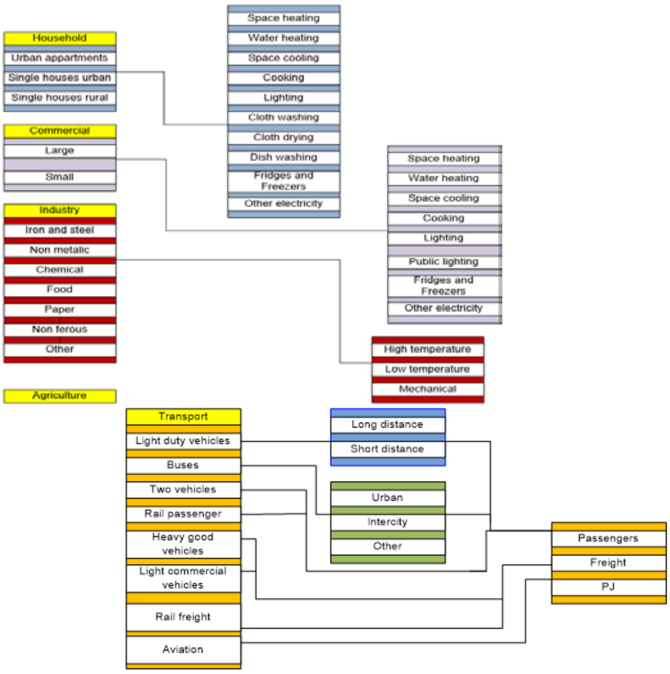


Source: MARKAL model

To satisfy the demand for useful energy, the model includes a considerable number of technologies on the demand side, including high-efficiency options and use of different fuels (Figure 3). The fuels include: domestic biomass, lignite, electricity, heat, solar, geothermal and almost all refinery products (gasoline, diesel, LPG, heavy fuel oil) and imported brown coal, coke, hard coal, lignite, natural gas, distillate, gasoline, heavy fuel oil, kerosene, LPG, aviation fuel and electricity.

On the supply side, except the existing technologies, new potential technologies that run on lignite and natural gas are included, as well as hydro, wind, PV and biomass/biogas technologies (all described in details in chapter Model inputs and assumptions).

Figure 3. Organization at the energy demand side



Source: MARKAL model

3. Key modeling assumptions

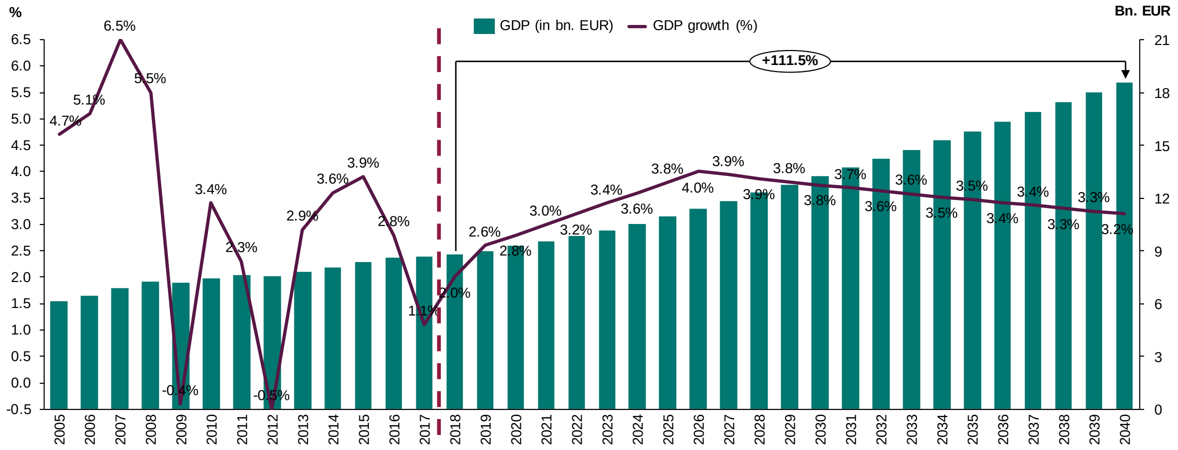
As mentioned above, Macedonia's enhanced NDC is based on the analyses in the TBUR, the National Energy and Climate Plan (NECP)[10] and the Strategy for energy development of the Republic of North Macedonia up to 2040 (Strategy for Energy Development up to 2040). These technical documents, prepared before the COVID-19 pandemic, used the MARKAL-Macedonia model. To facilitate comparisons of the results of this CO_2 tax study with the earlier assessments, the same model was employed with only a minor adjustment in the underlying assumptions: the assumed timing for the construction of wind power plants was postponed for two years from 2020 to 2022. The most important assumptions are described below.

We note that a revised version of the Energy Strategy was produced in 2020 that includes the expected impact of the COVID-19 pandemic. The results obtained deviate from the energy assumptions that underline the enhanced NDC in the first few years, but in the period after 2025 there is no major deviation. These updated assumptions were not considered in the CO_2 tax study.

Macroeconomic forecasts (GDP and population growth)

Using the macroeconomic drivers from the Energy Strategy, an average GDP growth rate of 3.3% is forecasted during the period 2018-2040 (Figure 4). The population is expected to decline by 0.2% in 2040 compared to 2017 (Figure 5).

Figure 4. GDP and GDP growth - historical and projected values up to 2040 in Macedonia



Source: SSO, Strategy for energy development up to 2040, project team analyses

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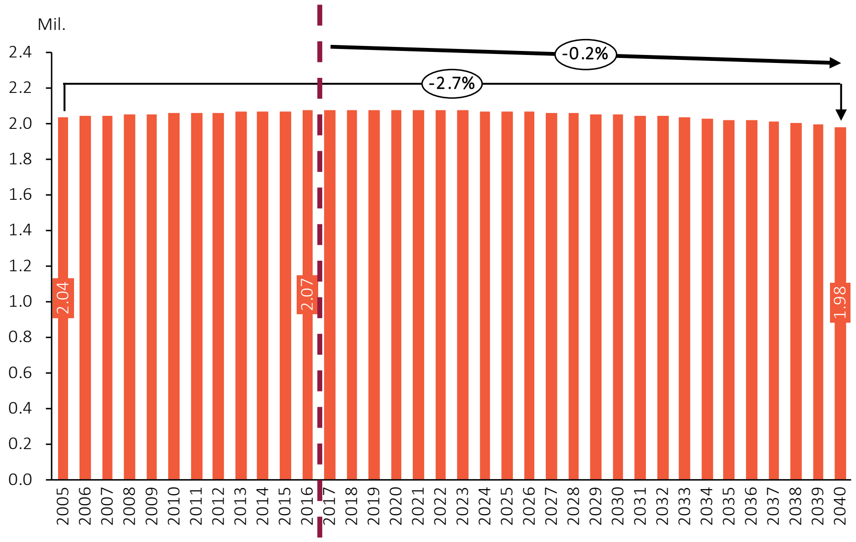
[10] The NCEP is elaborated under Energy Community obligations by each contracting country

Figure 5. Population in Macedonia – historical and projected values

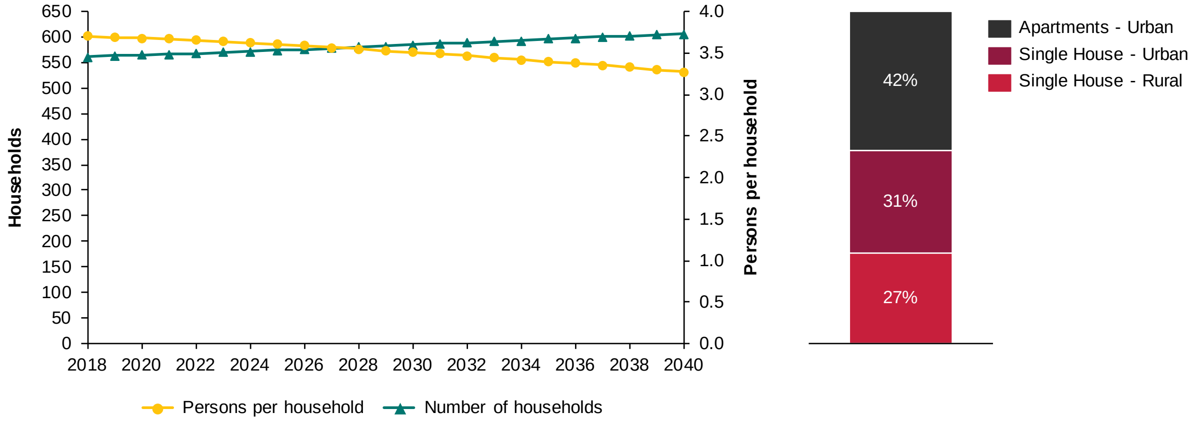


Source: SSO, Strategy for energy development up to 2040, project team analyses

Residential and commercial sectors

In addition to population and GDP, there are a number of other parameters that are important to projecting energy demand in the residential sector. One such parameter is the number of people per household, which is assumed to decrease from around 3.7 people per household in 2018 to 3.3 in 2040 (Figure 6). Considering population projections and the number of people per household, the number of households is calculated. The households are divided into three different groups (urban apartments, urban and rural single-family houses) (Figure 6).

Figure 6. Number of households, person per households and split of households by type



Source: SSO Energy consumption in households 2014, MARKAL input data for the Strategy for energy development up to 2040, project team analyses

It is projected that the size of urban and rural houses will increase to 100 m^2, while the size of apartments will reach around 80 m^2 in the analyzed period (Figure 7). From the current 32% and 40% of rural and urban houses, it is projected that in 2040 the heated area will be increased to around 40% and 50%, respectively (Figure 8). The model includes various fuels and technologies that can be used for home heating, including biomass. There is an assumed limit on the annual consumption of biomass in line with the annual growth rate consistent with sustainable use of biomass.

Figure 7. Size of dwelling by type

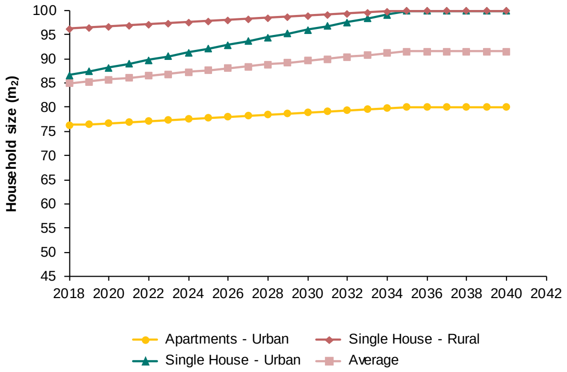
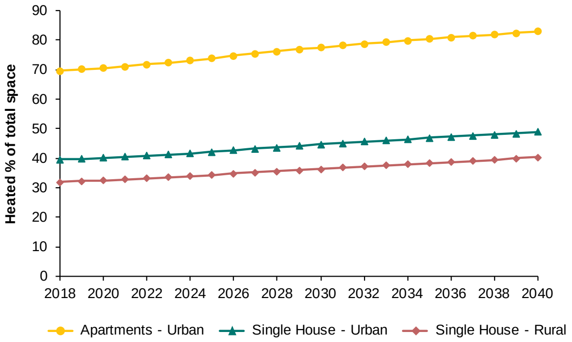


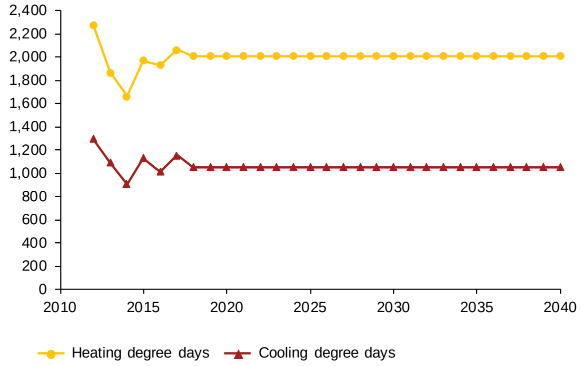
Figure 8. Heated area by type of dwelling



Source: SSO Energy consumption in households 2014, MARKAL input data for the Strategy for energy development up to 2040, project team analyses

For the projection of the useful energy demand in both sectors, residential and commercial, the number of heating and cooling degree days play an important role. The model is calibrated taking into account the heating and cooling degree days for the period from 2012 - 2017, while for the period after 2017 the average number of degree days is used. The average calculation takes into account the period from 2000 - 2017 (Figure 9).

