The Strategy for Energy Development of the Republic of North Macedonia until 2040 (the Strategy) is prepared according to the requirements of the new Energy Law, which was adopted end of May 2018. Overarching goal of the Strategy is to provide an evidence-based policy in the energy sector through a robust analytical work and broad participatory consultation, which supports sustainable growth and is understood by all stakeholders and implemented by the Government of the Republic of North Macedonia. The Strategy provides a platform for the overall energy sector modernisation and transformation in line with EU energy trends, contributing to increased access, integration and affordability of energy services, reduction in local and global pollution, and increased private sector participation, while considering North Macedonia's development potential and domestic specifics. Having said that, the Strategy integrates climate and environmental aspects of the energy sector, while proposing an affordable, reliable and sustainable energy for the future. In parallel, a Strategic Environmental Assessment (SEA) is developed as a separate document to assess environmentally viable and sustainable options for achieving the goals.

The Government, represented by the Cabinet of the Deputy Prime Minister responsible for economic affairs, and the relevant Ministries: Ministry of Economy and Ministry of Environment and Physical Planning, have demonstrated clear requirement for the development of the Strategy. In addition, other energy stakeholders comprising energy regulators, energy associations and energy utility companies (both public and private) have been actively engaged and the Energy Community Secretariat regularly updated through the overall process of Strategy development. In order to have a transparent and comprehensive process, as well as to gain public and NGO understanding, a representative group of NGOs was involved.

Technical work of the Strategy was carried out by PricewaterhouseCoopers (PwC), Strategy& (part of PwC network) and the Research Centre for Energy and Sustainable Development of the Macedonian Academy of Sciences and Arts (MANU) in North Macedonia. The project followed an inclusive process via stakeholder inputs and facilitated workshops that created strong ownership over the Strategy and resulted in aligned view across the entire energy value chain. The stakeholders participated in identifying issues, approving methodologies, establishing objectives, reviewing and discussing findings.

This project has been developed under the Good Governance Fund (GGF) program funded by the United Kingdom Government.

British Embassy Skopje Funded by UK Government	*This product is prepared within the programme* *Good Governance Fund (GGF) funded by the UK Government with the support of the British Embassy Skopje. The content of this publication does not necessarily reflect the position or the opinions of the UK Government.* *Овој производ е подготвен во рамки на проектот* *Good Governance Fund (GGF) финансиран од Владата на Обединето Кралство, со поддршка на Британската амбасада Скопје. Мислењата и ставовите наведени во оваа содржина не ги одразуваат секогаш мислењата и ставовите на Британската Влада.* *Ky produkt është përgatitur në kuadër të programit* *Good Governance Fund (GGF) i financuar nga Qeveria e Mbretërisë së Bashkuar me mbështetjen e Ambasadës Britanike Shkup. Përmbajtja e këtij publikimi nuk pasqyron domosdoshmërisht qëndrimin ose mendimet e Qeveria e Mbretërisë së Bashkuar.*

Based on the Article 11 paragraph (1) of the Energy Law (Official Gazette of the Republic of Macedonia" No. 96/18 and "Official Gazette of the Republic of North Macedonia No.96/19), the Government of the Republic of Macedonia, at its session held on 28.12.2019, adopted the following

STRATEGY

FOR ENERGY DEVELOPMENT OF THE REPUBLIC OF NORTH MACEDONIA UP TO 2040

EXECUTIVE SUMMARY

The Energy Development Strategy for the Republic of North Macedonia until 2040 provides the directions for development of the energy sector in North Macedonia, taking into account the energy policy trends at global and European level, and particularly in the framework of the Energy Community. Energy trends are emphasizing more ambitious transition towards low-carbon economy, with renewable energy sources (RES, the list of abbreviations is given in Appendix 3 which is an integral part of this strategy) and energy efficiency (EE) among the most important enablers of transition. The Strategy follows good practices of EU RES and EE policies, as well as decarbonisation, taking into consideration targets and trajectories with realistic dynamics that are adjusted to domestic specifics and priorities of the Government of the Republic of North Macedonia.

The Strategy paves the way for achieving the following 2040 vision:

Secure, efficient, environmentally friendly and competitive energy system that is capable to support the sustainable economic growth of the country.

The Strategy defines six strategic goals for North Macedonia, mapped along five energy pillars, and as such it is in line with the five dimensions of EU Energy Union. These strategic goals have an important role in energy system planning and can be achieved with different approaches.

The Strategy has been developed on the following basic inputs, assumptions and principles:

1. Average annual GDP growth rate of 3.3%, positioning North Macedonia in 2040 at today's level of GDP per capita of the Central and East European countries.
2. Least cost principle of the total energy system, taking into account investments, transmission, distribution and delivery costs, fuel prices, CO_2 price as well as different support mechanisms and policies.
3. Introduction of carbon price in different year for different scenario, which will gradually reach the Emission Trading System (ETS) level. Also, depending on scenarios, different WEO 2017 projections of CO_2 price are used, with most progressive in the Green scenario.

The modelling is conducted using two software tools - MARKAL and Power2Sim. The objective of the MARKAL model is to define the optimal development of the overall energy system in North Macedonia based on least cost principle, while the Power2Sim model is used to deep-dive and to confirm the electricity market results of the more comprehensive energy market model MARKAL.

In order to achieve the 2040 vision the Strategy defines three scenarios – Reference, Moderate transition and Green scenarios (Figure 0.2).

Figure 0.1 Overview of scenarios for the development of North Macedonia energy system until 2040

	Reference scenario	Moderate Transition scenario	Green scenario
Vision	**Transition from conventional energy based on current policy and least cost principles**	**Progressive transition from conventional energy based on new policy and least cost principle**	**Radical transition from conventional energy based on new policy and lignite phase out**
Assumption highlights: Demand drivers	• Macedonian GDP growth to reach neighboring EU countries' GDP per capita levels of today by 2040 • Current energy efficiency policies • Penetration of EVs	• Same GDP growth as for reference • Energy efficiency based on enhanced policy (in line with EU Directives / EnC guidelines) • Higher penetration of EVs	• Same GDP growth as for reference • Same as moderate transition but more incentives and advanced technologies • Highest penetration of EVs
Generation investments focus	• Lignite PP revitalization choice based on least cost principles • High focus on RES	• Lignite PP revitalization choice based on least cost principles • Further focus on RES technology investments	• Lignite PP revitalization choice based on least cost principles • Extreme focus on RES investments
Carbon price at ETS level	2027	2025	2023
Commodity prices (WEO 2017)[1]	Based on current policies scenario	Based on new policy scenario	Based on the sustainable development scenario
Fuel Supply / Availability	• Lignite production capped at a maximum level of annual supply expected (~ 5 M tons 2018-2035, ~ 3 M tons 2035-2040) • Hydro production and wind/solar in line with historical trends and adjusted for new entering power plants • Cross Border Capacities (electricity and gas) evolution in line with the ENTSO-E, ENTSO-G and EnC • Sustainable consumption of biomass[2] • Battery storage (EVs and pump storage)		

Source: Project team analysis

The Strategy evaluates the results of the strategic goals (Figure 0.2) via six linked indicators for each strategic goal. The integrated energy results show a progressive energy transition towards 2040 for all three scenario (Figure 0.3).

Figure 0.2 Strategic goals and scenario results in 2040

Energy pillar	Indicator	STRATEGIC GOALS	Metric
1 Energy efficiency	Energy efficiency	**Maximize energy savings**	• Reduction of primary and final energy consumption vs. BAU scenario
2 Integration and security of energy markets	Energy dependence	**Maintain current energy dependence around today's level (54% net import), while improving overall integration in European markets**	• Net import share in primary energy consumption
3 Decarbonisation	GHG emissions	**Limit the increase of GHG emissions**	• Absolute amount of GHG emissions (CO_2, CH_4 and NO_2) vs. BAU scenario and vs. 2005
	RES share	**Strongly increase RES share in gross final consumption from today's level (19% of RES) in a sustainable manner**	• RES share (heating & cooling, electricity, transport) in gross final energy consumption
4 R&I and competitiveness	Total system costs	**Minimize system costs based on least cost optimization**	• System costs per annum & cumulative in euros incl. overall annualized investments, O&M costs, delivery costs & fuel supply costs
5 Legal & regulatory aspects	Legal & regulatory compliance	**Ensure continuous harmonisation EnC acquis and its implementation**	• Harmonisation of national legislation with EnC acquis and its implementation in practice

Figure 0.3 Summary of integrated energy results in 2030 and 2040

Energy pillar	Indicator	Metric	Year 2030			Year 2040		
			Reference	Moderate Transition	Green	Reference	Moderate Transition	Green
1 Energy efficiency	Energy efficiency	% reduction of primary & final energy consumption vs. BAU	-15.3% primary -10.3% final	-31.2% primary -16.6% final	-34.5% primary -20.8% final	-34.9% primary -14.2% final	-47.9% primary -21.7% final	-51.8% primary -27.5% final
2 Integration and security of energy markets	Energy dependence	% of net import in primary energy consumption	48.7%	61.9%	59.1%	51.0%	61.9%	55.3%
3 Decarbonisation	GHG emissions	% reduction vs. 2005 and vs. BAU	-20.9% -22.9% vs. BAU	-57.2% -58.3% vs. BAU	-64.7% -65.3% vs. BAU	-8.1% -35.6% vs. BAU	-43.3% -60.2% vs. BAU	-61.5% -72.8% vs. BAU
	RES share	% of RES in gross final energy consumption	33%	38%	40%	35%	39%	45%
4 R&I and competitiveness	Total system costs	Bn. EUR in 2030 and 2040 with cumulative	3.8 41.0	3.3 38.3	3.2 37.3	5.1 86.5	4.8 81.2	4.5 78.1
5 Legal & regulatory aspects	Legal & regulatory compliance	EnC acquis harmonisation & implementation	Full compliance			Full compliance		

Source: Project team analysis

In terms of EnC indicative 2030 targets, the Strategy is on the way to achieve them (Figure 0.4).

Figure 0.4 Summary of results vs. indicative 2030 EnC targets

Energy pillar	Indicator	Year 2030 (relative terms)				Year 2030 (absolute terms)			
		EnC target	Reference	Moderate Transition	Green	EnC target	Reference	Moderate Transition	Green
1 Energy efficiency	Energy efficiency	-32.5% primary OR final vs. BAU	-15.3% primary -10.3% final	-31.2% primary -16.6% final	-34.5% primary -20.8% final	2,862 ktoe primary 1,996 ktoe final	2,975 ktoe primary 2,301 ktoe final	2,414 ktoe primary 2,138 ktoe final	2,300 ktoe primary 2,030 ktoe final
3 Decarbonisation	GHG emissions	+13% vs. 2005	-11.4% (-20.9%)	-37.6% (-57.2%)	-43.0% (-64.7%)	14.7 Mt CO_2-eq	11.5 Mt (7.4 Mt) CO_2-eq	8.1 Mt (4.0 Mt) CO_2-eq	7.4 Mt (3.3 Mt) CO_2-eq
	RES share	33.9% at least	33%	38%	40%	n/a	n/a	n/a	n/a

Results vs. EnC targets EnC 2030 achieved; EnC 2030 almost achieved; EnC 2030 not achieved; Targets not available

Note: The indicative 2030 EnC targets have not been formally adopted during the process of development of the Strategy. The GHG emissions target defined in the EnC Study is economy-wide (covering all IPCC sectors - Energy, IPPU, Waste and Agriculture excluding FOLU), and for North Macedonia it reads: in 2030 13% increase of total GHG emissions compared to 2005 emission level. In our Strategy only Energy sector is targeted, so in order to compare EnC GHG target and the Strategy consistent economy-wide target, it is assumed that emissions in all sectors except Energy in 2030 will increase for 13% compared to 2005. The upper values of GHG emissions correspond to Strategy consistent economy-wide figures, while the numbers in brackets correspond to Energy sector figures. RES share results include heat pumps

Source: Project team analysis

The Strategy provides a roadmap, which for each strategic measure and policy specifies the level of priority per scenario, the estimated time frame for implementation and the responsible administrative level for implementation. Each scenario has different set of policies and strategic measures how to achieve the strategic goals. Developed policies and strategic measures are categorized along five energy pillars and provide answers how to tackle current specific challenges and leverage on new opportunities. In addition, they are also in line with the priorities stipulated from the Energy Law in order to emphasize their relevance and contribution.

1. **Energy efficiency: the Strategy maximizes energy savings up to 51.8% of primary and 27.5% of final energy in the Green scenario in 2040**. In the period up to 2017, a decreasing trend can be noticed in the primary energy consumption with final energy consumption remaining stable. In the Energy efficiency pillar, the Strategy recommends:

   - ***Maximizing energy efficiency policies and measures*** in the sectors buildings, public, industry, transport, heating and cooling, transformation, transmission, distribution and demand response, as well as horizontal measures. All these policies and measures directly impact emission reductions, decrease import dependence, and stimulate domestic economy with local job opportunities. In all three scenarios, North Macedonia will use less resources to cover the same needs, which leads to decoupling of consumption from GDP starting from 2020.
   - ***Adopting the Decree on setting the national EE targets for 2030***, as stipulated in the Energy Efficiency Law, taking into account the Strategy results.
   - ***Expressing the EE targets relative to the primary energy savings***. The decrease of coal consumption, as well as the overall improvement of EE at the supply side contribute to the biggest energy savings in the Moderate transition and Green scenario.
   - ***Continuously reducing the losses in distribution network*** which will alleviate additionally the primary energy consumption.
   - ***Improving the efficiency of the district heating systems***, via systematic reconstructions of distribution network, reconnection of disconnected consumers, as well as attracting new consumers.
   - ***Monitoring of all planned EE measures*** and further stimulation of those with highest impact on energy consumption.