Figure 9. Heating and cooling degree days

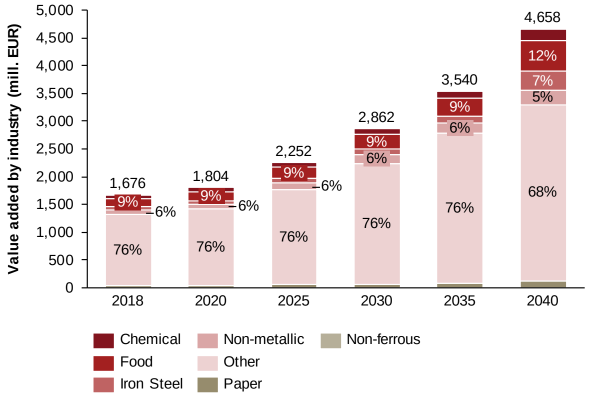


Source: Weather Underground (2000-2017), MARKAL input data for the Strategy for energy development up to 2040, project team analyses

Industry Sector

For the industry sector, the most important parameter is the value added per industry type. During the overall planning period, the Other Industry subsector contributes most to value added. In fact, in 2040, 76% of the total value added in the industry sector is coming from Other Industries (Figure 10). The next most contributing industries are Food (12%) and Iron and Steel (7%).

Figure 10. Value added by industries



Source: SSO - GDP components by sectors, MARKAL input data for the Strategy for energy development up to 2040, project team analyses

Transport Sector

For the transport sector, passenger and freight km traveled are calculated based on growth projections for GDP and population. Absent new measures to lower emissions, it is projected that both passenger and freight km will double during the planning period (Figure 11). Light duty vehicles are expected to contribute the most passenger km (around 77% in 2040) (Figure 12).

Figure 11. Transport (passenger + freight) evolution

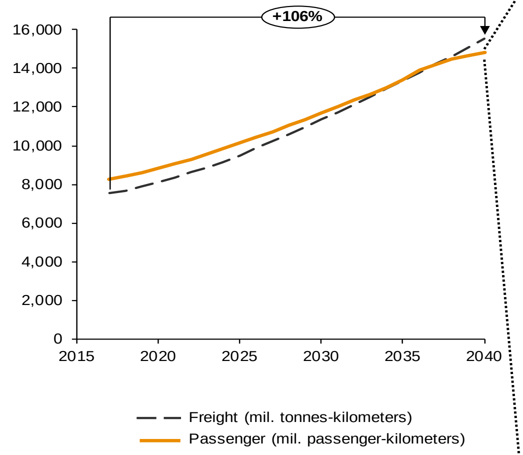
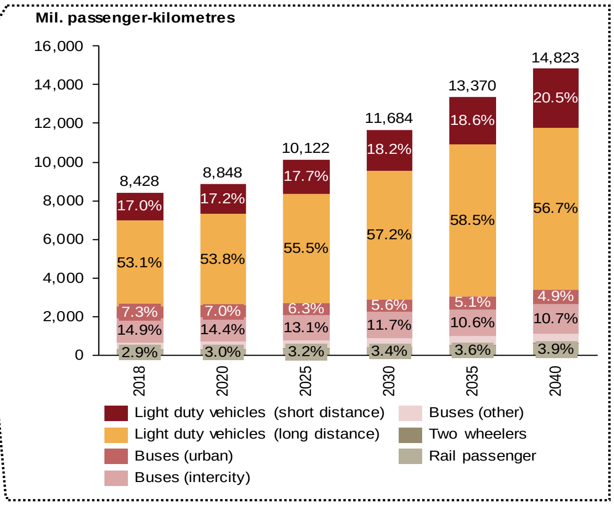


Figure 12. Passenger transport evolution

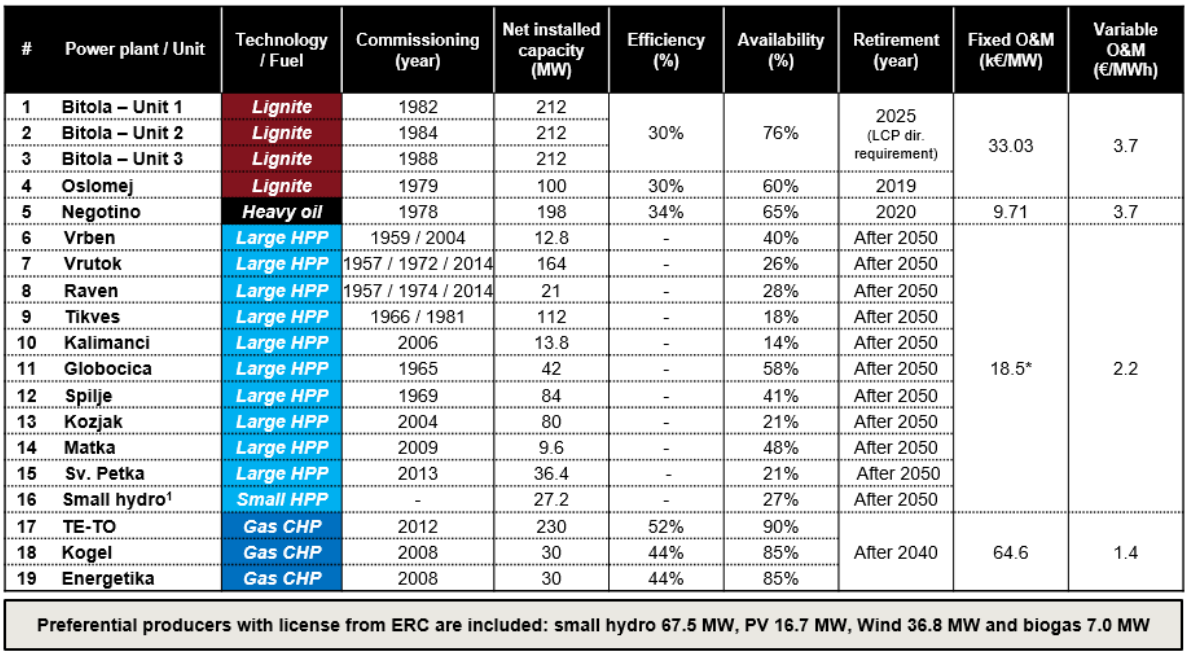


Source: MARKAL input data for the Strategy for energy development up to 2040, project team analyses

Electricity supply

The existing generation portfolio, including preferential producers (producers of electricity with feed-in tariffs or premiums), is included in the model inputs with their respective technical specification (*Figure 13*)

Figure 13. Overview of existing portfolio, 2017



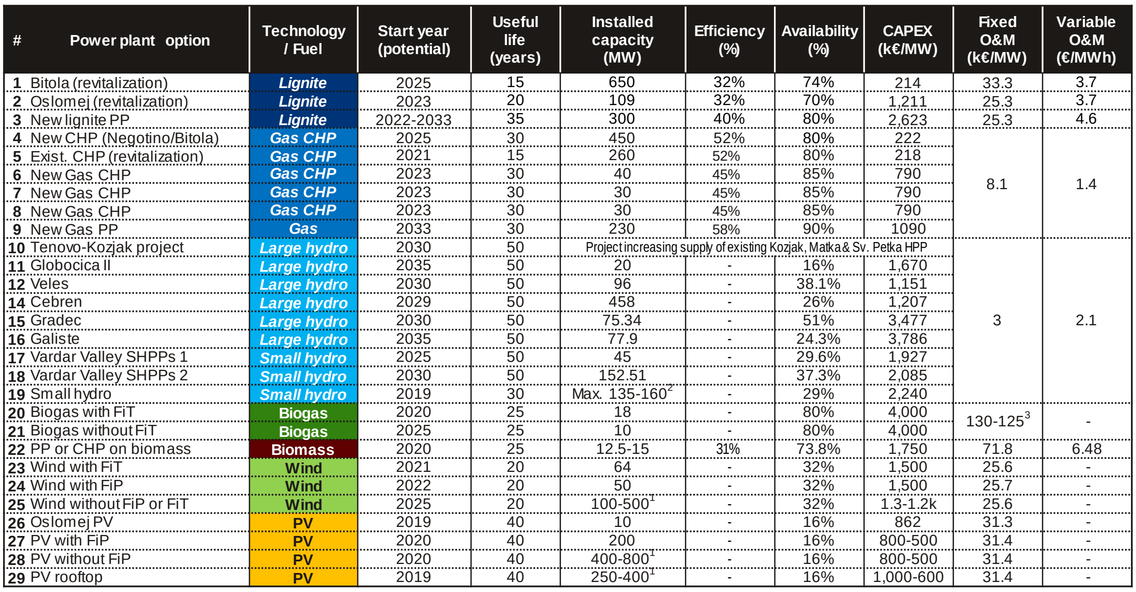
#	Power plant / Unit	Technology / Fuel	Commissioning (year)	Net installed capacity (MW)	Efficiency (%)	Availability (%)	Retirement (year)	Fixed O&M (k€/MW)	Variable O&M (€/MWh)
1	**Bitola – Unit 1**	**Lignite**	1982	212	30%	76%	2025 (LCP dir. requirement)	33.03	3.7
2	**Bitola – Unit 2**	**Lignite**	1984	212					
3	**Bitola – Unit 3**	**Lignite**	1988	212					
4	**Oslomej**	**Lignite**	1979	100	30%	60%	2019		
5	**Negotino**	**Heavy oil**	1978	198	34%	65%	2020	9.71	3.7
6	**Vrben**	**Large HPP**	1959 / 2004	12.8	-	40%	After 2050	18.5*	2.2
7	**Vrutok**	**Large HPP**	1957 / 1972 / 2014	164	-	26%	After 2050		
8	**Raven**	**Large HPP**	1957 / 1974 / 2014	21	-	28%	After 2050		
9	**Tikves**	**Large HPP**	1966 / 1981	112	-	18%	After 2050		
10	**Kalimanci**	**Large HPP**	2006	13.8	-	14%	After 2050		
11	**Globocica**	**Large HPP**	1965	42	-	58%	After 2050		
12	**Spilje**	**Large HPP**	1969	84	-	41%	After 2050		
13	**Kozjak**	**Large HPP**	2004	80	-	21%	After 2050		
14	**Matka**	**Large HPP**	2009	9.6	-	48%	After 2050		
15	**Sv. Petka**	**Large HPP**	2013	36.4	-	21%	After 2050		
16	**Small hydro**[1]	**Small HPP**	-	27.2	-	27%	After 2050		
17	**TE-TO**	**Gas CHP**	2012	230	52%	90%	After 2040	64.6	1.4
18	**Kogel**	**Gas CHP**	2008	30	44%	85%			
19	**Energetika**	**Gas CHP**	2008	30	44%	85%			

Preferential producers with license from ERC are included: small hydro 67.5 MW, PV 16.7 MW, Wind 36.8 MW and biogas 7.0 MW

*Note: * Same inputs applied for all HPP (costs include also financing costs to EU, etc.); 1) Excludes preferential producers. Source: ESM, ERC North Macedonia, Project team analysis*

In terms of future generation portfolio investments, a long list of 29 potential investment options was collected from the members of the Working Group established as a part of the process for Energy Strategy Development. Based on least cost optimization principles and underlying assumptions (e.g. commodity prices), the MARKAL model selects the best projects for construction in any given year, considering the “start year” for each powerplant option (Figure 14). Note that options labelled “revitalization” for the Bitola and Oslomej plants anticipate introduction of environmental equipment (e.g., flue gas desulfurization units and particulate matter filters). The revitalization also considers various replacement options, including replacement of one unit of the Bitola lignite plant with natural gas.

Figure 14. Potential generation capacity options



#	Power plant option	Technology / Fuel	Start year (potential)	Useful life (years)	Installed capacity (MW)	Efficiency (%)	Availability (%)	CAPEX (k€/MW)	Fixed O&M (k€/MW)	Variable O&M (€/MWh)
1	Bitola (revitalization)	**Lignite**	2025	15	650	32%	74%	214	33.3	3.7
2	Oslomej (revitalization)	**Lignite**	2023	20	109	32%	70%	1,211	25.3	3.7
3	New lignite PP	**Lignite**	2022-2033	35	300	40%	80%	2,623	25.3	4.6
4	New CHP (Negotino/Bitola)	**Gas CHP**	2025	30	450	52%	80%	222	8.1	1.4
5	Exist. CHP (revitalization)	**Gas CHP**	2021	15	260	52%	80%	218		
6	New Gas CHP	**Gas CHP**	2023	30	40	45%	85%	790		
7	New Gas CHP	**Gas CHP**	2023	30	30	45%	85%	790		
8	New Gas CHP	**Gas CHP**	2023	30	30	45%	85%	790		
9	New Gas PP	**Gas**	2033	30	230	58%	90%	1090		
10	Tenovo-Kozjak project	**Large hydro**	2030	50	Project increasing supply of existing Kozjak, Matka & Sv. Petka HPP				3	2.1
11	Globocica II	**Large hydro**	2035	50	20	-	16%	1,670		
12	Veles	**Large hydro**	2030	50	96	-	38.1%	1,151		
14	Cebren	**Large hydro**	2029	50	458	-	26%	1,207		
15	Gradec	**Large hydro**	2030	50	75.34	-	51%	3,477		
16	Galiste	**Large hydro**	2035	50	77.9	-	24.3%	3,786		
17	Vardar Valley SHPPs 1	**Small hydro**	2025	50	45	-	29.6%	1,927		
18	Vardar Valley SHPPs 2	**Small hydro**	2030	50	152.51	-	37.3%	2,085		
19	Small hydro	**Small hydro**	2019	30	Max. 135-160[2]	-	29%	2,240		
20	Biogas with FiT	**Biogas**	2020	25	18	-	80%	4,000	130-125[3]	-
21	Biogas without FiT	**Biogas**	2025	25	10	-	80%	4,000		
22	PP or CHP on biomass	**Biomass**	2020	25	12.5-15	31%	73.8%	1,750	71.8	6.48
23	Wind with FiT	**Wind**	2021	20	64	-	32%	1,500	25.6	-
24	Wind with FiP	**Wind**	2022	20	50	-	32%	1,500	25.7	-
25	Wind without FiP or FiT	**Wind**	2025	20	100-500[1]	-	32%	1.3-1.2k	25.6	-
26	Oslomej PV	**PV**	2019	40	10	-	16%	862	31.3	-
27	PV with FiP	**PV**	2020	40	200	-	16%	800-500	31.4	-
28	PV without FiP	**PV**	2020	40	400-800[1]	-	16%	800-500	31.4	-
29	PV rooftop	**PV**	2019	40	250-400[1]	-	16%	1,000-600	31.4	-

Notes: 1) Depending on the scenario; 2) The overall capacity including existing small HPPs; 3) Includes waste transport costs, etc. Source: Project team analysis

More details about the used input data can be found in the Strategy for Energy Development up to 2040.

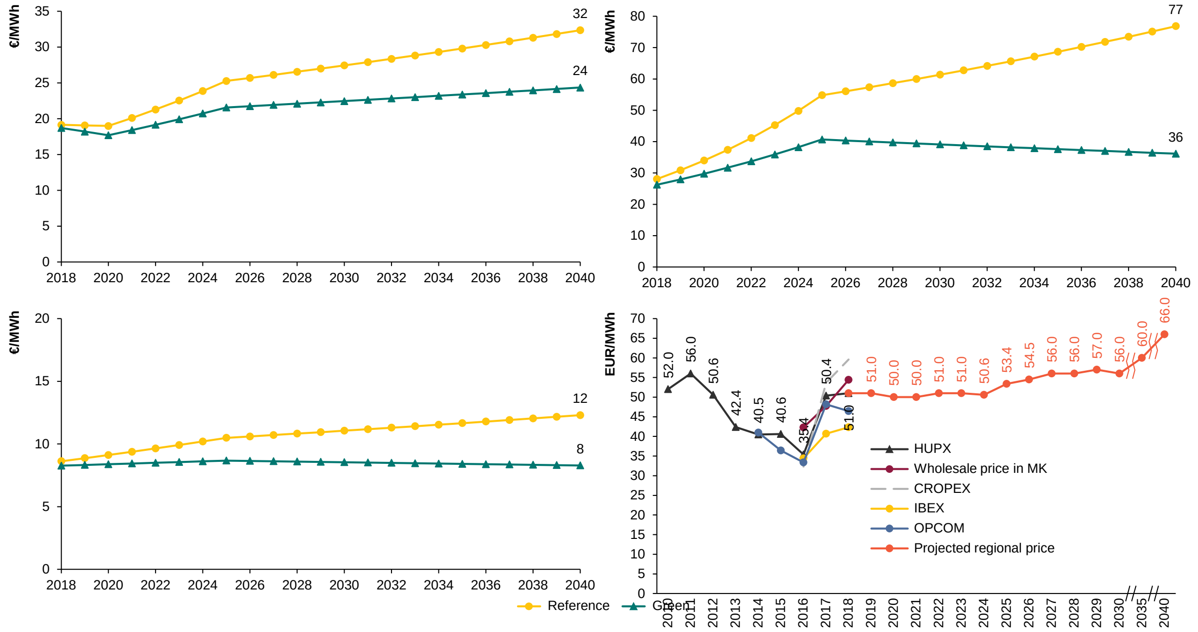
The model also provides for changes in electricity imports and exports. In the policy scenarios, electricity imports and exports can increase or decrease based on changes in electricity production costs and prices, subject to available transmission capacity.

Fuel and electricity prices

In order to give a regional context to the model and given the fact that Macedonia is an import-dependent country, the project team assumes international fuel prices (natural gas, oil and coal imports) from the World Energy Outlook 2017. These were the same same prices used in the adopted Strategy for Energy Development up to 2040 (Green scenario, Figure 15). In the CO2 tax scenarios, the tax was applied on top of the projected fuel prices.

Regarding the price of electricity, HUPX is considered as a reference market in the region, as one of the oldest and with the highest level of quantities traded. The average annual price of electricity on this market is in the range from 35 EUR/MWh to 56 EUR/MWh in the period 2010-2018 (Figure 15). Starting from 2016, three additional day-ahead markets were opened in the region (CROPEX in Croatia, SEEPEX in Serbia and IBEX in Bulgaria). It can be noted that the wholesale electricity price in Macedonia follows the price in the HUPX day-ahead market. The projection after 2022 are based on the results from the Strategy for Energy Development up to 2040 obtained from the Power2Sym model.

Figure 15. Global energy trends of fuel prices, 2018-2040



Source: Strategy for energy development up to 2040 (Reference scenario refers to the current policies scenarios, while the Green scenario applies the Sustainable development policies of WEO 2017); Source: HUPX, CROPEX, IBEX, OPCOM, Strategy for energy development up to 2040, project team analyses

GHG emissions

MARKAL-Macedonia is designed to calculate greenhouse gas emissions for all fuels separately. In addition, a division has been made which enables the model to display the results by sector. For the calculation of emissions, IPCC emission factors have been used for all fuels except for lignite and natural gas. For these fuels, country specific emission factors are used (Table 22). The lignite and natural gas emission factors are the same as those used in the preparation of the TBUR inventory.

Table 2. Emission factors used in the Energy sector (in kg/TJ)

Fuel	CO_2	CH_4	N_2O
Coking coal	94,600	10	1.5
Other Bituminous Coal	94,600	10	1.5
Sub-bituminous Coal	96,100	10	1.5
Lignite	107,879*	1(10)**	1.5
Crude oil	73,333		
Residual fuel oil	78,049*	3	0.6
Gas / Diesel oil	74,100	3	0.6
Motor gasoline	69,300	0.5	2
Jet kerosene	71,500	0.5	2
LPG	63,100	1	0.1
Petroleum coke	97,500	3	0.6
Natural gas	55,066*	1	0.1
Biomass	112,000	30	4

* Country Specific Emission Factor (CS EF)

Further, consistent with the TBUR inventory, the study makes use of the global warming potential (GWP) values provided in the IPCC AR4 (temporal horizon 100 years) (see Table 3).

Table 3. Global warming potential values used in the preparation of the GHG Inventory (100 years time horizon)

Gas	CO_2 equivalent
CO_2	1
CH_4	25
N_2O	298

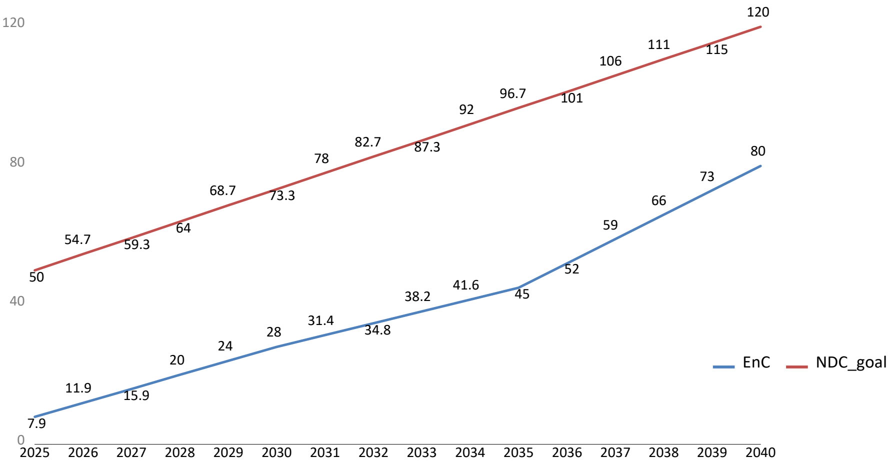
Source: IPCC Fourth Assessment Report (AR4), 2007

CO_2 tax

Regarding the CO_2 tax, which is the input data in the MARKAL-Macedonia model, the study employs “gradual” carbon prices similar to those from the Energy Community study (shown in Table 1) for the Energy Community (EnC) and Energy Community-All (EnC-all) scenarios. (These scenarios are described in the next section.) In both cases, an interpolation is made to generate annualized carbon prices (see Figure 16). As a result, the assumed CO_2 tax level in this study is somewhat higher in 2030 than that used in the Energy Community study.