2. **Integration and security of energy markets**: **the Strategy is aiming to ensure that North Macedonia is more integrated into European markets, without increase in the energy dependence, and to provide necessary flexibility for higher RES integration.** Current electricity consumption relies on ~30% import, with the rest supplied from domestic generation capacities, mainly lignite fired thermal power plants (TPP Bitola and TPP Oslomej) and large hydro power plants. Both thermal power plants are relatively old and face challenges of future coal supply. In the Integration and security of energy markets pillar, the Strategy recommends:

   - ***Implementing new interconnection with Albania and continuous investments in the transmission and distribution network*** for:
     - higher RES integration for electricity production, especially from wind and solar,
     - enabling prosumer mechanism,
     - higher penetration of electric vehicles,
     - meeting the growing electricity demand in the region in all three scenaros.
   - ***Establishing of organised day-ahead market in North Macedonia, coupling with Bulgarian market and participation in initiatives for establishment of regional market.*** Import price was used as control mechanism whether to build or revitalize domestic generation capacities.
   - ***Revitalization of TPP Bitola but only in the Reference scenario***, with required preconditions to open new Zivojno mines and securing continuous coal supply at competitive price.
   - ***Decommissioning of TPP Bitola in Moderate transition and Green scenarios***, which is being supplemented with a combination of new RES and gas fired capacities.
   - ***Decommissioning of TPP Oslomej in all three scenarios***. Construction of solar power plant (80 – 120 MW) which will use the same infrastructure (site and transmission network) and employees is planned in the series of transformation measures. The same approach could be applied for TPP Bitola.
   - ***Monitoring and adjusting of the investment plans***, to avoid the risk of stranded and underutilised assets given the expected trends - local pollutants requirements and potential CO_2 price.
   - ***Developing programs for socially responsible and just transition*** to mitigate negative effects of associated job losses, redeploying employees and stimulating new job opportunities in low carbon technologies and services.
   - ***Managing system flexibility*** by establishing a balancing mechanism in short run, SMM control block for cross-border balancing, as well as usage of existing and construction of new plants (e.g. storage hydro, hydro-pumped storage and gas fired capacities) in medium and long term. Usage of demand response options will be also important in the future (vehicle-to-grid, power-to-heat and battery storage).
   - ***Developing regulatory framework and support of relevant public institutions*** that can indirectly contribute to new investments in distribution network and behind the meter service.
   - ***Implementing the planned natural gas interconnections*** with Greece and other countries, as well as the gasification plan. With this, it is anticipated that the natural gas as a transition fuel until 2050, combined with RES, will play an important role in replacing coal used for power generation and industry in the Moderate

transition and Green scenarios. New cross-border infrastructure will diversify supply routes and increase market competitiveness of natural gas.

- ***Enabling infrastructure for stock keeping petroleum products.***

3. **Decarbonisation: In the Green scenario in 2040 the Strategy decreases GHG emissions up to 61.5% vs. 2005 or 72.8% vs. BAU, while strongly increasing the usage of RES in a sustainable manner up to 45% in gross final energy consumption.** Even though North Macedonia has lower GHG emissions per capita by ~30% compared to EU, the GHG emissions per GDP are five times higher than EU in 2014. Two thirds of overall GHG emissions come from energy sector fuel combustion, with energy transformation, industry and transport sub-sectors having the highest share. Since Moderate transition and Green scenario show coal phase out after 2025, introduction of carbon price should be seen as a key strategic measure to tackle CO_2 reduction in the electricity and heat production. In the Decarbonisation pillar, the Strategy recommends:

    - ***Promoting the use of RES in a manner that provides sustainable energy development.*** RES share in the gross final energy consumption increases in all scenarios, landing in the range of 35 – 45% in 2040. The PV and wind power plants will be the fastest growing technologies for electricity generation, in all scenarios (up to 1,400 MW PV and 750 MW wind), while construction of new small hydropower plants should be carefully assessed to avoid the impact on environment compared to benefits of generated electricity.
    - ***Financially supporting RES electricity generation*** via feed-in tariffs and feed-in premiums with auctions (granted in a tendering procedure) in all three scenarios, particularly for period 2020 – 2025.
    - ***Electrifying the heating & cooling sector*** using more efficient heat pumps and district heating fuelled by CHP on gas and biomass (including residual biomass). Utilization of large heat pumps, waste heat and thermal storage capacities in central heating systems. The electrification in combination with EE measures will enable a gradual replacement of current inefficient biomass usage.
    - ***Promoting combined systems for hot water*** utilising district heating, electricity and solar thermal systems.
    - ***Increasing the share of biofuels to 10% until 2030 and boosting the electric vehicles***. Financial incentives for purchase of such technologies are foreseen, as well as developing of the required infrastructure at national and local levels.
    - ***Enhancing the role of municipalities and the City of Skopje in energy planning*** to provide effective transposition of national policies at local level (e.g. more RES and EE, prosumers, local pollutants, etc.).
    - ***Installing local pollutants control equipment*** to meet the requirements from Large Combustion Plants Directive and Industrial Emissions Directive in case of TPP Bitola revitalisation.

4. **R&I and competitiveness: the Strategy minimizes total system costs based on least cost optimization taking into consideration country specific situation.** In the R&I and competitiveness pillar, the Strategy recommends:

    - ***Streamlining energy transition technologies into national R&I priorities***, and stimulating cooperation among research centres (institutes, universities, development units, etc.) and policy makers, industry, utilities, municipalities and associations.
    - ***Adjusting energy related curricula at all educational levels***, as well as stimulating researchers' geographical and inter-sectoral mobility.
    - ***Stimulating new services and jobs, especially for small and medium enterprises (SMEs)*** in field of RES and EE. North Macedonia has a positive business environment which is a very good precondition for supporting such SMEs in boosting new investments, reducing unemployment and stimulating overall growth. However, additional provision of financial and technical assistance for SMEs in the energy sector is needed in order to facilitate the access of enterprises to external services.
    - ***Revising the business models of ESM and other key energy companies with support from the Government*** in order to cope with the challenges related to decarbonisation and liberalisation of the energy and to ensure competitiveness in the future.
    - ***Increasing the competencies in pulling international donor funds***. Primarily, this holds for the responsible ministries which have to ensure effective units that will be involved in planning, managing, monitoring and evaluation of the donor projects. This will enable utilization of the largely underspent funds from international donors and financial institutions which the country is eligible for, including the funds related to Paris Agreement.

5. **Legal and regulatory aspects**: **the Strategy emphasizes full compliance with EnC acquis.** The adopted Energy Law in 2018 transposed the Third Energy Package in the electricity and natural gas sector, as well as RES Directive. In terms of EE, relevant obligations under the EnC Treaty to ensure compliance with the EE acquis are in different levels of implementation. In the Legal and regulatory aspects pillar, the Strategy recommends:

    - ***Adopting the new Energy Efficiency Law, as well as all bylaws***.
    - ***Implementing four EnC Climate Action Group topics*** – Monitoring Mechanism Regulation, mainstream climate related obligations across sectors, Integrated National Energy and Climate Plans as well as setting 2030 targets (and possibly beyond). Continuation of the work of the Climate and Energy Working Group to ensure better collaboration among institutions and more effective decision making.

- ***Implementing the EnC environmental acquis***, which includes:
    - Putting in practice the Large Combustion Directive
    - Adopting the Law on Control of Emissions from Industry, as well as transposition and implementation of relevant requirements of the Industrial Emissions Directive (with a deadline 1 January 2028 for the existing plants).

In order to achieve a cost competitive transition, the system would need cumulative overnight capital investments ranging 9.4 – 17.5 billion EUR until 2040, depending on selected scenario. Energy efficiency and RES investments are the main focus of all scenarios, which opens great opportunity to benefit from increasing access of funds that recognize the importance of energy transition projects - primarily EU funds as well as international financial institutions and donors. The national budget will also have a role as an important financing option for RES and EE projects, as well as revitalization of TPP Bitola. The Green scenario is most cost-effective scenario. The cumulative savings in the Moderate transition scenario are estimated at 5.4 billion EUR, while in the Green scenario the estimate is at 7.4 billion EUR.

From the scenarios realisation perspective, the critical year is 2025, and the decision on what will happen in this year should be made in 2020 or 2021 at latest. This requires immediate actions from the relevant energy stakeholders to start activities at all governance levels. The Strategy recommends to establish a Steering Committee, chaired by the Deputy Prime Minister of Economic Affairs that would be responsible for its implementation. As a first step, the Government needs to prepare a Programme for realization of the Strategy, based on one of the scenarios, within six months from the day of adoption of the Strategy.

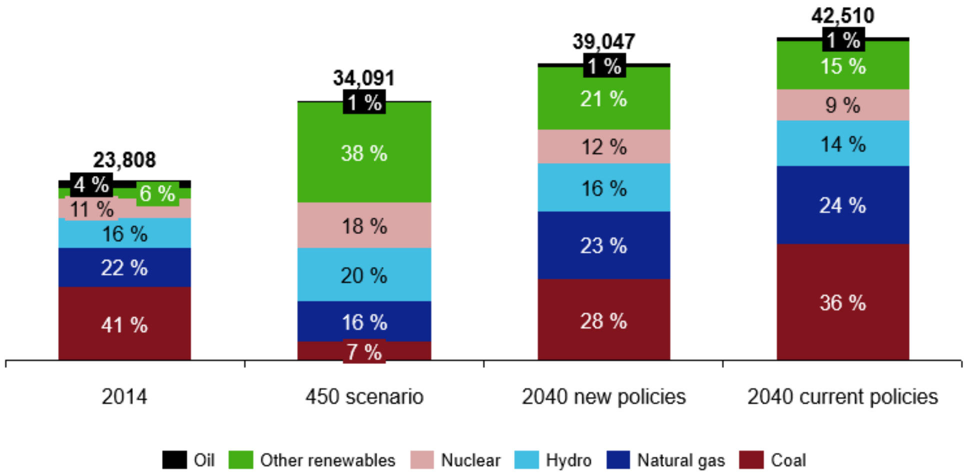
1 CONTEXT FOR MACEDONIAN ENERGY STRATEGY UNTIL 2040

1.1 Relevant global energy trends

Global energy trends are putting emphasis on climate change and resource scarcity. Parallel with growth of global demand for affordable and reliable energy, the world is transitioning to a low carbon energy. After signing the Paris agreement, world energy industry has started to change. Natural gas pushed coal as a cleaner energy source, while at the same time renewable energy showed rapid growth as part of world energy transformation. It is expected that the countries will formulate progressively more ambitious climate targets to keep global warming goal well below 2°C and to pursue efforts to limit the temperature increase to 1.5 °C.

Efficient use of energy and renewables are the cornerstone of energy transition. Zero carbon fuels are expected to have a much more significant role in the future primary energy consumption, with renewable energy sources (RES) winning growth race. According to IEA (Figure 1.1), Scenario 450 assumes more efficient use of energy and more RES that will result in significantly less coal consumption compared to 2014, and according to IPCC (International Panel of Climate Change), global community will meet its minimum commitment under the Paris Agreement (keep global warming to a limit of 2°C). The New Policies Scenario is a scenario that projects future trends on the basis not only of existing legislation but also takes into account the commitment of governments and regional economic organisations to transform their energy policies in the period up to 2040. Current Policies Scenario projects future trends on the basis of existing legislation, and assumes no significant changes to global policies on renewables, climate change, fossil fuels, technology investment, etc.

Figure 1.1 World energy generation by source, 2014 – 2040, TWh



Source: IEA World energy outlook, Project team analysis

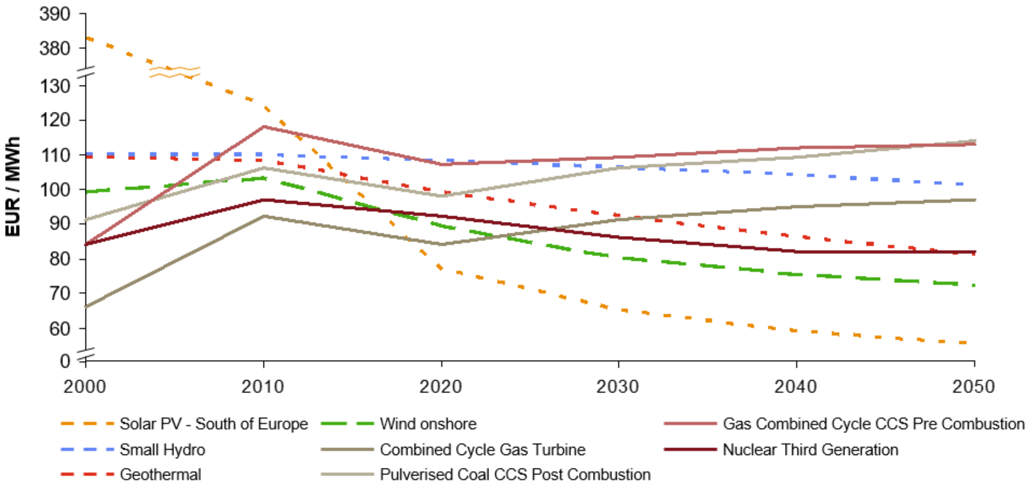
Nevertheless, there is much to do according to latest IPCC, which in 2018, presented four different possible scenarios to keep earth warm beyond 1.5 °C:

1. Radical change: energy demand decreases dramatically driven by society, business and technology change, achieving almost carbon free society until 2050. Apart from changed agricultural techniques and reforestation, no carbon removal is needed;
2. Improved sustainability: a world focuses on sustainability that keeps energy demand stable despite economic growth, and enables a broad shift to RES with usage of carbon capture technologies to compensate for the remaining emissions;
3. Managed growth: societal and technological progress continues in line with historical trends, where energy demand continues to rise, but at a moderate pace, with emissions being primarily reduced by shifting to renewables;
4. Intensive economy: the world economy grows rapidly consuming energy at a torrid pace, where high demand for transport and livestock keeps emissions high, while technological improvements and aggressive use of carbon capture and removal technologies keep net emissions in check.

Technological advancement will accelerate energy transition. Technology advancement is based on new developments that focus on energy efficiency improvements, low carbon technologies and energy storages. Intensive energy efficiency improvements will slow down the energy demand leading to 20% energy savings (450 Scenario vs. Current policy scenario, Figure 1.1) achieving decoupling of GDP and energy consumption with different intensity for developed and developing countries. The rapid implementation of renewable energy capacity across the globe, notably wind and solar PV, will enable greater role of renewable energy in global energy mix. With such a share of renewables, electricity storage will have an enhanced role in the energy systems.[1]

Decreasing cost of renewable technology for electricity production is becoming competitive to traditional energy sources. Since 2009, levelized cost of electricity for solar PV and wind has fallen almost for 70% and 20% respectively. According to the EU Reference Scenario, the electricity from renewable energy will be cheaper than conventional energy (Figure 1.2).

Figure 1.2 Levelized costs for electricity generation technologies, 2000 – 2050



Source: EU Reference Scenario 2016, Project team analysis

New energy trends require innovation, agility and new business models throughout the entire value chain. According to a survey conducted by the consulting company PwC, more than 70% of CEOs of the energy companies in Europe believe that the existing business models are not sustainable. Likewise, it has been agreed that the changes in the business models should be introduced gradually, yet continuously, because the energy sector transformation is complex and affects a number of economic and social factors. New trends have already begun by switching focus from traditional centralised generation to behind-the-meter services and distributed generation (Figure 1.3).