For the NDC_goal scenario, the final tax is determined using an iterative process to determine the price required to begin replacing coal in the industry sector with other fuels such as natural gas, biomass and electricity. The CO_2 tax in the NDC_goal scenario starts at 50 EUR/t in 2025 and reaches 120 EUR/t in 2040.

Figure 16. CO2 tax used in the MARKAL-Macedonia model



Regional Participation

As a default, the scenarios consider the likelihood that the European Community region and neighboring EU countries all enact a carbon price set to eventually reach carbon price levels consistent with the EUETS. This is considered to be an expectation of EU accession. Montenegro, as noted above, has already launched a cap-and-trade program with a floor price that starts at €24/ton. While the precise carbon price levels and timing adopted by neighboring jurisdictions could differ from the trajectories modeled in this study, it is reasonable to consider that Macedonia’s non-EU neighbors, including Albania, Kosovo and Serbia, will also be on a path to adopt a carbon price. Accordingly, the main scenarios presented all assume a border tax imposed on power imports at the same carbon price levels assumed for Macedonia, as described in the section above. However, to understand the potential impacts of Macedonia adopting a carbon tax while the neighboring jurisdictions do not, we modeled one sensitivity scenario, which is described in Section 5.

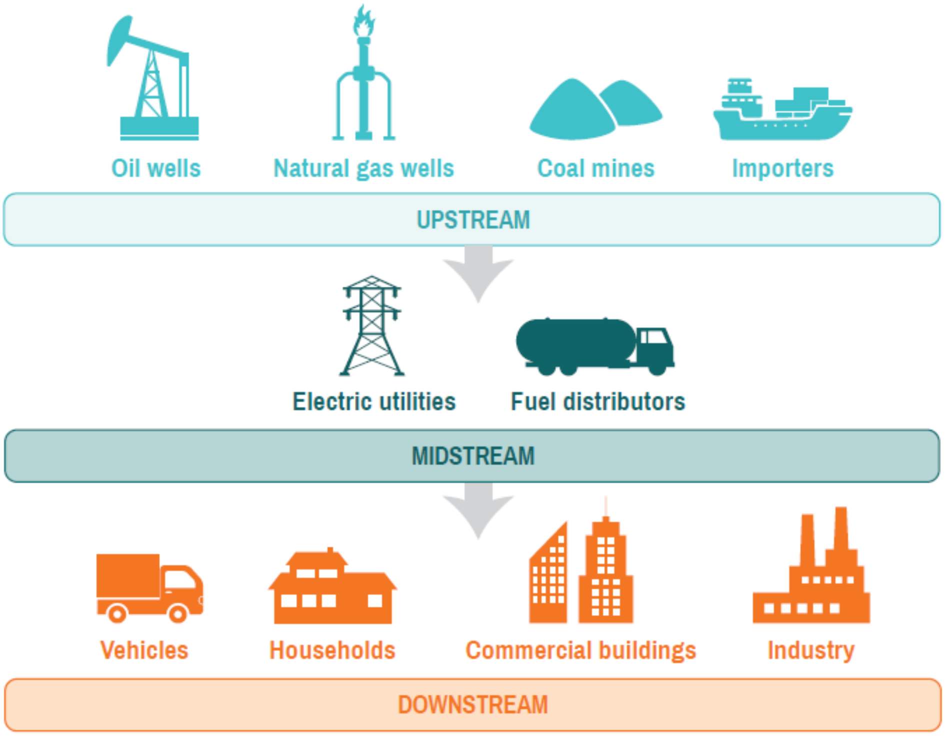
Point of Regulation

Energy supply involves a number of actors, each with their own specific role in the process. For example, the production of electricity from natural gas includes the production and import of natural gas, transmission of natural gas to the end user, production of electricity, and ultimately use of the electricity by the final consumer. Accordingly, the CO2 tax can potentially be applied at any of these points: the natural gas producer/importer (upstream); the natural gas system operator (midstream); or the electricity producer, in this case, a natural gas thermal power plant (midstream); or at the electricity consumer (downstream) (Figure 17).

- Upstream: Upstream carbon taxes are applied to fuels at the point where the product associated with the emissions enters the economy.
- Midstream: A midstream carbon tax refers to a tax that is applied somewhere between the point where the product enters the economy and the point of consumption.
- Downstream: A downstream carbon tax is applied at the point of final energy consumption, whether by consumers, businesses, or industry.

In the MARKAL-Macedonia model the CO2 tax is assumed to be paid by the consumer of the respective taxable fuel. For example, the producer of electricity from lignite power plants pays the CO2 tax (here, the tax is applied midstream), while coal consumed in industry is paid by the industry itself (a downstream application of the tax). The transportation tax is also assumed to be applied downstream. However, the economic incentives would be similar if the tax were applied further upstream. The pros and cons of the options for Macedonia are considered separately in the accompanying Roadmap.

Figure 17. General Categorization of Potential Points of Regulation for Fossil Fuels



Source: Carbon Tax Guide A Handbook for Policy Makers, World Bank, 2017

4. CO2 tax scenarios and sensitivity run and the reasons for selecting them

We undertook an initial set of **four modeling runs** using the MARKAL model aimed at informing policymakers and stakeholders of the key design parameters of a carbon tax. These four runs assumed that countries in the region applied a comparable carbon price. We also undertook **one sensitivity run** to understand the potential for emissions leakage in the case that the neighboring countries do not adopt a comparable carbon price.

The intent behind the construction of the four scenarios was not to copy the level of the carbon tax assumed in the Macedonian Strategy for Energy Development up to 2040, but rather to determine what tax level is necessary to achieve the mid- and long-term commitments of Macedonia with respect to the UNFCCC and its EU accession strategy. The four scenarios were:

- Business-as-usual (BAU)
- Energy Community Vision (EnC)
- Carbon Tax for all (EnC_all)
- NDC Attainment (NDC_goal)

In all of these scenarios, the changing variable was the level of the carbon tax, and/or the sources (sectors) covered by the carbon tax.

The sensitivity run to assess the impact of a carbon tax without a border tax on imported power (EnC_all_ind) was based off of the EnC_all scenario.

A detailed description of the four scenarios and the sensitivity run follows.

4.1 Business-as-Usual (BAU) Scenario.

This scenario assumes no carbon tax, but includes all other existing and planned energy, energy efficiency and other government policies included in the Green Scenario in the Strategy for Energy Development up to 2040. For example, the scenario assumes the planned reconstruction of the Bitola coal power plant, and planned energy efficiency and fuel supply policies, such as construction of new natural gas pipelines.

This scenario was created as a baseline against which Macedonia’s UNFCCC and EU commitments, as well as all other scenarios can be compared.

4.2 Energy Community Vision (EnC) scenario.

The Energy Community is an international organization established between the EU and countries of Southeast Europe to extend the EU internal energy market to Southeast Europe and beyond. Contracting parties commit themselves to implement the relevant EU energy *acquis communautaire*, to develop an adequate regulatory framework and to liberalize their energy markets in line with the *acquis* under the Treaty.

A study “Carbon Pricing Design for the Energy Community,” (Energy Community Study) is underway presently. The aim of the study is to propose a carbon pricing mechanism that is suitable for the decarbonisation of the electricity and heat production sector in the Energy

Community countries, including North Macedonia, considering the intrinsic political, economic and social context in these countries.

As the study states “[Energy Community countries] are not prepared to follow the EU in its decarbonisation pathway, as things stand. However, with the European Green Deal unfolding, it becomes increasingly obvious that Europe’s transition to climate neutrality can only be effective if the block’s immediate neighbourhood also takes meaningful climate action.” Therein lies the quest for a swift alignment with the new EU Climate Law and early inclusion of the Western Balkans in the EUETS or the institution of carbon taxes.

We reviewed the Energy Community Study and applied a similar level of carbon tax on the electricity and heat sectors, the only two sectors under consideration in the study. Additionally, this scenario also includes a carbon tax on electricity imports (which is not included in the EnC study), differentiating among the four importing countries per the tax levels in the Energy Community Study.

The main reason for this scenario was to understand whether the Energy Community Study and our modeling effort achieve the same or comparable emission reductions while applying a similar carbon tax to the same sectors.

4.3 Carbon tax for all (EnC_all) Scenario

This scenario applies a carbon tax similar to the Energy Community Study (the same as under the EnC Scenario, above) to electricity, heat, and electricity imports, but in addition also applies the tax to industry and transport.

This scenario was selected to gain understanding of what additional emission reductions could be possible with the same level carbon tax placed on industry and transport. The outcome of this scenario is important for the calibration of the relative importance of industry and transport to the attainment of Macedonian carbon mitigation strategies. These two sectors have outsized influence on the nation’s employment and social wellbeing, and a carbon tax in these sectors could threaten the social fabric of the country more than in other sectors. Therefore, understanding the implications of a carbon tax on industry and transport sector emissions can illuminate possible tradeoffs and inform decisions on whether and how to apply a carbon tax as opposed to alternative policies and measures.

4.4 NDC Attainment (NDC_goal) scenario.

The NDC attainment scenario was developed to estimate the level of carbon tax necessary to achieve the energy part of Macedonia’s NDC commitment of reducing emissions to 51% (including all sectors except forestry and land use) or reducing net emissions (including forestry and land use) to 82% below 1990 levels. An iterative process was used to determine what carbon tax would need to be applied to the electricity, heat, industry and transportation sectors to reach an energy sector emissions level of 3682 kt CO2 eq in 2030.[11]

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[11] Note that the assessment looked just at emissions in Macedonia, not MEMO. Note that the level evaluated (-49% below 1990 in 2030) comes close to reaching the specified economywide NDC goal.

4.5 Carbon tax for all scenario without a border tax (EnC_all_ind).

This final run was identical to the EnC_all scenario described above except that it is assumed that Macedonia's Energy Community and EU neighbors do not adopt a similar carbon price. The EnC_all_ind sensitivity run assumes that Macedonia alone adopts a carbon price to understand how this might impact cross-border transactions of power. It would be expected that if Macedonia adopts a carbon tax and its neighbors do not, power imports not subject to the tax would become more competitive relative to power generated in Macedonia. Power producers from neighboring countries could potentially increase production to serve the Macedonia market, subject to transmission and other constraints[12]. This could result in an increase in emissions from imported power (leakage) that would need to be taken into account in calculating the emissions impact of the Macedonia carbon tax.

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[12] Note that only transmission constraints are considered in the model. The model does not consider how much excess capacity is available.

5. Summary of the results of the four scenarios and the sensitivity run

Considering all energy sector emissions associated with demand in Macedonia, including emissions from electricity imports and aviation (MEMO), the BAU scenario already achieves a reduction in greenhouse gas emissions stemming from planned energy efficiency measures, primarily in the residential, commercial and industry sectors, as well as the construction of power plants for electricity generation from renewable sources. Emissions in this scenario in 2040 are projected to decrease by 5% compared to the level of emissions in 2017 (Figure 18). The biggest decrease is in 2030, after which emissions start to grow again, mostly as a result of the industry sector where coal consumption increases with the expected increase in the industrial production index.

Under the EnC scenario where there is a carbon tax only on the electricity and heat sectors, the industry and transport sectors contribute to a visible increase in emissions after 2030. It is predicted that the introduction of the carbon tax will contribute to a reduction of GHG emissions by 42% in 2040 compared to 2017.

The introduction of a carbon tax in other sectors, as assumed in the EnC_all scenario, contributes to reducing emissions by an additional 7 percentage points.

If only the emissions generated within the borders of Macedonia are analyzed, then the GHG emissions in the BAU scenario increase by 6%, while in the other three scenarios (EnC , EnC_all and NDC) they decrease by 33% and 42% and 45% respectively (Figure 19).

To achieve the energy sector's expected contribution to the NDC as described above, it is necessary to introduce a much more aggressive CO2 tax, not only in 2040, but also starting in 2025. This tax should start at 50 EUR/tCO2 in 2025 and ramp up to over 120 EUR/tCO2 in 2040. To better understand the underlying factors that drive this result, we undertook additional sensitivity assessments to identify the carbon price required to reach the final mitigation outcome in each sector. While a lower tax level is sufficient to realize the NDC level of ambition in the electricity, heat and transportation sectors, a higher CO_2 tax is needed in order to reduce the use of coal in the industry sector—the last measures needed to reach the NDC ambition.

Figure 18. GHG emissions by sectors (including MEMO) for the BAU, EnC, EnC_all and NDC_goal scenarios, (kt CO_2-eq)

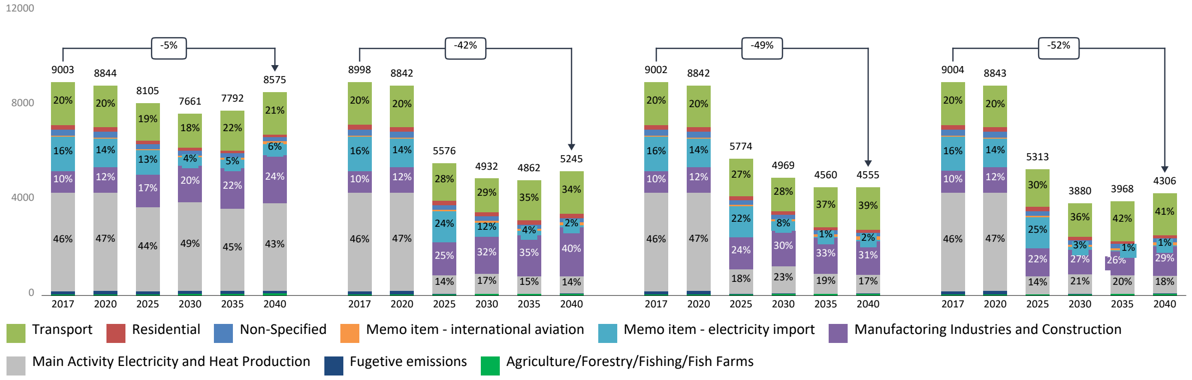
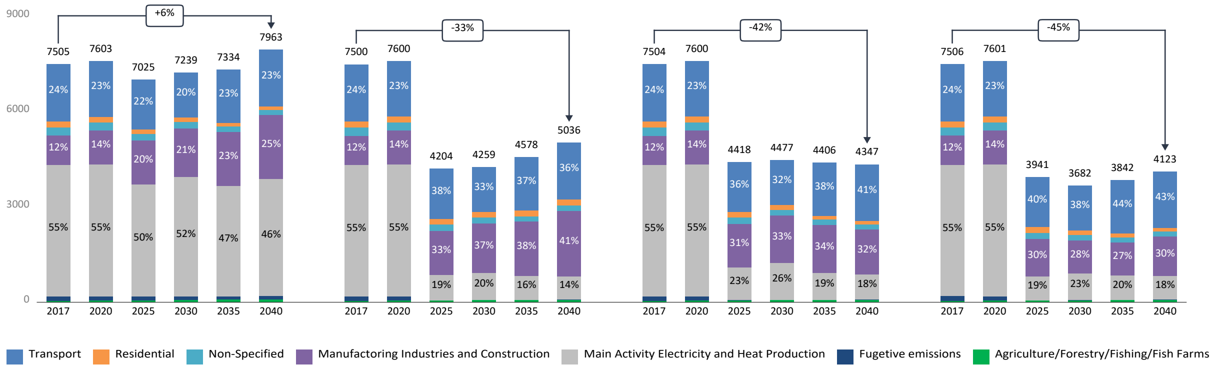
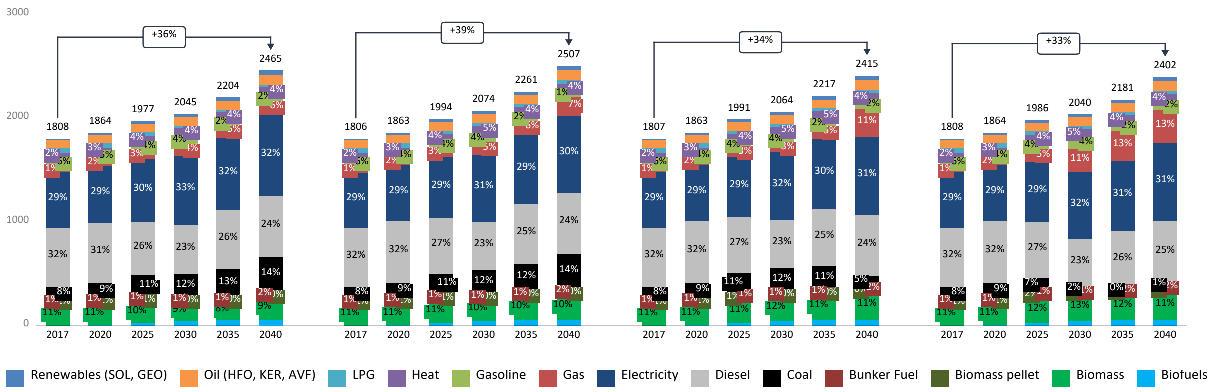


Figure 19. GHG emissions by sectors (without MEMO) for the BAU, EnC, EnC_all and NDC_goal scenarios (kt C_2-eq)



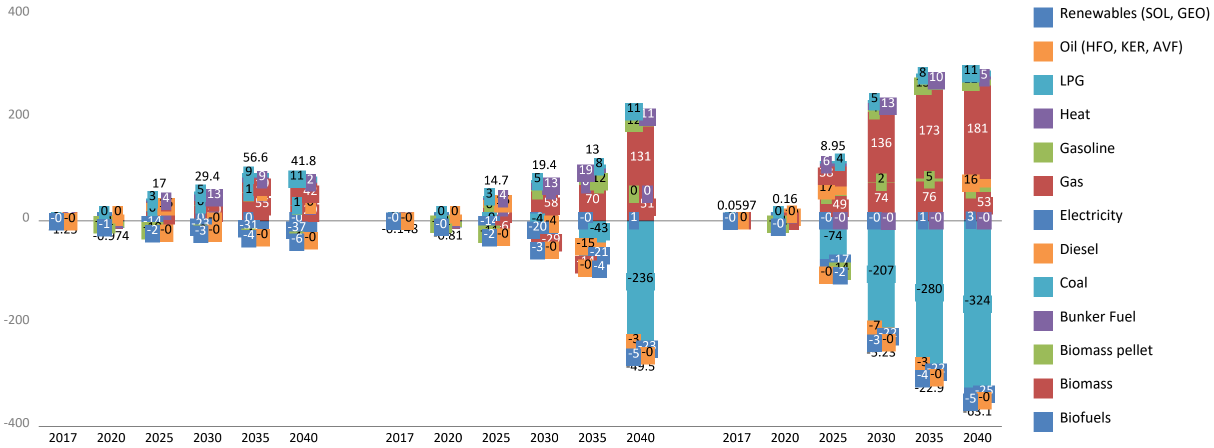
The final energy consumption in all scenarios grows by over 30% (the highest, 39% in the EnC scenario) (Figure 20). The share of diesel and electricity dominates in all four scenarios. In the power sector, lignite-fired power plants are replaced with various alternatives (renewables, natural gas), substantially reducing emissions. In the industry sector, lignite is replaced by electricity, natural gas and biomass. If CO_2 tax is not introduced in all sectors (EnC scenario) then come to a slight increase in the consumption of natural gas in households while the consumption of the biomass is at the same level as in 2017. However, biomass use, in the other two scenarios, decreases by 10-15% in the residential sector as heat pump technology is competitive, in part due to assumed government policies included in the model, as well as the price of heat pumps and their efficiency compared to the efficiency of the biomass stove. These energy sector changes would be expected to improve air quality across the country, especially in cities.

Figure 20. Final energy consumption by fuels for the BAU, EnC, EnC_all and NDC_goal scenarios, (ktoe)



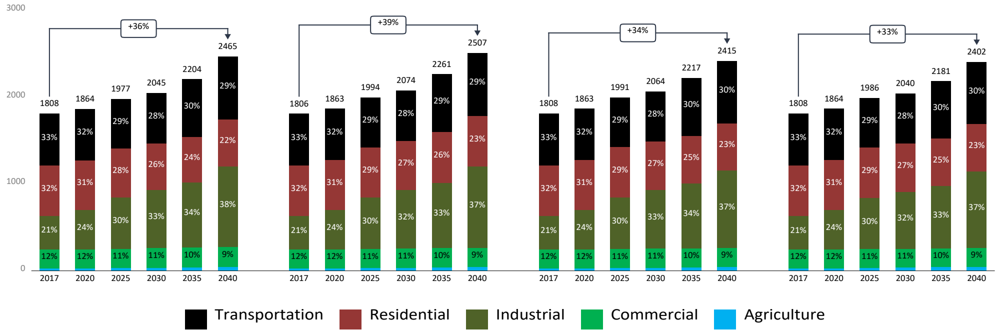
As concluded above, the higher CO2 tax needed to reach the NDC goal mainly is needed to produce shifts in energy consumption in industry, i.e. the higher tax contributes to the fuel switch needed to reach the NDC goal. In the NDC_goal scenario, energy consumption is reduced by 63 ktoe (compared to BAU) as a result of the use of more efficient natural gas technologies (Figure 21).

Figure 21. Changes in energy use by fuel type for the EnC, EnC_all and NDC_goal compared to BAU scenario, (ktoe)



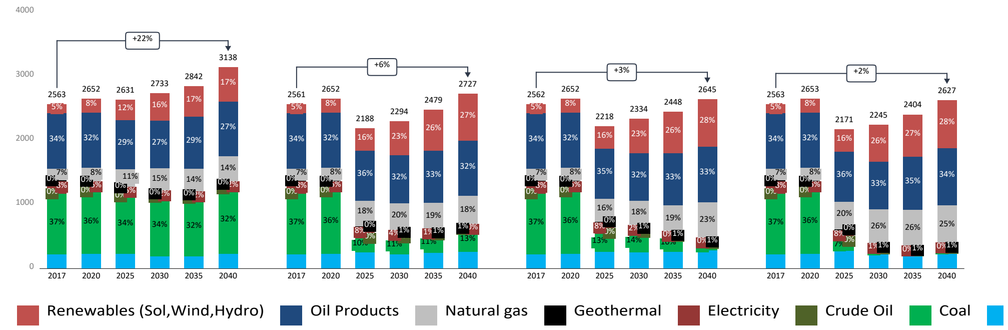
In all scenarios, the industry and transport sectors drive growth in energy consumption throughout the period. The introduction of energy efficiency and other measures in the other sectors (residential and commercial) contributes to the absolute amounts of energy consumption in these sectors not changing significantly, i.e. their share is reduced (Figure 22).