Figure 1.3 Changes throughout the value chain

	Generation	Transmission	Distribution	Metering	Retail	Behind the meter (BTM)	Distributed generation
Revenue of traditional utilities %	***30 – 40***	***15 – 20***	***40 – 50***	***0 – 10***	***0 – 5***	***0 –2***	***0 – 2***
Change drivers	• Falling demand & significant overcapacity • Low plant utilization • Investments in renewable	• Network investments • Regulatory pressures on allowed revenue • Consumption decline • International inter-connections • Renewables integration • Strategic role of DSOs		• Smart meters • AMI services • Analytics • Technical and regulatory discussion regarding operating models (ex. multiservice)	• Price pressures • „Self-service" • New energy services	• Smart grid services • New IT services • Lease & installation of equipment for distributed generation & batteries • „Energy management" • „Demand management" • Holistic services („smart home")	
Change direction	↓	↓	↓			↑	↑
Future revenue structure (%)	***20 – 30***	***10 – 15***	***20 – 30***	***5 – 15***	***5 –10***	***0 –10***	***15 –20***

Source: Project team analysis

[1] Electricity storage and renewables: cost and markets to 2030, IRENA

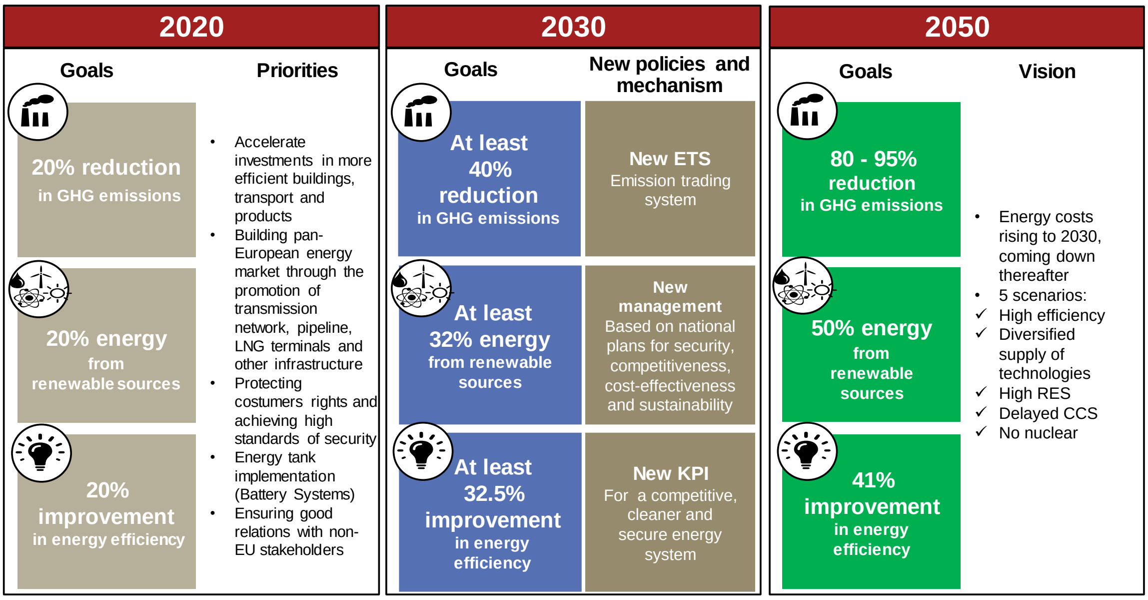
1.2 EU targets and trends

European energy union is a European Union's project that is ensuring transit to a low-carbon and competitive economy. Faced with uncertain energy demand, volatile prices, disruptions in network and most important, climate change, European Union has set an ambitious climate policy and has adopted the Energy Union Strategy based on five closely related pillars and mutually reinforcing dimensions:

1. **Security, solidarity and trust:** diversifying Europe's sources of energy and ensuring energy security through solidarity and cooperation among Member States;
2. **A fully integrated internal energy market:** enabling a free flow of energy throughout the EU through adequate infrastructure and without any technical or regulatory barriers;
3. **Energy efficiency:** improved energy efficiency will reduce dependence on energy imports, reduce emissions, and drive jobs and growth;
4. **Climate action – decarbonizing the economy:** actions include policies to be RES leader, European trading scheme (ETS), national targets for sectors outside the ETS, a roadmap towards low emission mobility;
5. **Research, innovation and competitiveness:** supporting breakthroughs in low-carbon and clean energy technologies by prioritising R&I to drive the transition and improve competitiveness.

As part of its long-term energy strategy, the EU has set targets for 2020 and 2030. These cover GHG emissions reduction, improved energy efficiency, and an increased share of renewables. EU has also created an Energy Roadmap for 2050, in order to achieve its goal of reducing GHG emissions by 80-95% compared to 1990 levels (Figure 1.4). It is important to note that if the EE and RES targets are fully implemented by 2030, the reduction of GHG emissions in 2030 will be much steeper (almost 45% vs. current target of 40%) compared to 1990.

Figure 1.4 Key characteristics and direction of energy policy

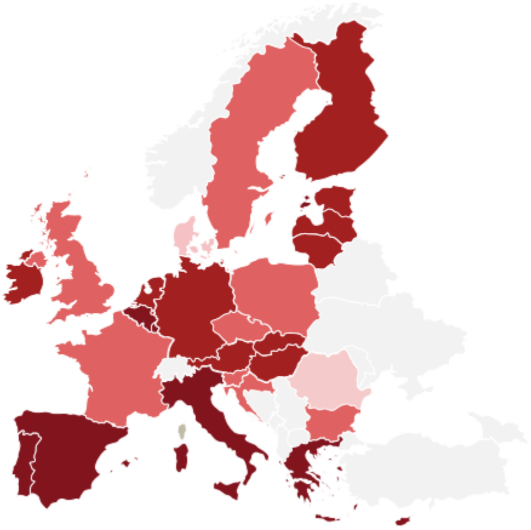


Source: European Commission, Project team analysis

1.2.1 Security, solidarity and trust

All countries in European Union are exposed to certain level of risk considering the security of supply. The key drivers of energy security are the completion of the internal EU energy market, more transparency and solidarity among the Member States, as well as more efficient energy consumption. Diversification of energy sources, suppliers and routes is crucial for ensuring secure and resilient energy supplies to European citizens and companies, who expect access to affordable and competitively priced energy at any time. In the period 2000 - 2016 primary energy production reduced for almost 20%, while at the same time the primary energy consumption reduced by around 5%. In 2016, the EU's dependence on primary energy import amounted 55%, especially fossil fuels (60% oil and 30% natural gas) putting pressure on security of supply (Figure 1.5). This holds true for every Member State, however it is more emphasized in less integrated and connected regions such as the Baltic and Eastern Europe. Six member states (Bulgaria, Estonia, Finland, Slovakia, Latvia and Lithuania) are 100% dependent on a single natural gas source of supply from Russia, while three member states (Estonia, Latvia and Lithuania) are dependent on external electricity system operator.

Figure 1.5 Energy net import of EU-28 countries, 2016



Note: The dependency rate shows the extent to which an economy relies upon imports in order to meet its energy needs. It is measured by the share of net imports (imports - exports) in primary energy consumption
Source: Eurostat; European energy security strategy; Project team analysis

EU tackles the challenge of security of supply by developing solidarity mechanisms, physical infrastructure and harmonizing the external energy policies. One of the measures is to strengthen the emergency / solidarity mechanism with focus on crude oil and petroleum products reserves, prevention and mitigation of natural gas supply risk, physical protection of critical infrastructure and introduction of solidarity mechanisms among Member States. Second priority area includes diversification of natural gas import sources via pipelines and LNG, as well as diversification of supply of nuclear fuel for electricity generation. Third set of measures is to have one voice in external energy policies that are fully compliant with EU legislation and EU security of supply policy, as well to use EU political level engagement to support commercial deals in the field of energy, especially natural gas.

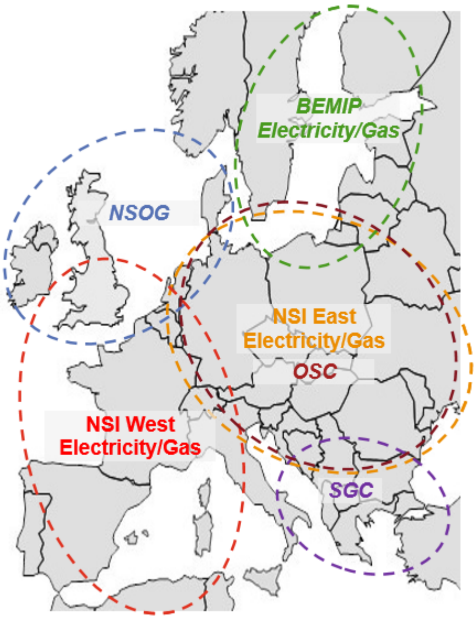
1.2.2 A fully integrated internal energy market

EU has adopted TEN-E policy and is financing Projects of Common Interest which will help Europe to achieve integrity. The TEN-E framework is focused on six regions, which cover electricity, natural gas and oil infrastructure (Figure 1.6). Every two years since 2013, the European Commission prepares a list of Projects of Common Interest (PCIs) that are the key cross border infrastructure projects linking the EU energy systems. The latest third PCI list comprises of 173 projects: 106 electricity transmission and storage, 4 smart grid deployment, 53 gas, 6 oil and 4 cross-border carbon dioxide network.

Integrated electricity market enables lowering of wholesale electricity price and cooperation among countries in case of crisis. EU sets electricity interconnection target to assure electricity network development so that each country should have in place electricity cable capacities that allow at least 10% of the electricity produced by its power plants to be transported across its borders to neighbouring countries. 17 Member States have already reached this target.

Further development and integration of natural gas network in Baltic and South East Europe is needed. Besides the development of critical infrastructure, the network codes are needed to regulate the cross border trade and use of infrastructure.

Figure 1.6 Trans – European Network for Energy (TEN-E)



North Seas offshore grid (NSOG)
- Integrated offshore electricity grid development and related interconnectors in the North Sea, Irish Sea, English Channel, Baltic Sea and neighboring waters

North-south electricity/gas interconnections in western Europe (NSI West Electricity/Gas)
- Interconnections between EU countries in this region and with the Mediterranean area including the Iberian peninsula
- Gas infrastructure for regional connections between and within the Baltic Sea region, Adriatic and Aegean Seas, eastern Mediterranean Sea

Baltic Energy Market Interconnection Plan in electricity/gas (BEMIP Electricity/Gas)
- Interconnection and strengthening of internal grid and gas infrastructure, to end the energy isolation of the Baltic States

North-south electricity/gas interconnections in central eastern and south eastern Europe (NSI East Electricity/Gas)
- Interconnections and internal lines in north-south and east-west directions to complete the EU internal energy market and integrate renewable energy sources
- Gas infrastructure for regional connections between and within the Baltic Sea region, Adriatic and Aegean Seas, eastern Mediterranean Sea and Black Sea, and for enhancing diversification and security of gas supply

Southern Gas Corridor (SGC)
- Infrastructure for the transmission of gas from the Caspian Basin, Central Asia, Middle East and eastern Mediterranean Basin to the EU to enhance diversification of gas supply

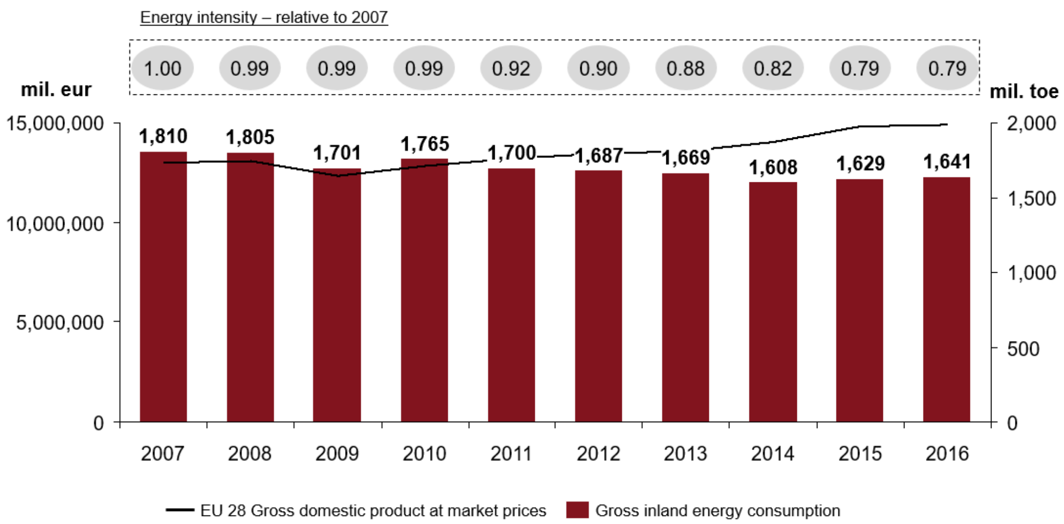
Oil supply connections in central eastern Europe (OSC)
- Interoperability of the oil pipeline network in central eastern Europe to increase security of supply and reduce environmental risks.

Source: European Commission, Trans – European networks for Energy

1.2.3 Energy efficiency

Energy efficiency measures lead to reduction of energy intensity. Gross inland energy consumption is decoupling from GDP, resulting in less energy intensity on the EU level that has decreased by 21% in 2016 compared to 2007 levels (Figure 1.7). The highest energy savings were achieved in industry and household sectors, while savings in service, transport and electricity & heat generation sector were less impactful. Since heating and cooling sector account for ~50% of EU energy consumption, the Commission in 2016 proposed a Strategy to make heating and cooling more efficient and sustainable. On top, there are three main directives that promote the usage of energy efficiency measures: Energy Efficiency, Energy Performance of Buildings and Eco Labelling.

Figure 1.7 EU energy consumption and GDP



Source: Eurostat Complete energy balances - annual data; Eurostat - primary domestic product at market prices; Project team analysis

1.2.4 Climate action – decarbonizing the economy

Emissions Trading System (ETS) and effort sharing mechanism are the main measures to reduce GHG emissions. In order to fulfil the obligations for GHG emission reduction, EU has set targets for ETS and non-ETS sectors (Figure 1.8). The ETS target is set on the European level, while the non-ETS targets are implemented on EU country level. Each country has set own non-ETS targets according to their economic growth. This means that EU countries with smaller GDP per capita have lower GHG emission contributions as their expected high economic growth is likely to drive emissions, while more developed EU countries have higher GHG emission contributions instead.