Figure 22. Final energy consumption by fuels for the EnC, EnC_all and NDC_goal compared to BAU scenario, (ktoe)



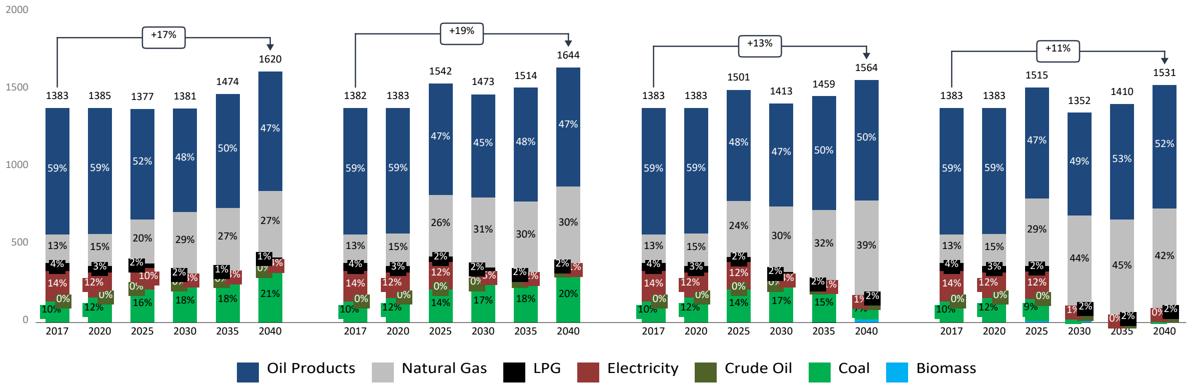
Unlike final energy consumption, primary consumption in all scenarios except BAU has slightly increased compared to 2017 (Figure 23). The introduction of a higher CO2 tax also contributes to ending generation from coal-fired power plants, i.e., it is not cost-effective to modernize them. With the reduction of coal consumption, the main problem that remains is the consumption of petroleum products, primarily in the transport sector, which after some time increases due to having already taken full advantage of measures to improve the efficiency of vehicle technologies.

Figure 23. Primary energy consumption by fuels for the BAU, EnC, EnC_all and NDC_goal scenarios, ktoe



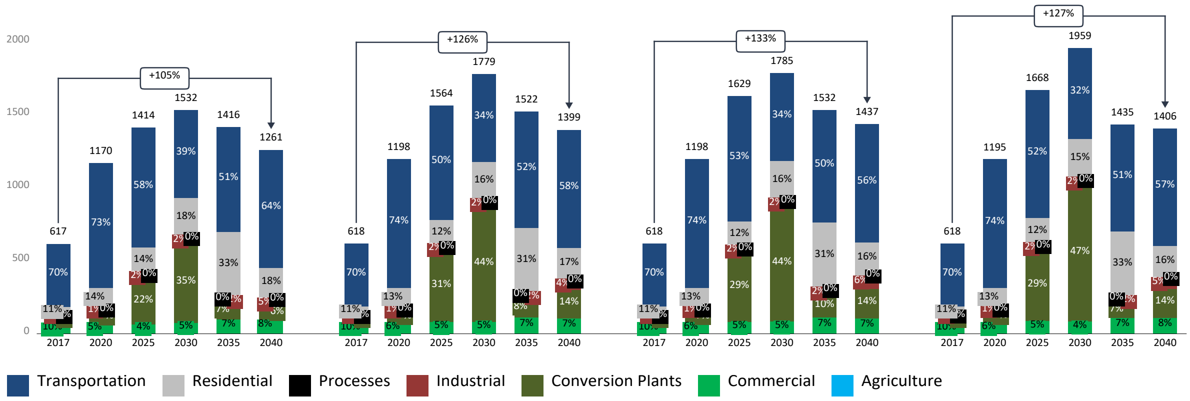
Macedonia is an import-dependent country where more than 50% of energy is imported and this will continue even as imports are subject to the carbon tax. However, the composition of the imported energy would be expected to change. By replacing coal with natural gas, natural gas increases its share of energy imports up to 42% in 2040 in the NDC_goal scenario (Figure 24).

Figure 24. Energy imports of fuels under the BAU, EnC, EnC_all and NDC_goal scenarios, (ktoe)



In terms of investment, the NDC_goal scenario leads to increased investments in efficient and lower-emitting technologies as compared to the other scenarios, particularly in the period through 2030, and consequently higher investment costs. In 2030, energy investments reach nearly 2 billion EUR (Figure 25). Most investments are made in the transport and electricity generation sectors.

Figure 25. Investments by sector for the BAU, EnC, EnC_all and NDC_goal scenarios, (Euros)

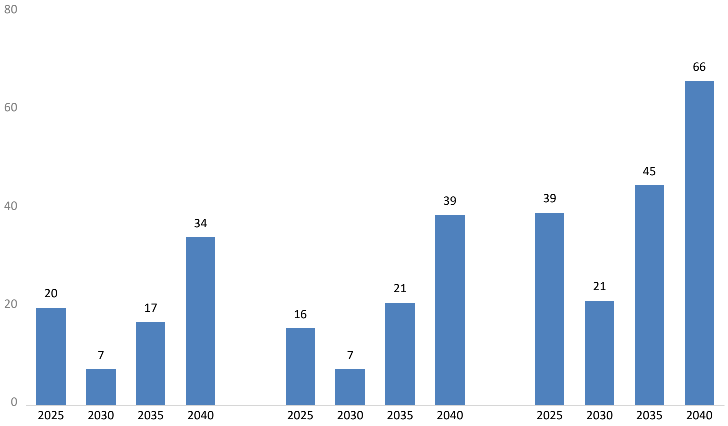


Higher electricity sector investment costs are projected to translate to higher electricity prices for customers as compared to BAU. Under the BAU scenario, following an increase in electricity prices through 2030, the industry and commercial sectors are expected to pay almost the same price in 2040 as they pay in 2017 (Figure 26). Investments in renewable resources for electricity production that have lower electricity production costs than conventional technologies will contribute to a reduction in the BAU price of electricity after 2030. In the case of the residential sector, due to BAU plans to remove existing subsidies as part of an expected restructuring of the electricity market, residential sector electricity prices are expected to increase by about 40% between 2020 and 2030 in the BAU scenario. By 2030, it is assumed that the residential sector will pay the full cost of electricity delivered and will no longer be subsidized by the rest of the market. After 2030, as is the case for all other sectors, the residential sector will see electricity prices decline due to the lower overall electricity production price of renewable resources. However, 2040 prices will be above those paid in 2017.

Figure 26. Price of the electricity by sector in the BAU scenario (EUR/MWh)

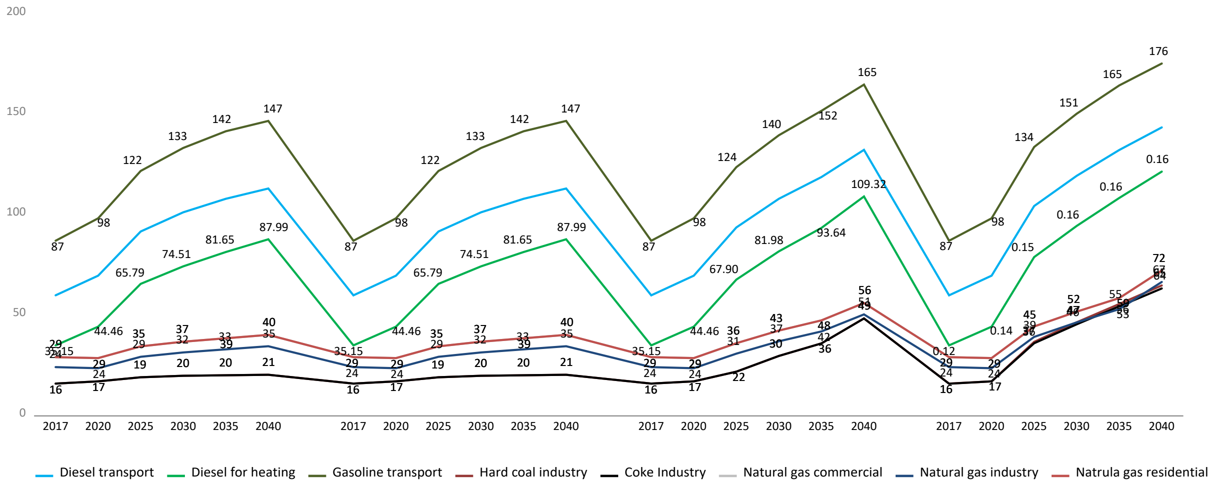
The introduction of a CO2 tax is projected to contribute to an increase in the final price of electricity paid by consumers over the next two decades. This is especially pronounced in the NDC_all scenario when the increase reaches 66 EUR/MWh in 2040 (Figure 27). In 2030 there is a decrease in the growth of the price of electricity which is again a result of the construction of renewable energy for electricity production. Care must be taken with the introduction of the CO2 tax, especially in the electricity generation sector because that energy is used by all, including vulnerable consumers. Therefore, a portion of the CO2 tax revenues should be directed towards helping vulnerable consumers, particularly those with low incomes and least able to afford increases in energy costs. A detailed assessment to define vulnerable consumers was conducted as a part of the NECP process (see Annex 1). Although there is a projected increase in the price of electricity, the expectation that GDP/capita will increase by about 2.5 times should be taken into account. Despite the increase in prices, on average, households will allocate a smaller share of funds for electricity from their budget as compared to the current situation.

Figure 27. Increase of the electricity price by scenario relative to BAU scenario (EUR/MWh)



The introduction of a CO2 tax in other sectors in the EnC_all and NDC_goal scenarios also increases the prices of other energy sources in addition to electricity. The price of diesel for transport has the least consequences from the introduction of CO2 tax, i.e. in the NDC_goal scenario it increases by 27% compared to the BAU scenario, while the largest increase is in the prices of coal in the industry sector by more than 200% (Figure 28). There is also an increase in the price of natural gas, which doubles in price in the industry sector compared to the BAU scenario in 2040.

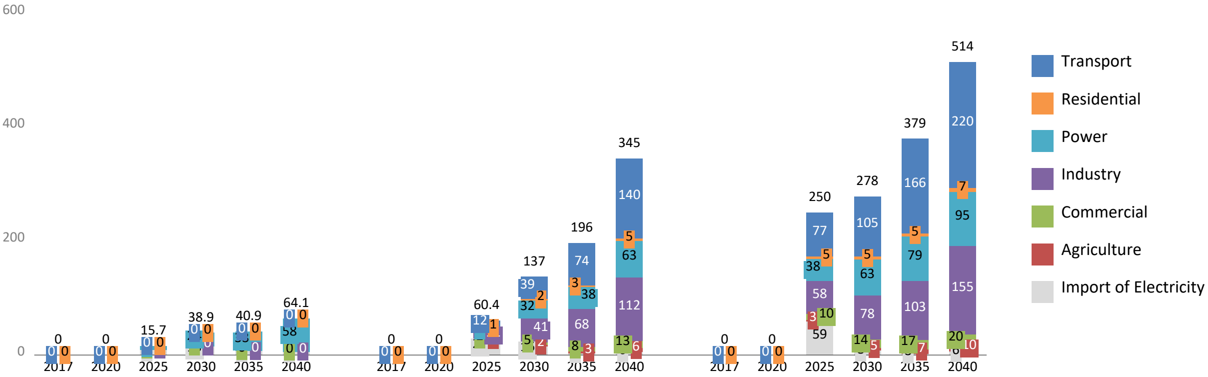
Figure 28. Marginal costs of fuels by sectors for the BAU, EnC, EnC_all and NDC_goal scenarios, (EUR/MWh)



As far as carbon tax revenues, 1.4 billion EUR would be collected on the basis of the CO2 tax from the NDC_goal scenario, which is almost twice as much compared to the tax collected in the EnC_all scenario, and 9 times higher than in the EnC scenario (Figure 29).

The transport sector participates with the largest percentage in the tax, followed by the industry and the electricity generation sectors.

Figure 29. Revenue collected by the carbon tax for the BAU, EnC, EnC_all and NDC_goal scenarios



Sensitivity run results of Macedonia acting unilaterally to adopt a carbon tax

When it is assumed that Macedonia acts independently to implement a carbon price under the EnC_all_ind scenario, we find that Macedonia still sees significant emissions reductions within its own borders. This includes full replacement of coal with natural gas at the Bitola power plant and some expansion of renewable energy as compared to business-as-usual. However, some of the growth in renewables seen under the EnC_all scenario does not materialize; a portion of this power is replaced by power imports, resulting in emissions leakage. The growth in emissions from these increased power imports reduces the overall emissions impact of the carbon tax by 10% in 2025 and 32% in 2030. (When a border tax was assumed, the emissions impact of the carbon tax was reduced by 10% in 2025 but only 2% in 2030 as compared to business-as-usual power imports.) This suggests that Macedonia could implement a lower carbon tax (~8 EUR per ton) independently without compromising the emissions reductions from the tax, but that it should avoid raising the tax too high unless neighboring countries adopt comparable carbon prices.

Main differences between scenarios from this study and the Energy Community study

In addition to differences in the assumed carbon prices under the scenarios (described earlier under assumptions) as well as other differences in the underlying assumptions[13], the studies differ with respect to the scenarios evaluated and the results.

Scope of the assessment. The Energy Community study considers application of a CO2 tax to the electricity and heat sectors across the Energy Community region. They include two different carbon price paths (gradual and full) as well as different assumptions about regional energy integration, as described in Annex II. In contrast, this study has one scenario that similarly looks just at the electricity and heat sectors, and others that consider application of the CO2 tax to the electricity and heat, transportation and industry sectors. This study assumes a carbon price path comparable to the gradual scenario in the Energy Community study, as well as a far more ambitious price path set to approximate the NDC goal.

Results. The studies show important differences in the capacity that would be economically viable.

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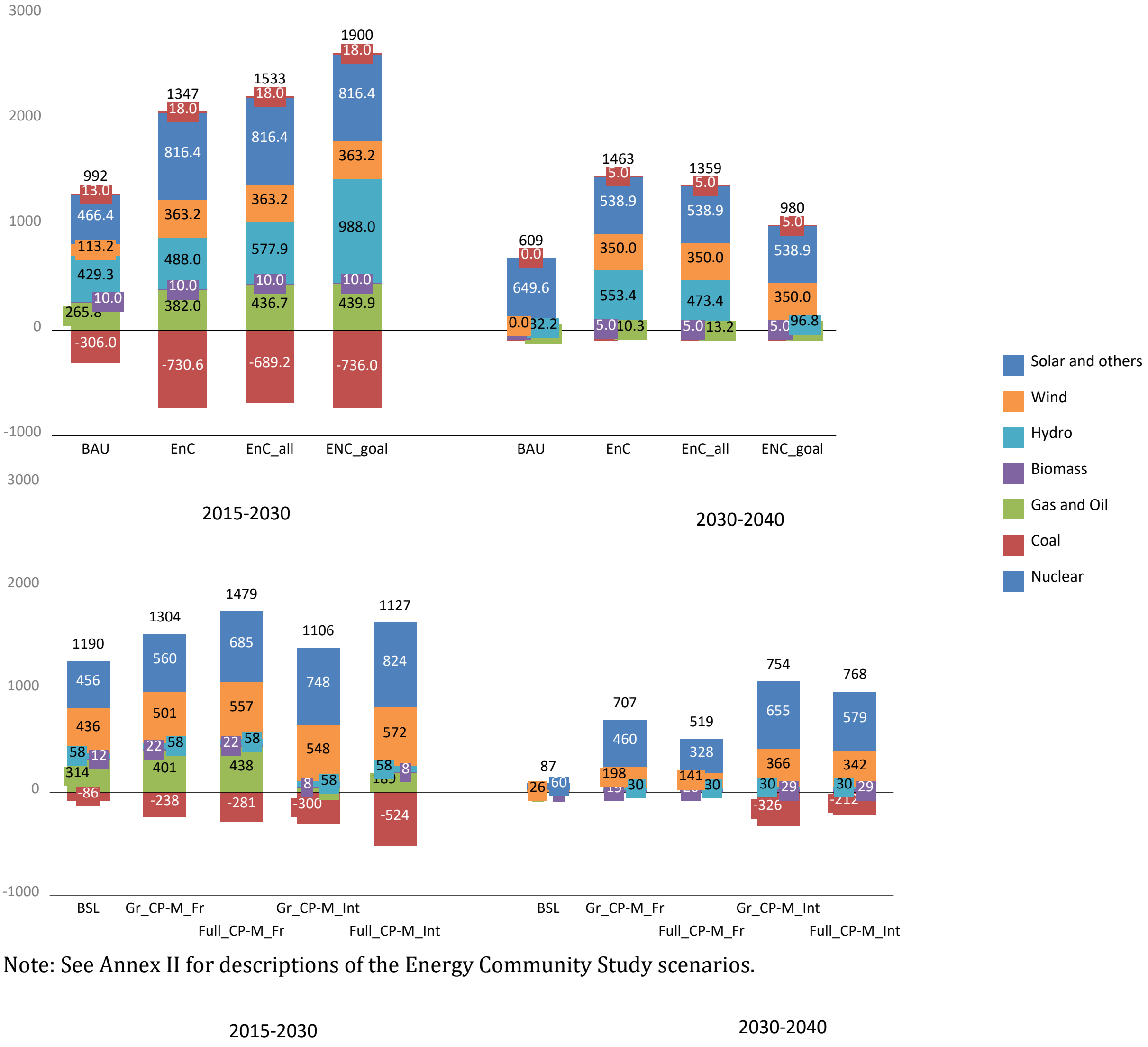
[13] The carbon tax study uses official data for Macedonia that has been adopted by the government.

This study envisages the construction of between 1000 and 2000 MW of new electricity generation facilities in the period 2017-2030 (a combination of wind, solar, hydropower and natural gas) as well as partial modernization of the existing thermal energy power plants (Figure 30). The largest installed capacity is envisaged in the NDC_goal scenario where about 1000 MW of new hydro facilities are built (including the Tenovo-Kozjak tunnel modeled as a power plant with installed capacity). The NDC_goal scenario also sees construction of solar power plants (over 800 MW) and wind power plants (about 360 MW). TPP Bitola and Oslomej are not economically viable after 2025 under all three CO2 tax scenarios.

In contrast, the results of the Energy Community study show that Bitola will operate in all scenarios they consider, with reduced intensity. Hydro power plants are almost non-existent in the Energy Community study. The picture is similar in the period 2030-2040. Despite the differences in hydro and coal-fired power plants, the installed capacity of wind and solar power plants is almost at the same level.

Figure 30. Comparison of the net capacity installed, scenarios of this study (first row below) with scenarios from Energy Community carbon study (second row below) in 2020-2030 (left) and 2030-2040 (right)



Note: See Annex II for descriptions of the Energy Community Study scenarios.

Differences in the installed capacity also brings differences in the amount of electricity produced from different sources. In this study, the share of generation from hydropower plants reaches 41%, while wind and solar power plants account for 20% and 16%, respectively (Figure 31). Total electricity generated from domestic sources reaches about 9500 GWh, which is about 1500 GWh more than the Energy Community study scenario (the Baseline scenario) with the highest electricity generation (Figure 32). Notably, in the Energy Community study, there are about 2000 GWh of net electricity imports after 2030 while in this study the net electricity imports is almost zero in that timeframe (Figure 33 and Figure 34). As both scenarios assume at least some amount of regional participation in carbon pricing or application of a border tax, this suggests differences in the assumed costs of hydropower and natural gas as compared to the costs of imported power in the two studies. Likewise, there could be differences in the assumed costs of shifting from coal to natural gas at the Bitola plant. However, these differences cannot be verified as the Energy Community Study does not provide details on the assumptions. It is also possible that differences in the assumed carbon prices in 2030 are influencing the results.

Figure 31. Electricity generation by technology for the BAU, EnC, EnC_all and NDC_goal scenarios (GWh)

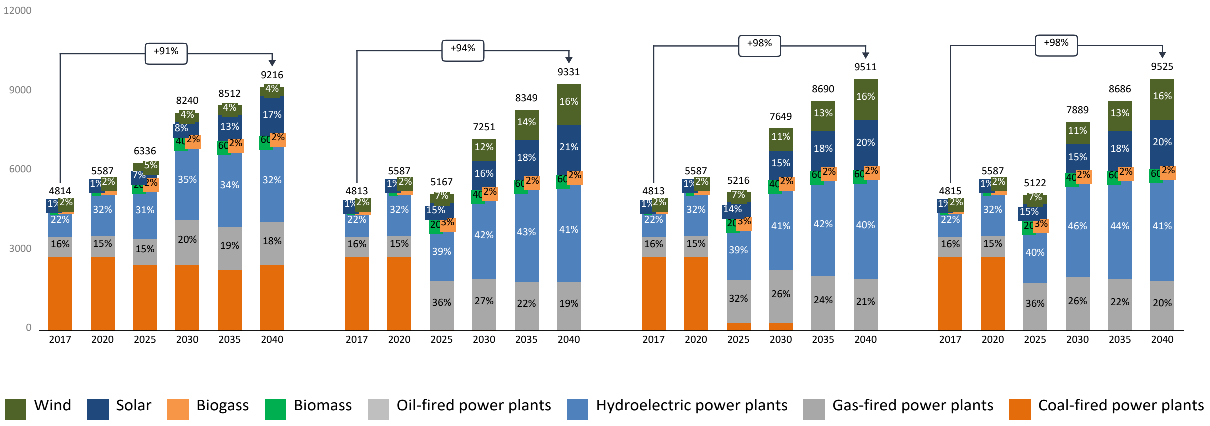


Figure 32. Energy Community CO2 study, projected electricity generation in Macedonia