Figure 1.8 GHG reduction measures and targets

	EU Emission Trading Scheme (ETS)	Effort sharing
Description	• The scheme is a cap-and-trade system, that provides cost-effective incentives to the main CO2 intensive sectors in each Member State	• The Effort Sharing legislation establishes binding annual greenhouse gas emission targets for Member States for the periods 2013–2020 and 2021–2030
Sectors included	• Power generation • Energy intensive industry sectors[1] • Aviation	• Sectors not included in ETS • Transport • Agriculture • Buildings • Waste
% of EU GHG	**45%**	n/a
EU emission reduction target, 2020 vs 2005	**- 21%**	**- 10%**
EU emission reduction target, 2030 vs 2005	**- 43%**	**- 30%**

Note: 1) Energy-intensive industry sectors include large combustion sites, oil refineries, steel works and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals
Source: Choice of sectors and GHG coverage under an ETS Some views from the EU; Project team analysis

In the past few years, high level of allocated allowances led to lower carbon auction prices. In order to increase carbon prices, EU has reduced auction volumes by 400 million allowances in 2014, which led to tripling of carbon price in 2018. The trend of carbon price increase is expected to continue in the future causing more pressure on capacities that use conventional sources of energy (Figure 1.9 and Figure 1.10).

Figure 1.9 ETS - Allocated allowances vs. verified emissions, Mt CO_2-eq

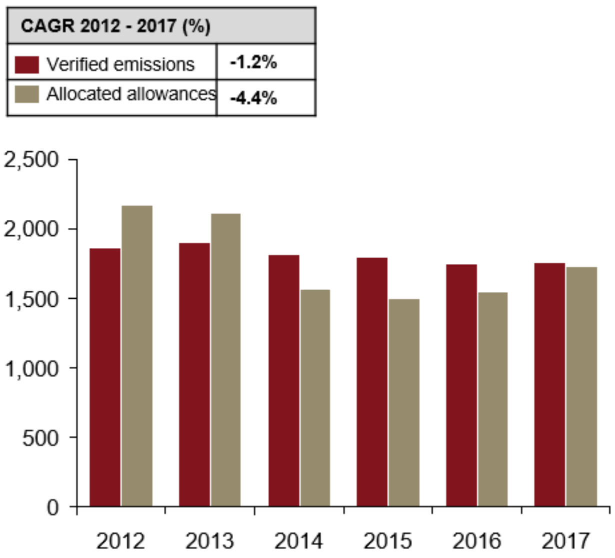
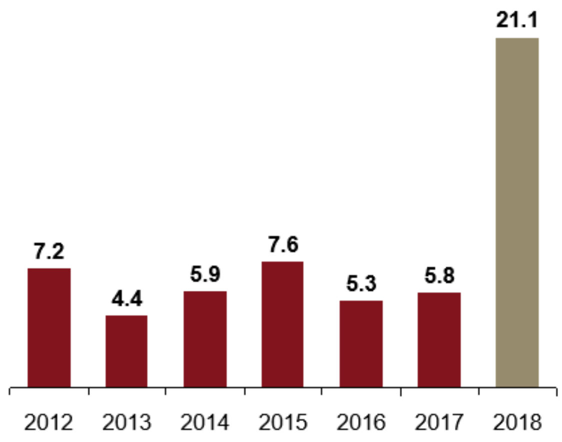


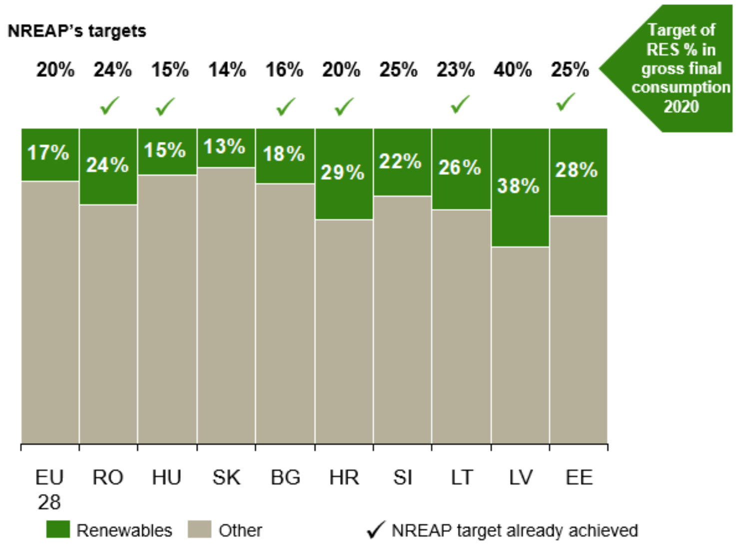
Figure 1.10 EEX Average auction price, EUR/t CO_2



Source: Eurostat, European Energy Exchange, Project team analysis

The increase of renewable sources is being balanced with market based support mechanisms. Each Member State sets its own target (Figure 1.11) and indicative trajectory in their National Renewable Energy Action Plans (NREAP). EU adopted guidance for renewable energy support schemes, which suggests that financial support for renewables should be limited to what is necessary and should aim to enhance their competitiveness at the market. EU also suggests that support schemes should be flexible and respond to decreasing production costs. As technologies mature, schemes should be gradually transformed from the feed-in tariffs mechanism to feed-in premiums with auctions and other support instruments that incentivize producers to respond to market developments.

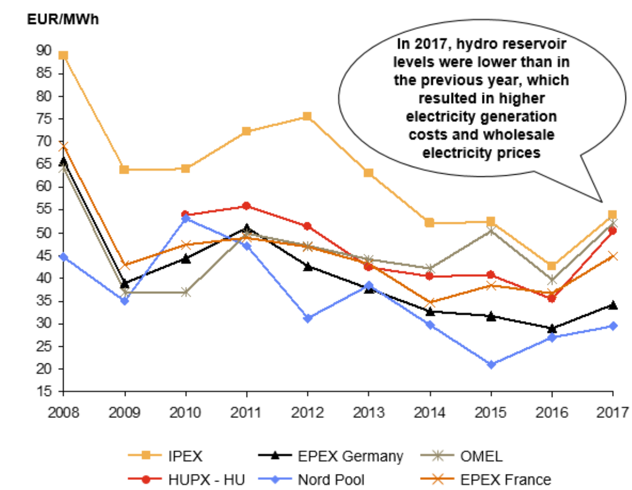
Figure 1.11 Overview of the EU target achievements from RES across the Member States in CEE, 2016



Source: Eurostat, Project team analysis

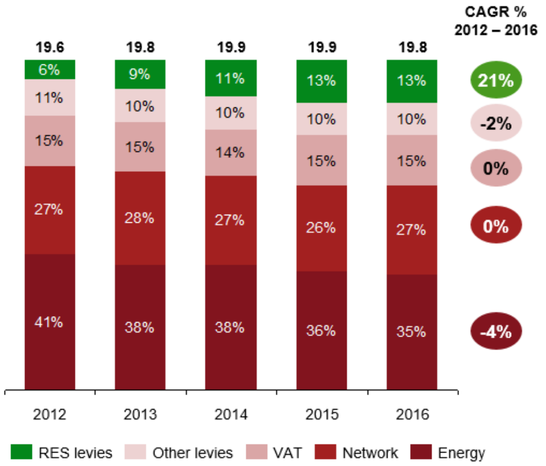
Drop in wholesale electricity prices caused by lower marginal cost of RES did not reflect on end users due to increase in RES levies. Low marginal cost of electricity generated from solar and wind, in addition with priority to come first in the merit order, is making electricity produced from conventional sources dispensable at times. The electricity price for households in 2016 increased by 1.5% compared to 2012, reaching 19.83 euro cents/kWh. During this period, the drop in wholesale price was supplemented by RES levies (Figure 1.12 and Figure 1.13).

Figure 1.12 Trend in EU wholesale electricity price, 2008 – 2017, EUR/MWh



Source: GME(Gestori Mercati Energetici),HUPX, Project team analysis

Figure 1.13 Average electricity retail prices for households in EU capitals, 2012 – 2016, ¢/kWh



Source: ACER Market Monitoring Report 2016 – Electricity and Gas Retail Markets , Project team analysis

1.2.5 Research, innovation and competitiveness

Horizon 2020 is the key financial mechanism for energy research an innovation in the EU. Horizon 2020 is the biggest European research and innovation programme with nearly 80 billion EUR of funding available over 7 years (2014-2020). It covers seven societal challenges including Secure, Clean and Efficient Energy, Smart, Green and Integrated Transport, as well as Climate Action, Environment, Resource Efficiency and Raw Materials. The main focus of the energy related societal challenge is on energy efficiency, law carbon technologies, smart cities and communities, as well as Strategy Energy Technology Plan (SET Plan) as a center-piece of the research and innovation policy.

The goal of EU's R&D activities is to pursue the decarbonisation agenda in a cost-effective manner and to strengthen its leadership in the manufacturing industry of low-carbon and energy-efficient technologies. Financial instruments are set to play an increasingly prominent role to meet this challenge. In 2016, most of the energy project investments were related to RES, which is also expected to be the biggest investment area in 2020 (Figure 1.14 and

Figure 1.15). As a part of Third Energy Package, Member States are required to ensure the implementation of smart metering system. Although, huge amount of financial resource have already been invested in energy projects, it is estimated that for reaching EU energy climate targets, annual amount needed for required electricity generation is 54-80 billion EUR in period from 2021 until 2050.

Figure 1.14 Investments in energy projects in 2016, mil. EUR

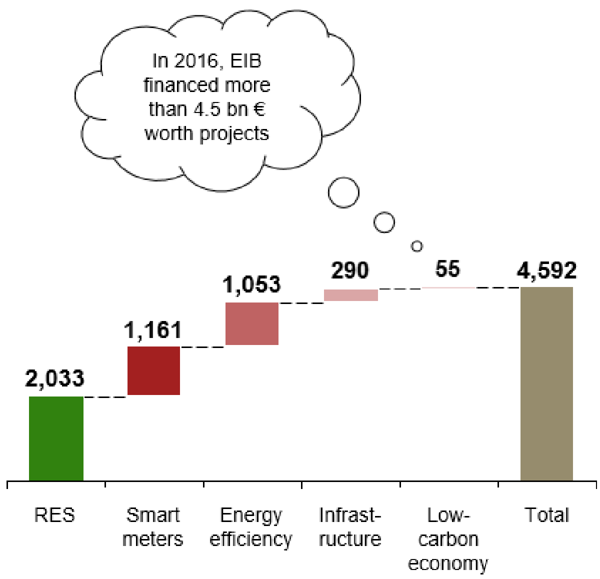
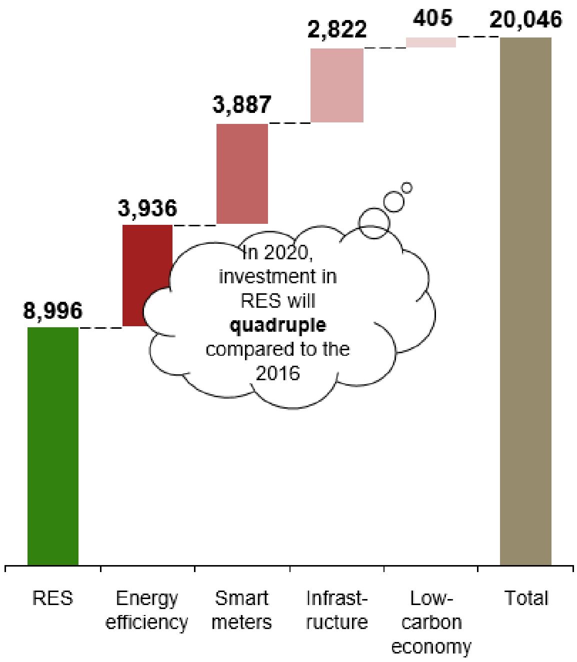


Figure 1.15 Expected triggered investments by 2020, mil. EUR



Source: European Commission - The Investment Plan for Europe and Energy

1.3 Macroeconomic overview of North Macedonia

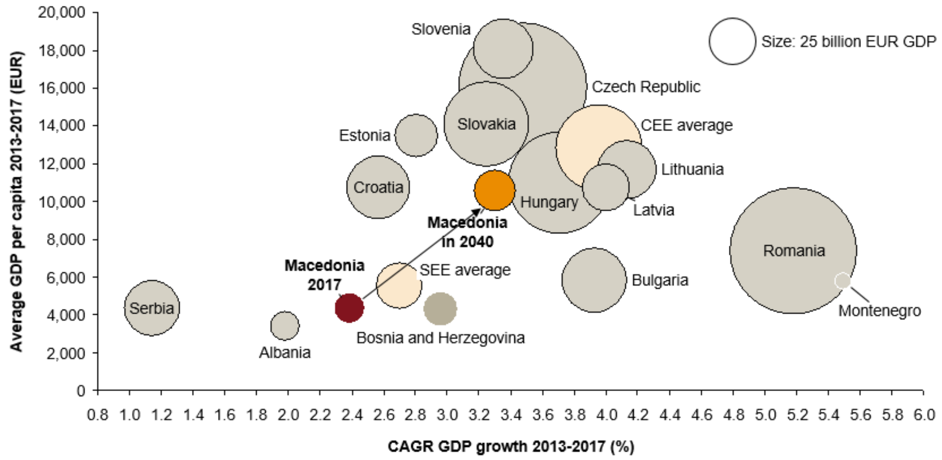
1.3.1 Introduction

North Macedonia as Energy Community Contracting Party and EU candidate country is willing to follow the European energy policy and is obliged to transpose and implement the EU energy directives and regulations. North Macedonia was granted the candidate status for entering the European Union in 2005. Since 2009, the Commission has recommended to the Council to open accession negotiations with North Macedonia. Furthermore in 2018, the Commission has also recommended that the accession negotiation will be opened with North Macedonia in 2019.

1.3.2 Gross domestic product and unemployment

GDP growth till 2040 is projected to position North Macedonia closer to today's CEE region economies. GDP, as the most important measure of a country's economic activity, shows that today North Macedonia is relatively close to SEE average, but lags behind CEE region. Taking into account the projections of International Monetary Fund and Ministry of Finance, it is projected that until 2040 the Macedonian real GDP growth rate will grow at an average rate of 3.3%. Such GDP growth rate could be expected for a developing country, and should lead to convergence towards levels of GDP per capita that are common for developed CEE countries today (Figure 1.16).

Figure 1.16 CEE and SEE GDP trends



Note: SEE includes AL, BA, BG, HR, MK, RS, ME, SI and RO; CEE includes HU, LV, LT, CZ, EE and SK; GDP growth projections for North Macedonia take into consideration growth rates of 3.3% per annum.
Source: Eurostat, WB, Government of North Macedonia GDP projections, Project team analysis

North Macedonia has the second highest unemployment rate in the region, but it is showing positive trend over the years (Figure 1.17 and Figure 1.18). In addition, employment is characterized with unfavourable gender structure, which has remained unchanged over a longer period due to unstable economic and social conditions, as well as imbalance between the available and required profiles on the labour market. The employment rate in women population in the second quarter of 2018 was 39.5% (298,618 women) significantly lower than the man employment rate of 60.5% (456,455 men).

Figure 1.17 Unemployment rate in North Macedonia, 2013 –Q3 2018, %

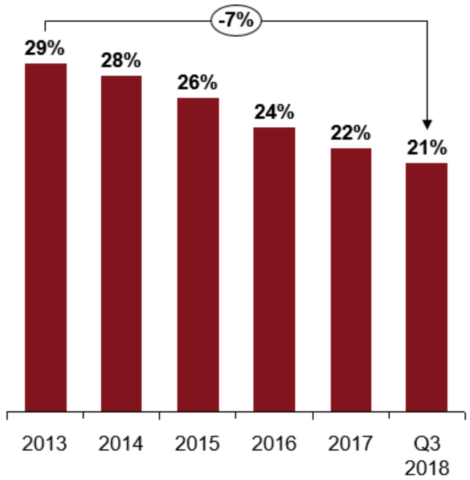
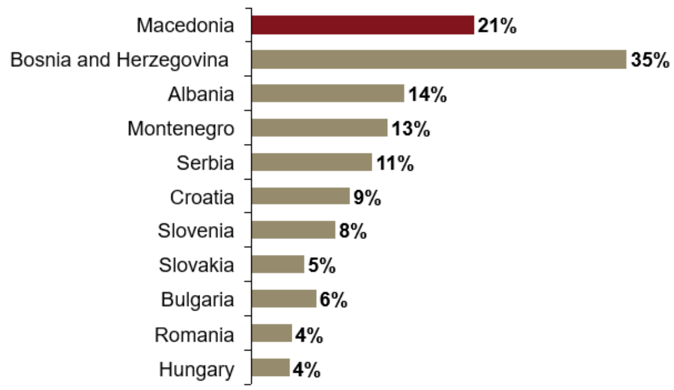


Figure 1.18 Unemployment rate CEE and SEE, 2018, %



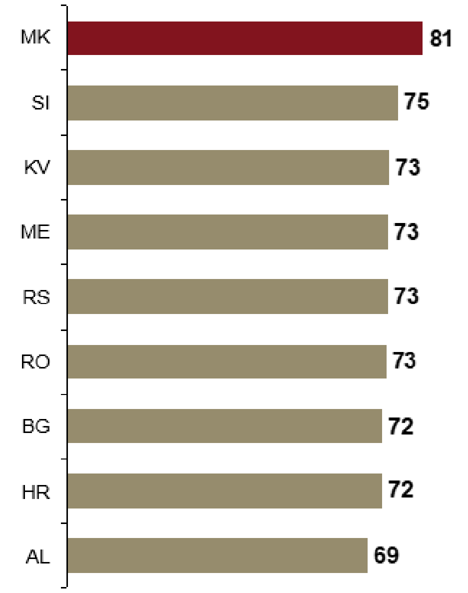
Source: Eurostat, ec.europa.eu reports Trading Economics; Project team analysis

North Macedonia has a positive business environment to provide opportunities for small and medium enterprises in RES and energy efficiency. According to The World Bank Doing Business 2018 report, North Macedonia is ranked 4th out of 190 countries in starting a business which is a very good precondition for boosting new investments and increasing employment. Such circumstances provide new opportunities for smaller and local business enterprises. North Macedonia has the highest cumulative index for business environment compared to countries in the region, and in particular stands out in the fields of starting a business, paying taxes and dealing with construction permits. Still, there is room for improvement in the registering property and enforcing contracts as their ranking is the worst compared to the other categories (Figure 1.19 and Figure 1.20). It is expected that future investments, including the investments in the energy sector (especially RES and energy efficiency), could have a positive impact on decreasing county's unemployment rate as well as the economic growth.

Figure 1.19 Business environment per category, 2017

Category	Description	Global ranking (out of 190)
Starting a business	Procedures required from an entrepreneur to start a business (time and cost)	4
Dealing with construction permits	Procedures required to comply with building regulations (time and cost)	11
Getting Electricity	Time and cost to obtain electricity connection as well as supply reliability and tariff transparency	29
Registering property	Effective administration of land, necessary for formal property transfer	48
Getting loan	Considers the depth of loan information and strength of legal rights	16
Protecting minority investors	Protection from conflict of interest and shareholders rights in corp. govern.	13
Paying taxes	Considers tax rates and tax administration complexity	9
Trading across Borders	Time and cost associated with the logistical process of export and import	27
Enforcing contracts	Time and cost for resolving standardized commercial dispute through local first-instance court	36
Resolving Insolvency	Time, cost and outcome of insolvency proceedings involving local legal entities	32

Figure 1.20 Business environment compared to countries in the region, 2017



Source: The World Bank – Doing Business 2018 report, Project team analysis

1.3.3 Foreign direct investment

Energy sector can contribute to attract foreign direct investments. The process of globalization has increased the importance of foreign direct investments, especially for developing countries such as North Macedonia. Due to the limited internal financial and investment capacity the interest of all developing countries is to achieve a more favourable investment climate and better operating conditions. Additionally, entrance of new foreign companies can stimulate domestic companies to improve their business and consequently contribute in boosting overall market development. In the long run, such economic trends create positive externalities. Foreign direct investments in North Macedonia amounted 225 million EUR per year or 107 EUR per capita which is substantially lower than the region (Figure 1.21 and Figure 1.22).

Figure 1.21 Foreign direct investments in North Macedonia, 2012 – 2017, mil. EUR

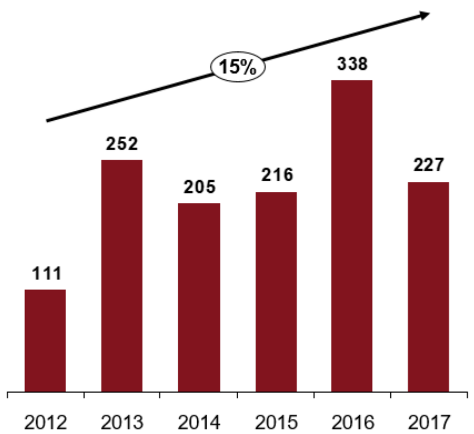
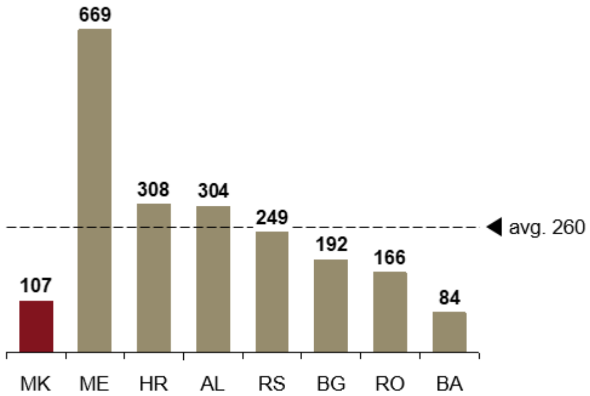


Figure 1.22 Foreign direct investments per capita – Region inflow, average 2012 – 2017, EUR



Note: Countries analysed for the region are BA, RO, BG, RS, AL, HR and ME
Source: United Nations – World Investment Report 2018, Project team analysis

1.4 Overview of the Macedonian energy sector

1.4.1 Integration and Security of Energy Markets

1.4.1.1 Electricity

Coal fired thermal power plants and hydro power plants are the main generating capacities in North Macedonia. The total installed capacity for production of electricity in North Macedonia is 2.06 GW with ~48% being thermal power plants, ~34% large and small hydro power plants, ~15% combined natural gas fired plants and ~3% other renewables. The main entity in North Macedonia for electricity production is a state owned company Power Plants of North Macedonia (ESM), with ~70% of the total installed capacity. ESM is the owner of the two large coal fired thermal power plants, Bitola and Oslomej. In recent years electricity generation from coal has been decreasing steadily to ~60% in 2017. On the other hand, overall RES is increasing over the years in terms of capacity amounting to 37%, which led to the increase of RES generation up to 25% in overall generation in 2017 (Figure 1.23 and Figure 1.24).

Figure 1.23 Evolution of Net Installed Capacity, 2012 – 2017, MW

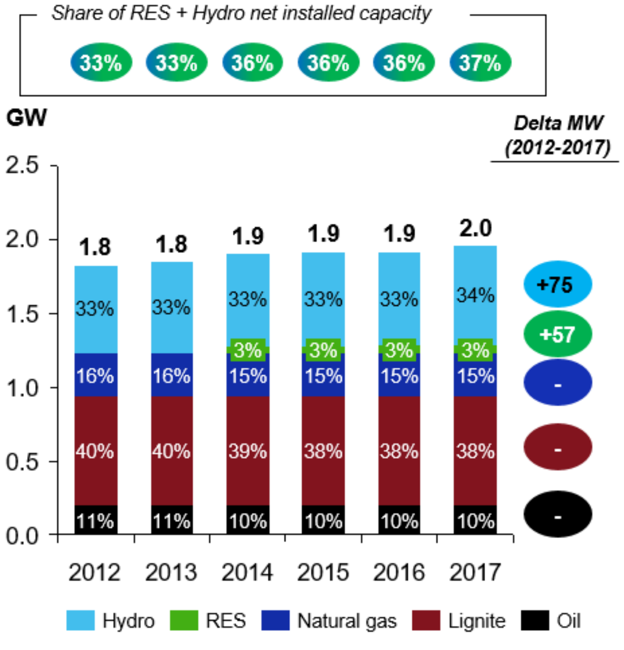
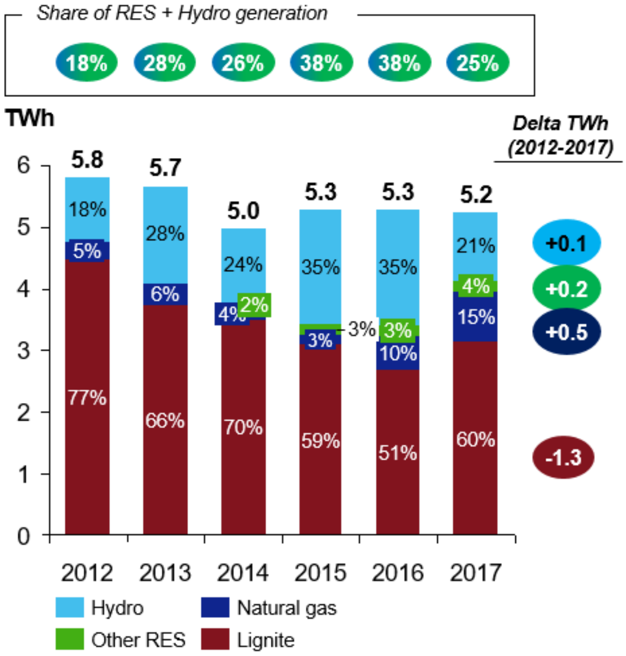


Figure 1.24 Historical net generation mix, 2012-2017, TWh



Notes: "Hydro" includes both large (mainly reservoir) and small (mainly run of the river) hydro power plants
Source: ERC, MANU, Project team analysis

North Macedonia has relatively high import dependency in the region. Electricity consumption in North Macedonia has been decreasing 2010-2016 at an average annual rate of 3.7% primarily due to industry sector. Despite the declining consumption, average share of import in the observed period made up ~30% of total electricity consumption. Comparing to the countries in the region, North Macedonia, together with Croatia and Slovakia, has one of the highest shares of import of electricity (Figure 1.25 and Figure 1.26).

Figure 1.25 Electricity balance, average for the period 2010 – 2016, TWh/year

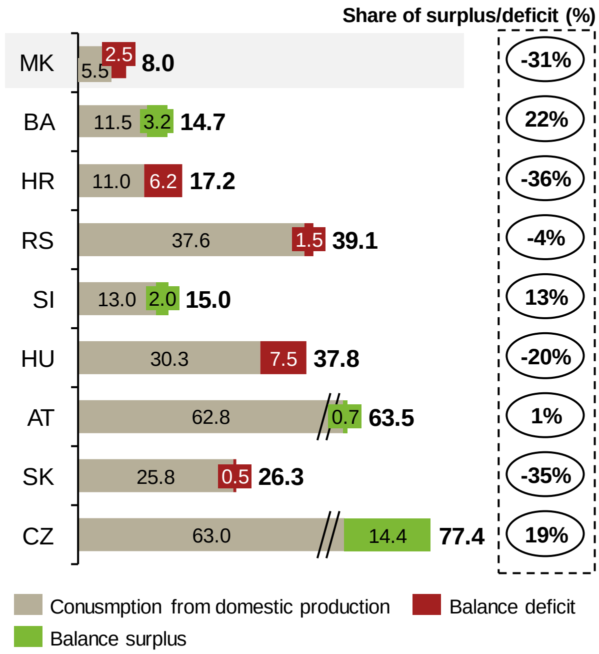
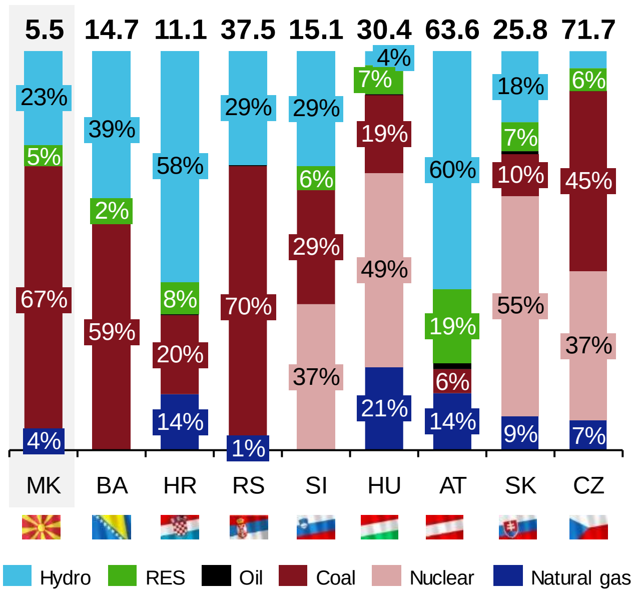


Figure 1.26 Domestic electricity generation mix, average for the period 2010 – 2016, TWh/year and share by fuel



Source: ENTSO-E Statistical Report 2015, ERC, Project team analysis

Suvodol and Brod Gneotino are the largest mines (~98% of total coal produced for energy transformation). Electricity produced from coal fired power plants make up ~60% of total domestic production. However, the production of coal used for transformation has been declining at an average annual rate of 3.8% from 2010 to 2017 (Figure 1.27). The most significant coal mine, in terms of produced volume, is the Suvodol mine, making up between 68% and 88% of total coal produced for energy transformation depending on the year. It consists of a surface mine commissioned in 1979, which is expected to close in 2020 and Podinski coal layer which is a lower layer already started with exploitation. The second most significant mine is Brod-Gneotino, located in the vicinity of the Suvodol mine and accounts for 10% - 30% of total coal produced for energy transformation. Oslomej mine currently produces less than 2% of total coal produced for energy transformation (Figure 1.28).