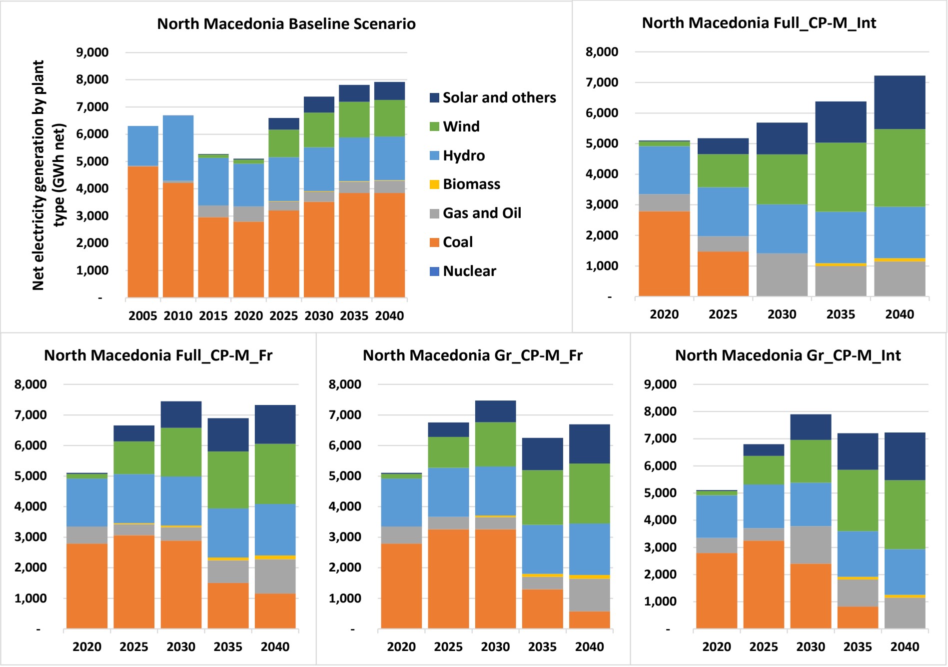


Figure 33. Projected net imports by scenarios in this study (GWh)

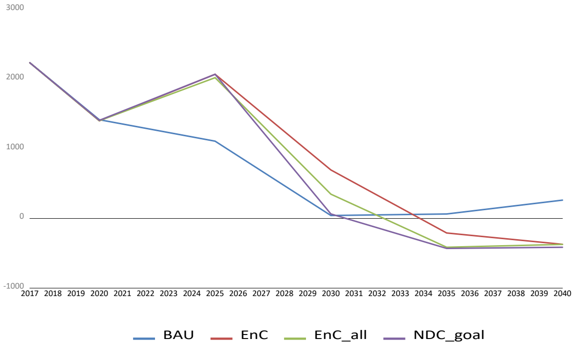
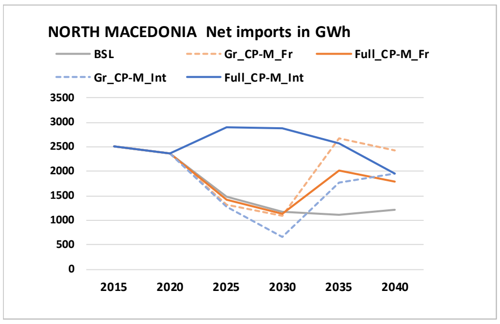


Figure 34. Energy community CO2 study, projected net imports (GWh)



6. Initial conclusions and recommendations for the design of a carbon tax in Macedonia

Initial conclusions and recommendations from the carbon tax in Macedonia study are described below.

6.1 The tax should include electricity and heat production, industry and transportation.

Including industry and transportation in the carbon tax (under the EnC-All scenario) will encourage improvements in industrial and transportation efficiency and yield additional emissions reductions as compared to the EnC scenario that only covers electricity and heat production. The EnC-All scenario also avoids sectoral distortions that can happen when only some sectors are covered by a carbon price. For example, when only electricity and heat production are covered by the tax, it appears that energy use and emissions shift from covered electricity and heat production sources to uncovered sources. This is evidenced by the reduced revenues from the electricity and heat production sector under the EnC as compared to the EnC-All scenario in Figure 32, and also by the slight increase in industrial sector emissions under the EnC scenario as compared to BAU.

6.2 The optimal level of the tax should balance ambition and cost

Considering the results of the NDC_goal scenario, the carbon price needed to realize the national NDC goal from just the electricity, heat, industry and transportation sectors was estimated at 73.3 Eur per ton in 2030. This tax level is substantially (over 2-3 times) higher than those modelled under the EnC and EnC_all scenarios and the related Energy Community analysis. In particular, it should be noted that the effort to reach the last 3 percentage point increment of GHG emissions reductions in 2040 comes at a very high incremental carbon price. This high price could be politically difficult and destabilizing.

It could make sense to set the tax rising to a level of 28 EUR per ton in 2030, which would come close to reaching the ambition modeled in the NDC_goal scenario. The last increment of emissions reductions could likely be achieved at a more manageable cost through policies and measures in other sectors. However, if the government wanted to reach the full level of the NDC with a carbon tax on the energy sector, the following design options could be considered to lower the cost of reaching the last increment of emissions reductions:

- Using a portion of the auction revenues to reduce emissions in uncapped sectors (e.g., forestry, agriculture, waste) up to the needed amount to meet the NDC;
- Using a portion of auction revenues to facilitate additional mitigation opportunities in the covered sectors (e.g., through investments in EV infrastructure) or to support industrial sectors to adopt innovative, low-carbon solutions;
- Allowing for a portion of compliance to be met via domestic and/or international offsets;
- Converting to a regionally-linked cap-and-trade program that would allow sources in Macedonia to purchase emissions reductions from lower-cost mitigation opportunities that may be available elsewhere in the region;

6.3 Dedicate a portion of the revenues to protect vulnerable consumers

Given the relatively large impact on electricity prices, even under the EnC-All scenario, at least a portion of the tax revenues collected should be directed towards helping vulnerable consumers, particularly those with low incomes and least able to afford an increase in energy costs. Funds could also be directed to weatherization and other measures that would ensure low income consumers can invest in efficiency solutions that would blunt the impact of higher energy prices.

6.4 Macedonia should work with neighboring countries to adopt a common carbon price

While the results suggest that Macedonia could adopt a lower carbon price (~8 EUR/ton) without prompting emissions leakage in the electricity and heat sectors, as shown in the sensitivity run without a border tax, a higher unilateral carbon tax has the potential to increase electricity and heat production from imported power in order to meet energy demand in Macedonia. The resulting increase in emissions could meaningfully compromise the overall emissions reductions achieved from the carbon tax while also reducing power and heat sales by domestic energy companies. In contrast, when a border tax was applied, representing what could happen when the countries in the region adopt the same carbon price path, the results suggest that any leakage would be much more modest, and could even be negative in the longer-term. Such scenarios suggest that when all countries in the region have a comparable carbon price, Macedonia will produce more clean renewable energy within its own borders. Accordingly, we recommend that Macedonia engage with other countries in the Energy Community to promote adoption of a common (or comparable) price path roughly consistent with the optimal levels identified above.

ANNEX I: Vulnerable consumers

The term “energy poverty” is not defined in the legislation in Macedonia, so the first objective of the NECP is to establish an appropriate definition in the adequate laws and bylaws.

25% of the population in Macedonia is unable to keep their homes adequately warm. With the aim to improve the situation, the Energy Law introduces a new program for vulnerable consumers. This program defines:

- the consumers belonging to the category of vulnerable consumers;
- the measures to be taken to protect vulnerable energy consumers, including energy consumption subsidies intended for households not provided for in the energy subsidy programme in accordance with the social security regulations;
- the measures for energy saving and energy efficiency improvement;
- the manner of implementation of the measures and the competent authorities responsible for their implementation;
- the measures taken by the energy distribution systems operators;
- the measures to be undertaken by the supplier with the obligation to provide a public service i.e. a universal service in the energy supply and
- the necessary funds and financing sources.

The program defines **vulnerable consumer** as a household:

1. that uses the guaranteed minimum assistance and makes a monetary allowance to cover part of the costs of energy consumption in the household in accordance with the Law on Social Protection;
2. in which a person lives in a state of social risk (motherhood, illness, old age, injury and disability) to which the power supply and/or the right to use the network are granted under special conditions and in the manner specified in a separate supply rules for the type of energy.

Additionally, this program defines three different categories of vulnerable consumers: vulnerable electricity consumer, vulnerable natural gas consumer and vulnerable heat consumer.

Vulnerable electricity consumer is a household that meets the requirements for vulnerable consumer and also:

1. is supplied by a supplier with an obligation to provide universal service in the supply of electricity;
2. electricity consumption annually does not exceed 3600 kWh,
3. electricity consumption is measured by a single-phase meter with a rated current on fuse or connection line of 25 A or a three-phase meter with a rated current on fuse or connection line of 16 (A)

Vulnerable natural gas consumer is a household that meets the requirements for vulnerable consumer and also:

1. is supplied by a supplier with an obligation to provide public service in the supply of natural gas; and

2. natural gas consumption for the months of October to March annually does not exceed 70 normal cubic meters.

Vulnerable heat consumer is a household that meets the requirements for vulnerable consumer.

We note that recent assessments conducted by the UNDP gender expert suggest that these definitions may miss or deemphasize certain categories of vulnerable consumers. For example, it is found that that single households are among the most vulnerable consumers, more precisely: single fathers, mothers, men 65+ and women 65+ with low incomes. Accordingly, the definition of vulnerable customers considered for carbon tax revenues could be broader than the one used in the NECP and/or better targeted to reach the groups most at risk.

Also, it may not be enough to simply offer assistance to vulnerable consumers; it is also essential to ensure that the benefits are well utilized and fairly applied. For example, according to the gender analysis of vulnerable populations and other persons, recipients of subsidies for pellet stoves, in absolute numbers, included: “Other Persons” (328 recipients are men, 16 are women) and “Vulnerable groups” (106 recipients are men, 4 are women). Learning from earlier programs, it could be important to incorporate gender considerations in the design of the program, and to avoid “first come, first served” approaches to distributing subsidies, which could lead to gender bias.

To ensure that vulnerable consumers are properly targeted in policy development and implementation, it will be important to track which consumers receive the assistance aimed at such customers. Up to 2020 there is no information about the number of vulnerable customers, so a key objective in 2021 is to develop a plan for indicators through which the households experiencing energy poverty will be monitored. In the future, based on the findings, programs could be regularly adjusted to ensure they are working as intended and applied in a fair manner, including consideration of gender.

(Note: This part is taken from the Final draft version National Energy and Climate Plan of the Republic of North Macedonia.)

ANNEX II: Description of the Energy Community Study scenarios

SCENARIOS	ACRONYM	AUCTIONING	MARKET INTEGRATION	CBAT	OTHER POLICIES
Baseline	BSL	NO	NO	NO	Opt-out applied, RES policies as BSL
Baseline with cross-border adjustment carbon tax	BSL_CBAT	NO	NO	YES	Opt-out applied, RES policies as BSL
Full Carbon Pricing and Market Integration	Full_CP-M_Int	FULL	YES	NO	Opt-out applied, RES policies enhanced
Full Carbon Pricing and Market Fragmentation	Full_CP-M_Fr	FULL	NO	NO	Opt-out applied, RES policies enhanced
Gradual Carbon Pricing and Market Integration	Gr_CP-M_Int	PARTIAL	YES	NO	Opt-out applied, RES policies enhanced
Gradual Carbon Pricing and Market Fragmentation	Gr_CP-M_Fr	PARTIAL	NO	NO	Opt-out applied, RES policies enhanced

Source: A carbon pricing design for the Energy Community, final study report 2020