Figure 1.27 Annual coal production, 2010 – 2017, mil. tonnes

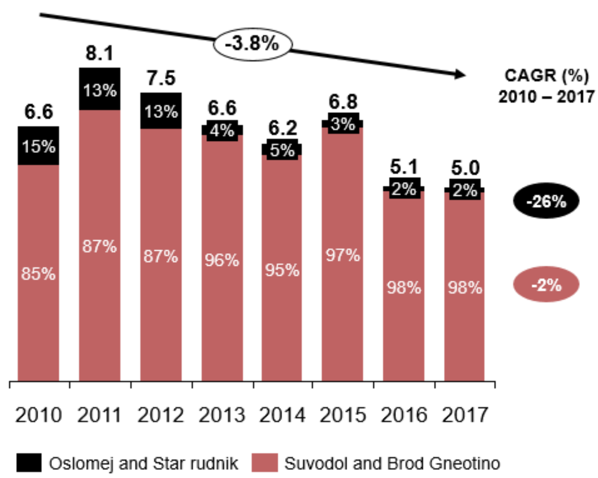
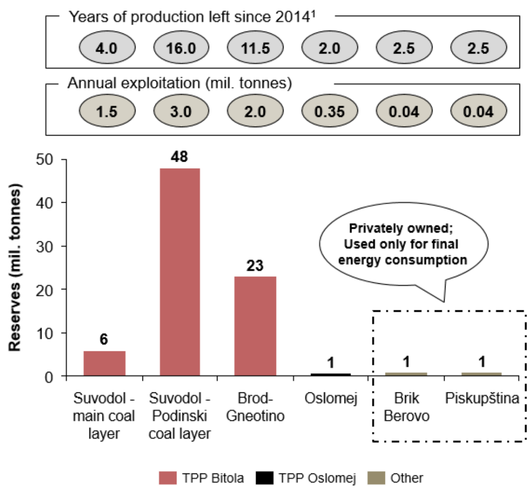


Figure 1.28 Current exploitation lignite reserves, 2014, mil. tonnes



Note: 1) Indicative estimate based on exploitable reserves in 2014 and average annual production
Source: ESM annual reports 2010 – 2017, Analysis of the availability of lignite in the Republic of North Macedonia, Strategy For Development Of Energy In The Republic Of North Macedonia For The Period Until 2035; Project team analysis

TPP Bitola coal resources are nearing depletion in mid-term. Suvodol and Brod Gneotino mines are used to supply TPP Bitola. Considering the estimated exploitable coal reserves in 2014 and the annual capacity of production, the new Podinski coal layer in Suvodol has the longest remaining estimated production life of ~16 years and Brod-Negotino ~11.5

years. The Suvodol surface mine is nearing depletion. Considering the projected average annual consumption of coal of TPP Bitola of ~5 Mt, the reserves in the area are estimated to be sufficient for ~15.4 years of production. According to ESM's 5-year investment plan 2018-2022, the commissioning of new Zivojno mine could extend the coal supply to TPP Bitola for another ~10.6 years (Figure 1.29).

TPP Oslomej is facing challenges with secure coal supply. TPP Oslomej is supplied solely from the Oslomej mine which is nearly depleted and produces less than 300 kt of coal per year. Due to low coal supply, TPP Oslomej works with limited capacities. According to the ESM 5 year investment plan 2018-2022, commissioning of new reserves in the vicinity of TPP Oslomej is not expected due to the socio-environmental reasons (Figure 1.30). Therefore, other sources of fuel supply such as import of higher calorific coal, use of domestic resources from other mines or switching to other forms of fuel are taken into consideration.

Figure 1.29 Planned development of exploitable reserves – Bitola, mil. t, 31.12.2014

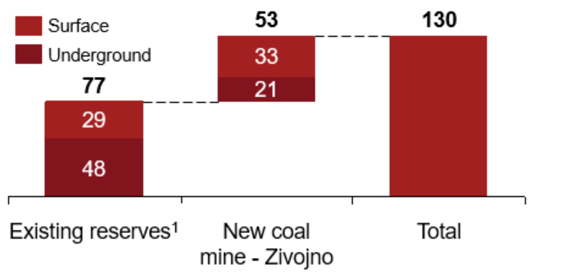
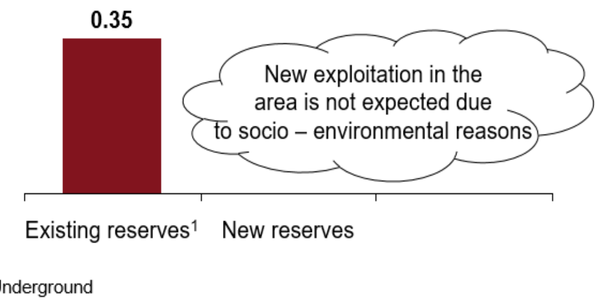


Figure 1.30 Planned development of exploitable reserves – Oslomej, mil. t, 31.12.2014



Note: 1) Data on existing reserves is from 31.12.2014
Source: ESM Development and Investment Plan 2018-2022; Analysis of the availability of lignite in the Republic of North Macedonia, Project team analysis

North Macedonia has a well-developed transmission network with five interconnection points. The overall transmission network consists of 577 km of 440 kV and 1,601 km of 110 kV lines. Makedonski elektroprenosen sistem operator (MEPSO) as a transmission system operator manages the 2,122 km lines. The 400 kV lines form a ring and connect the largest producer of electricity, TPP Bitola, the direct consumers and connect North Macedonia with neighboring countries. North Macedonia has interconnections with Serbia, Kosovo and Bulgaria and two with Greece (Table 1.1). The 110 kV is well developed and connects large hydro power plants, TPP Negotino, and other producers with all urban and industrial areas (Figure 1.31). North Macedonia and the other contracting parties are already above the interconnection threshold for 2020 (10%) and 2030 (15%).

Figure 1.31 Electricity transmission infrastructure in North Macedonia

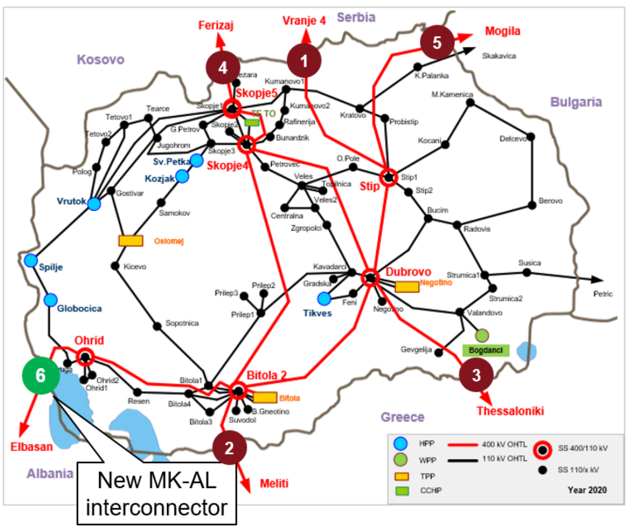


Table 1.1 Existing Interconnection lines with neighbouring countries & MEPSO 5y plan

Interconnection lines			Type of conductors	Length (km)	Year
1 Serbia	400 kV	TS Stip 1 - TS Vranje 4	ACSR 2x490/65 mm²	70.2	2015
2 Greece	400 kV	TS Bitola 2 - TS Meliti	ACSR 2x490/65 mm²	17.3	2007
3 Greece	400 kV	TS Dubrovo - TS Thessaloniki	ACSR 2x490/65 mm²	54.7	1978
4 Kosovo	400 kV	TS Skopje 5 - TS Ferizaj	ACSR 2x490/65 v	22.7	1978
5 Bulgaria	400 kV	TS Stip 1 - TS Mogila	ACSR 2x490/65 mm²	71.3	2009
	110 kV	TS K. Palanka - TS Skakavitsa	ACSR 240/40 mm²	12.8	1994
	110 kV	TS Susitsa - TS Petric	ACSR 240/40 mm²	11.1	1979

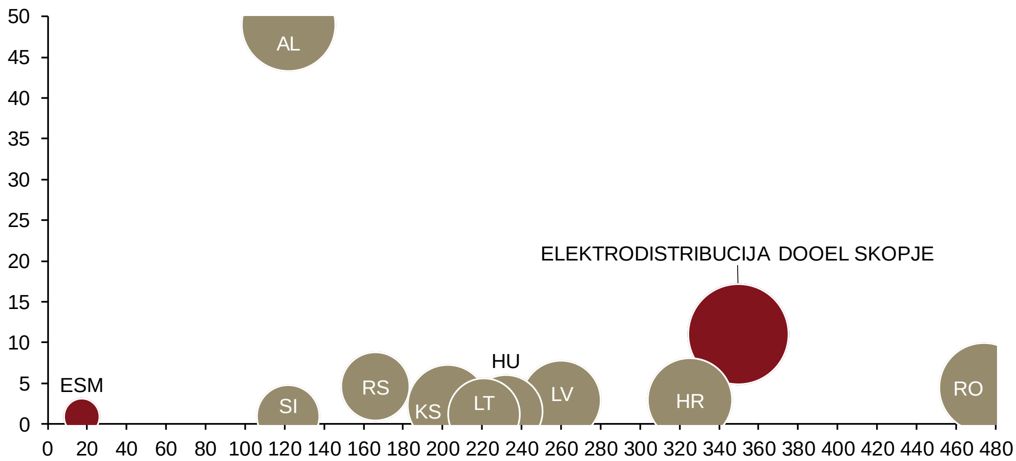
MEPSO 5 year network development plan		Year	Current status	CAPEX mil. EUR
6 **Interconnection line with Albania (PECI list)**	400 kV-TS Bitola 400/110 kV Ohrid SS Line in / line out interconnection on new 400 kV MK-AL	2018-2020	EIA /legal relations/ project documentation	36.92
New transmission lines	Line in / line out connection of one of the substations in Polog region to the existing 110 kV OHL Vrutok - Skopje	2018-2022	n/a	5.1
Revitalization / reconstruction of OHL	8 x 110 kV	2018-2022	n/a	24.44
Revitalization/reconstruction of transformer stations		2018-2020	n/a	14.12
Modernization of electricity transmission system		2018-2020	n/a	8.1
Total CAPEX				88.68

Source: MEPSO Strategic Plan for transmission system 2020 – 2040; MEPSO - Plan for Development of the Electric Power System of the Republic of North Macedonia Period 2018 – 2022; Project team analysis

Interconnection point with Albania will contribute to regional integration, while the aging infrastructure will require investments for revitalization and reconstruction or new construction. Realization of the new interconnector between Bitola (MK) and Elbasan (AL) is of great importance and is the last segment of the realization of Corridor 8 for transmission of electricity between Bulgaria, North Macedonia, Albania and Italy (Figure 1.31). This project is of regional significance and has been listed as a Project of Energy Community Interest (PECI). In addition to development of new transmission lines and interconnectors, the current aging transmission network needs revitalization. The aim is to increase reliability of overall transmission infrastructure including overhead lines, transformer stations, protection systems, surveillance and control systems, etc. According to MEPSO, facing the replacement wave and revitalization of 110 kV transmission lines will be the largest challenge. Considering the MEPSO long term investment plan till 2040, the system needs investment of 163 mil. EUR, out of which 87mil. EUR for new network and 76 mil. EUR for network revitalization. The largest investments in the revitalization of ~70% is expected to be in period 2025-2040, while ~98% of new network investments should be carried out until 2030 based on least cost.

Duration and frequency of electricity supply interruptions in distribution network in North Macedonia are relatively high compared to region. Considering the distribution network, North Macedonia has a potential for improvement of power supply reliability (Figure 1.32). Although the differences between countries could vary due to different voltage levels and network configuration (e.g. ELEKTROSDISTRIBUCIJA has a large percentage of overhead lines), as well as indicator measurement approach, investing in the distribution network is one of the most important activities to improve the supply reliability. The major factors that drive these investments are DSO's investment capacities, amount of investments approved by the regulator and role of state institutions during the development and construction phase of infrastructure.

Figure 1.32 Planned + unplanned SAIFI and SAIDI indicators for distribution (excluding extreme weather condition) in 2016



Note: data for Albania is for 2017 Source: CEER Benchmarking Report 6.1 on the Continuity of Electricity and Gas Supply; Regulatory Commission for Energy of the Republic of North Macedonia, Elektrodistribucija DOOEL Skopje, AERS Annual report 2016, Energy regulatory office Kosovo Annual report 2016, Project team analysis

North Macedonia has an active role for cross-border electricity exchange. In the period between 2010 and 2015, North Macedonia has reached power balance mostly relying on imports, which significantly increased in 2014. From Kosovo and Bulgaria North Macedonia realizes primarily import of 4 TWh – 5.6 TWh while towards Greece export of 1.5 TWh – 3.9 TWh is realized. Additionally, in 2016 North Macedonia became a founding partner of the SEE CAO (South East Europe Coordinated Auction Office). SEE CAO facilitates cross-border electrical power trade, through alignment of technical, financial and legal prerequisites among participants, which allows for simpler and cost effective trade process. From 2016 electrical power trade on the MK-GR border is organized by SEE CAO. For other borders which are not part of the SEE CAO contract, MEPSO has appropriate Auction Rules for allocation of cross-border transmission capacities.

Day ahead market coupling with Bulgaria is the next regional integration initiative, with possibility for a power exchange in North Macedonia. In 2018, the Government of North Macedonia adopted a feasibility study of establishing power exchange. To further enhance regional integration, North Macedonia is on its way to achieve day ahead market coupling with Bulgaria. The new Energy Law sets the legal ground to establishing an organized day-ahead market and for its coupling with the neighbouring markets. With signed Memorandum of Understanding between North Macedonia and Bulgaria in 2018, North Macedonia is taking operational steps for implementation of the initiative. Market coupling is one of the most important market integration trends seen in the region. Currently, reference price for electricity trading in the region is the price on the Hungarian Power Exchange (HUPX) due to its liquidity. But in the future, as liquidity of local markets increases via regional integration, price convergence among countries is expected.

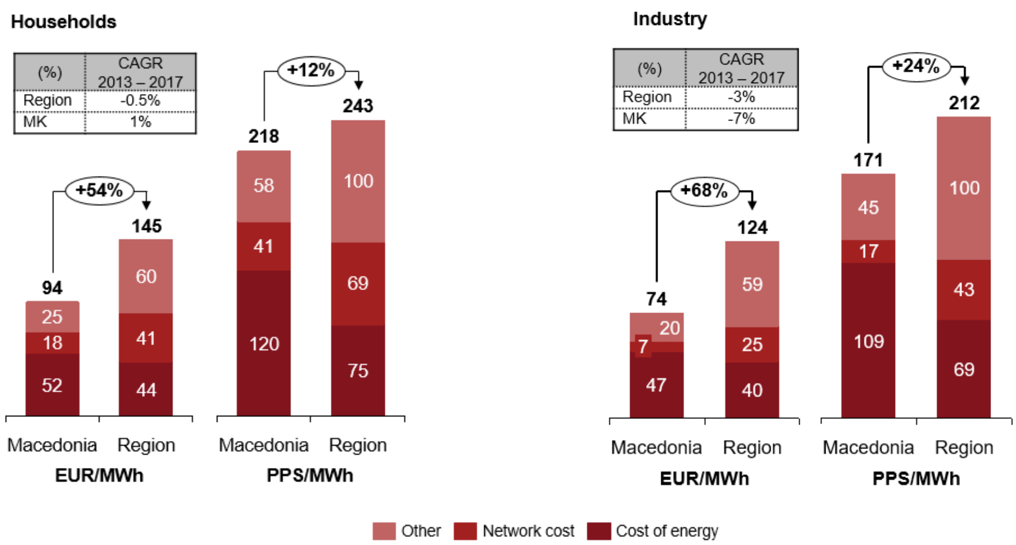
Regional cooperation on share and exchange of auxiliary services (power control reserves and balancing energy) between Serbia, North Macedonia and Montenegro (SMM) control block will increase flexibility for more RES and decrease the operating costs. Market integration is an important element to promote network flexibility and integration of renewables. The advanced option of SMM control block is expected to increase market flexibility and decrease reserve allocation costs. The goal is to provide all the auxiliary services to the extent that is sufficient for reliable operation of the electric power system and reliable power supply at the lowest possible price. TSOs from Serbia, North Macedonia and

Montenegro form a control block which is in line with the target model of regional integration of electricity balancing markets by ENTSO-E network code on electricity balancing. For individual balancing of each country, total amount of balancing reserves equals 1000 MW and for SMM control block it equals 700 MW. Therefore, by advanced operation of SMM block in regard to share and exchange of auxiliary services, the costs for ensuring balancing capacity would reduce and part of generation capacity would be freed to provide energy on the commercial market. Additionally, the SMM block is also important form the perspective of electricity cross-border balancing. With the future introduction of RES, especially wind and PV generation capacities, market integration in terms of the SMM block will allow for more efficient balancing of generation and demand.

Electricity prices in North Macedonia are lower than in the wider region. The average electricity prices in North Macedonia are lower compared to the average price in the region. The cost of energy is higher in North Macedonia while other costs that include various taxes, fees and levies are significantly lower than in the region (Figure 1.33 and Figure 1.34). As a result of the cross-subsidies between households and small costumers, the network costs for households are less than twice compared to the region. However, if electricity prices are normalized for purchasing power parity, the price in North Macedonia is close to regional level. Market integration within the region is expected to decrease the cost of energy in North Macedonia, even though the national electricity market liberalization may increase the network costs (especially for the households). This will maintain the price in the country at least at the same level as of 2017.

Figure 1.33 Electricity prices for households in North Macedonia vs. region, 2017

Figure 1.34 Electricity prices for industry consumers in North Macedonia vs. region, 2017



Note: Category "Other" includes taxes, fees, levies and charges, VAT, renewable taxes, capacity taxes and environmental taxes; Category "Network cost" includes transmission and distribution costs; Category "Cost of energy" includes commodity price with end-user costs; Region considers Bulgaria, Czech republic, Croatia, Hungary, Romania, Slovenia, Slovakia, Serbia, Bosnia and Herzegovina; For the households we used category DC: 2.5 MWh < consumption < 5 MWh; while for the industry customers we used category IC: 500 MWh consumption > 2 000 MWh
Source: Eurostat; Project team analysis

1.4.1.2 Natural gas

North Macedonia has a single import route with Bulgaria and is 100% reliant on import. In North Macedonia commercial reserves of natural gas have not been declared. Natural gas made up only 7% of primary energy consumption in 2017, however with Macedonian ambitious natural gas network development this share has a great potential to increase in the future. In order to assure security of supply, North Macedonia is developing other supply routes.

Interconnection with Greece is the key project that will diversify supply by 2022. MER AD, responsible for development of the Macedonian transmission network, is involved in the Central and South East Gas Connectivity (CESEC) initiative, where according to the Memorandum of Understanding signed in Dubrovnik in 2015, the projects for interconnectors between North Macedonia, Greece and Bulgaria are included. One of the key supply routes is the interconnector between North Macedonia and Greece, currently on the PMI list, which is expected to be completed by 2022. Through this interconnector North Macedonia will be connected to the Trans Adriatic Pipeline which brings natural gas from the Caspian region to Europe. There is a potential for five interconnections with Serbia, Albania, Kosovo, Bulgaria and Greece (link with Bitola).

North Macedonia has started an ambitious country wide gasification plan. North Macedonia has an ambitious gasification plan in three phases which is expected to bring natural gas to the entire territory of North Macedonia. Projects that belong to phase 1 are expected to be completed by 2020, phase 2 projects are expected to be completed by 2022 and phase 3 projects after 2022 (Figure 1.35). In total, planned investments in all three phases amount to 323.1 mil EUR, with the first phase being 142 mil. EUR, the second phase being 72.6 mil EUR and the third phase being 108.5 mil EUR.

Additionally the planned investments into interconnectors are expected to amount 83.2 mil EUR, with the MK-GR interconnector being the most significant one (Table 1.2). The natural gas, with the planned interconnections with Greece and other countries, as well as the already started ambitious gasification plan, is anticipated to have a more important role as a bridge fuel to 2050 and replacing coal.

Figure 1.35 Relevant country level natural gas projects

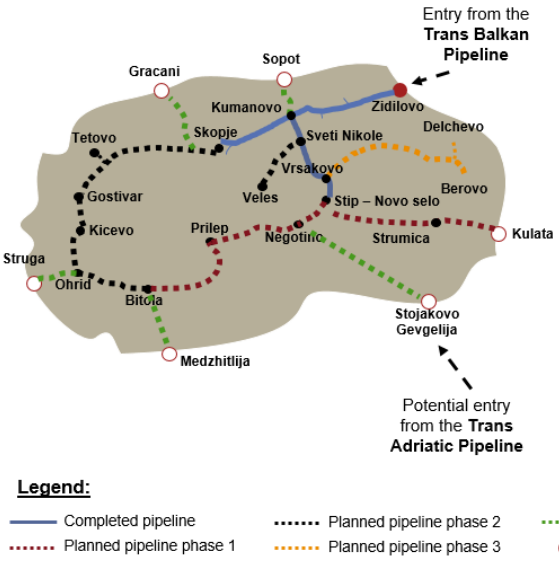


Table 1.2 Planned natural gas interconnection points

Interco-nnector	Section	Length (km)	Technical capacity (000 m³/h)	Expected completion	Value (mil. EUR)
MK - GR	Negotino - Stojakovo	68-70	326	2022	51.2
MK - GR	Bitola - Medzhitlija	-	-	-	-
MK - RS	Klechovce - Sopot	23	160	after 2022	16
MK - KV	Matka - Gracani	16	236	after 2022	16
MK - AL	Ohrid - Struga - Kafasan	27	248	-	-
MK - BG	Strumica - Kulata	-	-	-	-

Source: National strategy for gasification of the Republic of North Macedonia, Energy community - presentation of energy promoters; Project team analysis

Utilization of current gas transmission grid is on average low with peaks during winter. Average annual utilization in 2017 was 34%. The largest natural gas consumption occurs in the winter period because natural gas is primarily used for heat generation. Combined heat and power (CHP) plants and heat plans accounted for ~76% natural gas consumption in 2017. Peak utilization of 80% at the MK-BG interconnector in 2017 was recorded in specific period in January, while the lowest utilization of 5% was recorded in specific period in June.

Macedonian cost of energy (natural gas) is higher than in wider region – market integration and diversification could bring natural gas prices in line with the region. In 2017, the cost of energy in North Macedonia is twice higher compared to the region when adjusted for purchase power standard, which leads to overall high natural gas prices for households and industry. On the other hand, the network cost in North Macedonia is lower than in the region due to small portion of consumers connected to distribution network compared to other countries. Diversification of supply routes, which allows purchasing of natural gas from multiple sources, has the potential to decrease the cost of energy in the overall natural gas price in North Macedonia (Figure 1.36 and Figure 1.37).

Figure 1.36 Natural gas price in North Macedonia vs region for households, 2017

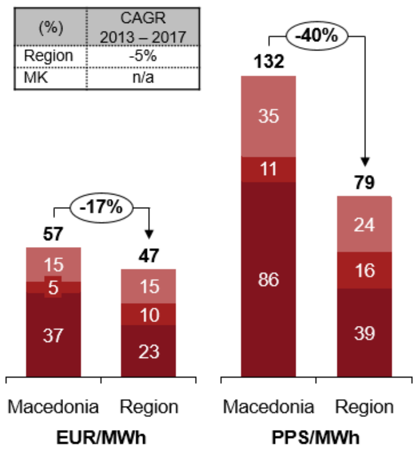
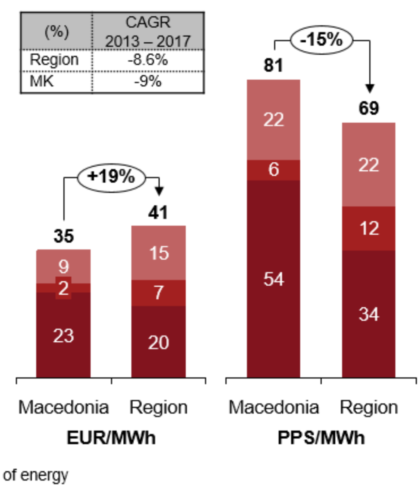


Figure 1.37 Natural gas price in North Macedonia vs region for industry, 2017



Note: Category „Other" includes taxes, fees, levies and charges, VAT, renewable taxes, capacity taxes and environmental taxes; Category "Network cost" includes transmission and distribution costs; Category "Cost of energy" includes commodity price with end-user costs; Region includes Bulgaria, Czech Republic, Croatia, Hungary, Romania, Slovenia, Slovakia, Serbia, Bosnia and Herzegovina; For the households used consumption category is DC: 20 GJ < consumption < 200 GJ; while for the industry customers category DC: 10.000 GJ < consumption < 100.000 GJ was used
Source: Eurostat

Diversification will contribute to better security of supply. In addition to potentially positive impact on the natural gas prices, supply diversification will assure higher security of supply allowing North Macedonia to respond in case of the unexpected disruptions that may occur on a single supply route, as well as to respond in case of sudden demand changes in North Macedonia.

1.4.1.3 Oil and petroleum products

Since 2013, all petroleum products are imported. North Macedonia does not have confirmed commercial crude oil reserves. In 2013 OKTA refinery stopped processing crude oil, and North Macedonia has become 100% reliant on the import of petroleum products. Petroleum derivatives are imported by road from surrounding countries which assures diversified supply sources and security of supply.

Storage infrastructure exists, however condition and purpose could be improved. North Macedonia already has capacities through private entities that could be used for storage of compulsory oil reserves. The total capacity is estimated to 543,500 m^3, but most of it has unsolved status, so the licenced storage capacity is 310,155 m^3. The largest storage capacities are located in the OKTA refinery which currently serves as a hub for majority of the imported fuels. Major concern is the condition of the storage units and their applicability for compulsory oil stocks. In addition, certain part of these capacities are used by traders of petroleum products for their operational reserves as obliged by the Energy Law (Figure 1.38).

Figure 1.38 Petroleum products storage capacity per product, m^3

	EC 95	EC 98	Diesel	Diesel for heating	LPG	HFO	Kerosene	Total
OKTA	48,000	-	60,000	-	6,000	80,000	-	194,000
Makpetrol	-	-	-	-	500	10,000	-	23,050
Lukoil	1,320	1,320	3,960	1,320	400	-	-	8,320
Other	2,750	200	10,670	6,335	2,480	62,200	100	84,785
Total	-	-	-	-	9,380	-	-	310,155

Note: Other includes 34 traders in North Macedonia
Source: Project team analysis

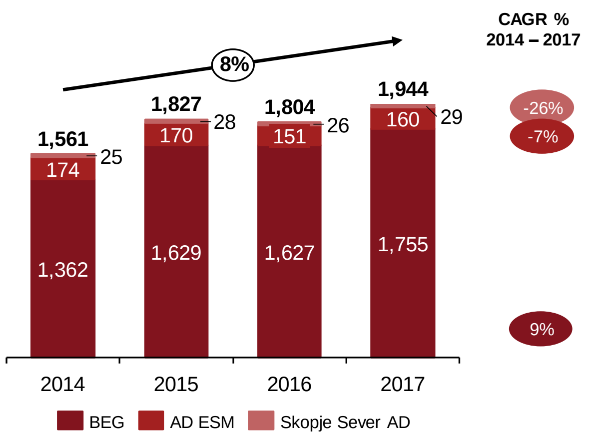
Vardax pipeline could provide considerable supply in the future. A crude oil pipeline was commissioned in 2002 between Thessaloniki in Greece and the OKTA refinery. The crude oil pipeline has the capacity of ~2.5 Mt year, however since the OKTA refinery stopped processing crude oil in 2013 the pipeline is no longer operational. The pipeline technical characteristics have been changed to enable potential transport of petroleum products.

1.4.1.4 District heating

District heating system is operational only in Skopje. 8.33% of households in North Macedonia rely on heat energy from district heating system, while 61.59% consume fuelwood, 28.60% use electricity, and the remaining 1.48% use other fuel types. The analyses conducted as a part of the Second Biennial Update Report on Climate Change (SBUR) show that in Skopje 24.8% of the households are connected to the district heating system. There are three district heating systems in Skopje. Balkan Energy Group (BEG) covers the biggest part of district heating market in Skopje (Figure 1.39).

Figure 1.39 District heating system companies and delivered heat per company, 2014 – 2017, TJ

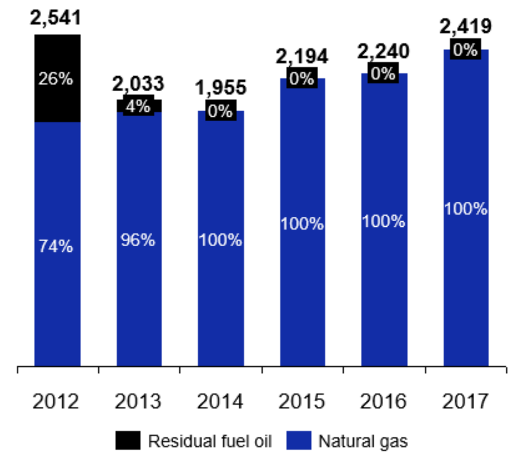
	Balkan Energy Group (BEG)	ESM Energetika	Skopje Sever
Ownership	Private	State	Private
Total production capacity (MW)	478	96	46
Total engaged power of consumers (MW)	443	50.4	7.6
Households users (#)	46,116	3,595	468
Network length (km)	192.2	38	10.4
Approved technical loses (%)	12	7	7



Source: ERC North Macedonia, Annual Report 2016, Project team analysis

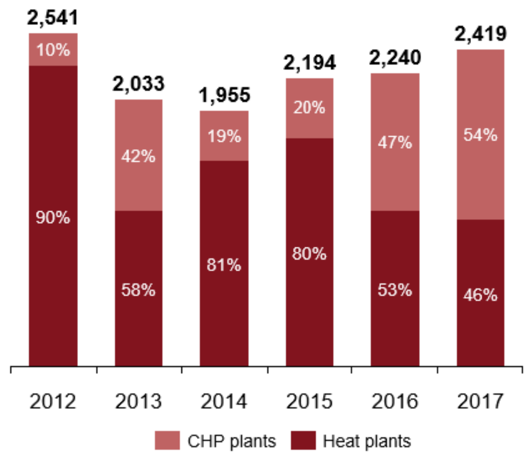
The steadily decreasing natural gas price contributes to the system stability and viability. In the recent years, only natural gas is used in the district heating systems in North Macedonia with 2.418 TJ in 2017 (Figure 1.40 and Figure 1.41). The amount of heat production from CHP plants depends on the relationship of the market prices of electricity and natural gas and on the regulated price of heat energy in North Macedonia.

Figure 1.40 Heat production by fuels, 2012 – 2017, TJ



Source: State Statistical Office of the Republic of North Macedonia, Project team analysis

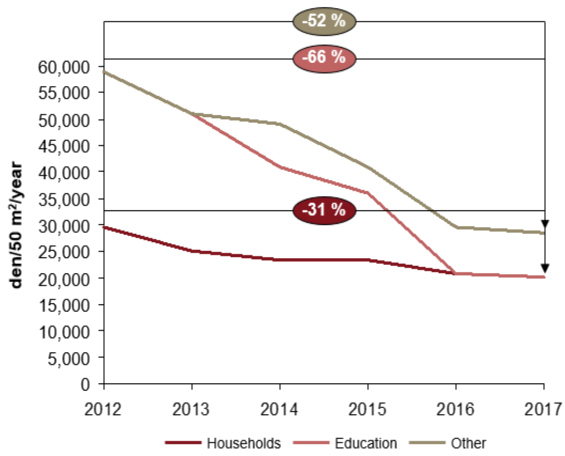
Figure 1.41 Heat production by plant type, 2012 – 2017, TJ



Source: State Statistical Office of the Republic of North Macedonia, ERC North Macedonia, Project team analysis

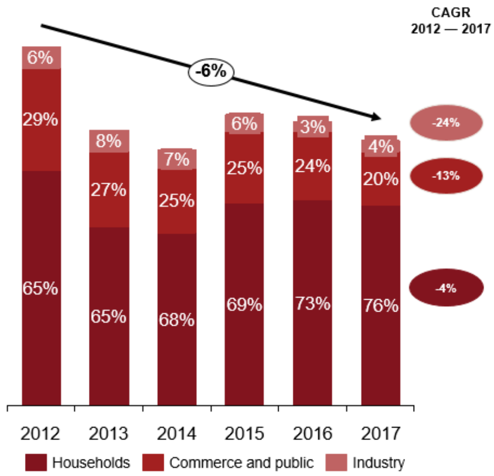
The price of delivered heat is constantly decreasing in the last few years. In the period 2012-2017, there is a substantial decrease in the price of delivered heat for each category, especially for education for -66% (Figure 1.42). At the same time, the final price for delivered heat decreased on average each year by 7% for households, 19% for education buildings and 14% for others. Decreasing heating price contributes to the stability of the system (Figure 1.43). Additionally, the heat consumption is following the weather condition, so in 2012 and 2013 the number of connected consumers was almost equal, but 2012 had extremely low temperatures, which resulted in higher heat consumption.

Figure 1.42 Price of delivered heat energy, 2012 – 2017, den/50 m² per year



Note: For a heating space of 50 m² with a heat consumption of 7.500 kWh per year and an installed capacity of 6,25 kW
Source: ERC, Project team analysis

Figure 1.43 Delivered heat energy by sectors, 2012 – 2017, TJ



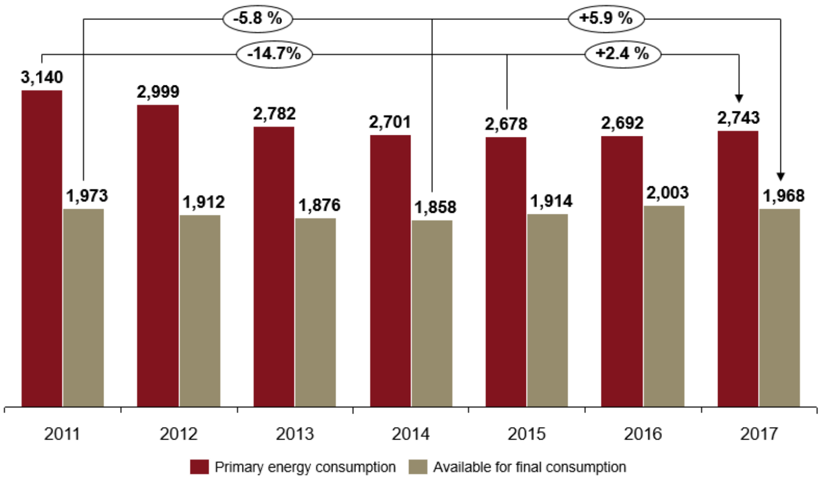
Note: The heat consumption in the industry is decreased due to the changes of the methodology used by State Statistical Office
Source: State Statistical Office of the Republic of North Macedonia, ERC North Macedonia, Project team analysis

1.4.2 Energy efficiency

1.4.2.1 Past developments and progress against targets

In general, a decreasing trend can be noticed in the primary energy consumption while final energy consumption remained stable. In period 2011-2017, the primary energy consumption decreased for 12.6% mainly due to higher import of electricity and petroleum products, as well as implementation of energy efficiency measures and increased RES electricity production. The final energy consumption remained stable with few variations mainly due to fluctuation of industry consumption and weather conditions (Figure 1.44).

Figure 1.44 Primary energy and final energy consumption, 2011 – 2017*, ktoe

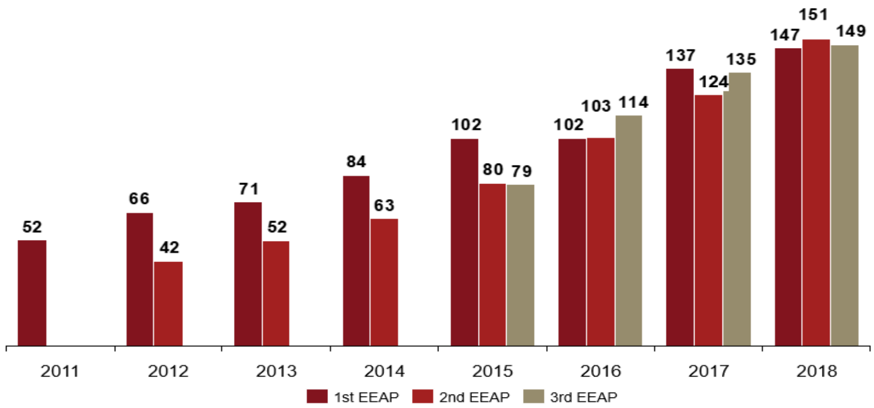


**Note: Preliminary data for 2017*
Source: State Statistical Office, Energy Balances, 2011-2017 (MAKStat Database)

The indicative target is to reduce the final energy consumption in North Macedonia for at least 9% until 2018 relative to reference consumption[2], or the cumulative final energy savings to be 147.2 ktoe. In the second NEEAP, a set of measures have been analysed resulting with projected cumulative final energy savings of 151.2 ktoe, which represent a reduction of 9.24% compared to the reference consumption. This implies achievement of higher savings than the indicative target. In the third NEEAP, besides the measures from the second NEEAP, two new measures are included altogether contributing to cumulative energy savings of 148.7 ktoe in 2018. This value represent 9.09% reduction compared to the reference consumption, which is slightly above the indicative target of 9%. In the third NEEAP it was assessed that achieved energy savings in 2015 amount to 79.4 ktoe, which represent 4.85% of the reference consumption. That means that 99% of the planed energy savings in 2015 were achieved (Figure 1.45).

For the first time the third NEEAP analyses the target for the primary energy consumption in 2020. The projections of primary energy consumption were made by taking the consumption in 2016 energy balance, as a base year, and assuming the annual growth rate of 2.2%. According to that, estimated primary energy consumption in North Macedonia will reach 3,014 ktoe in 2020. This means that North Macedonia will keep the primary energy consumption according to the 'individual cap consumption' set for the EnC countries, which is 3,270 ktoe.

Figure 1.45 Indicative trajectories of final energy savings according to the 1st, 2nd and 3rd EEAP, ktoe



Source: 1st, 2nd and 3rd EEAP, Project team analysis

[2] The reference consumption is the average energy consumption in the period 2002 - 2006

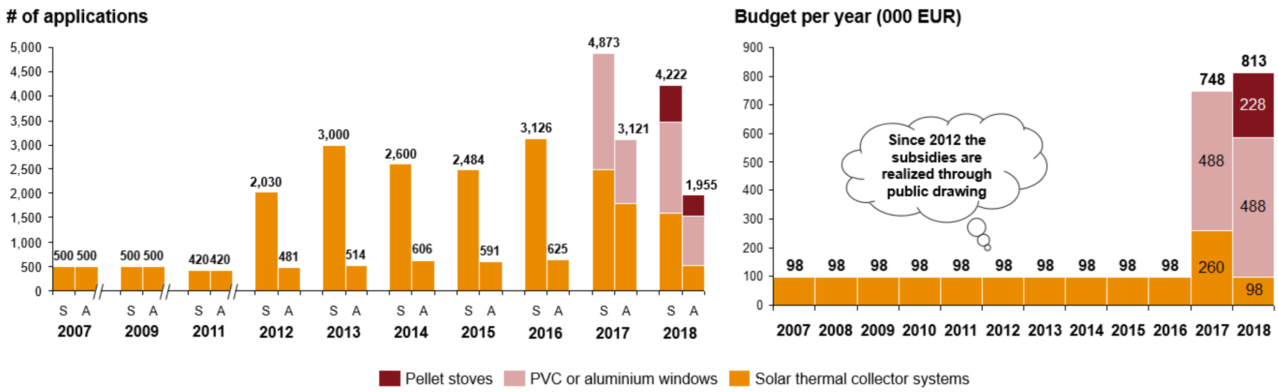
Most of the energy savings is projected to come from enhancements in transport and industry, contributing with 28.7% and 27.8% individually in 2018, but the estimates shows that the household and public sectors are also important for energy savings, with share of 19.6% and 10.4%, respectively.

1.4.2.2 Enrolled EE measures and current support schemes

The third NEEAP gives an overview of 31 policies and measures where majority of them are implemented as planned. The measures are divided in seven sectors: buildings, household, public, commercial, industry, energy and transport. Some of them affect several sectors and their overall savings are reported separately (as a horizontal measures). The implementation of four measures is even better than planned (promotional programme for wider application of solar collectors, municipal street lighting, wider application of RES, and promotion of greater use of railway). One third of the measures are partially implemented and only one not implemented (heat cost allocators).

The Government also promotes usage of RES and EE in households under an annual National Programme. The implementer of the programme is the Ministry of Economy realizing the following support schemes stipulated in the programme: up to 30% reimbursement, but not more than 300 EUR (~18,000 MKD), of the costs for purchasing and installation of solar thermal collector system; up to 50% reimbursement, but not more than 500 EUR (~30,000 MKD) of the costs for purchasing and installation of PVC or aluminum windows; and up to 50% reimbursement, but not more than 500 EUR (~30,000 MKD) of the costs for purchasing pellet stove. Each year, the programme is revised with some new technologies for support being considered that has been increasing in terms of allocated funds (Figure 1.46). The interest for the programme is obvious given the increase in overall applicants each year.

Figure 1.46 Subsidies for promotion of RES and EE in households, 2007 – 2018, number of applications and budget per year



Note: S – submitted applications; A – approved applications
Source: Ministry of Economy, Project team analysis

Support schemes for promotion of EE and RES have been also implemented at local level. The City of Skopje is leading by example with the Program for subsidizing citizens on the territory of the City of Skopje for buying pellet stoves. The support scheme has started in 2016 and covers a partial reimbursement or up 70% of the stove value, but not more than 30,000 MKD (~500 EUR).

1.4.3 Decarbonisation

1.4.3.1 Current GHG and local pollutant emission trends

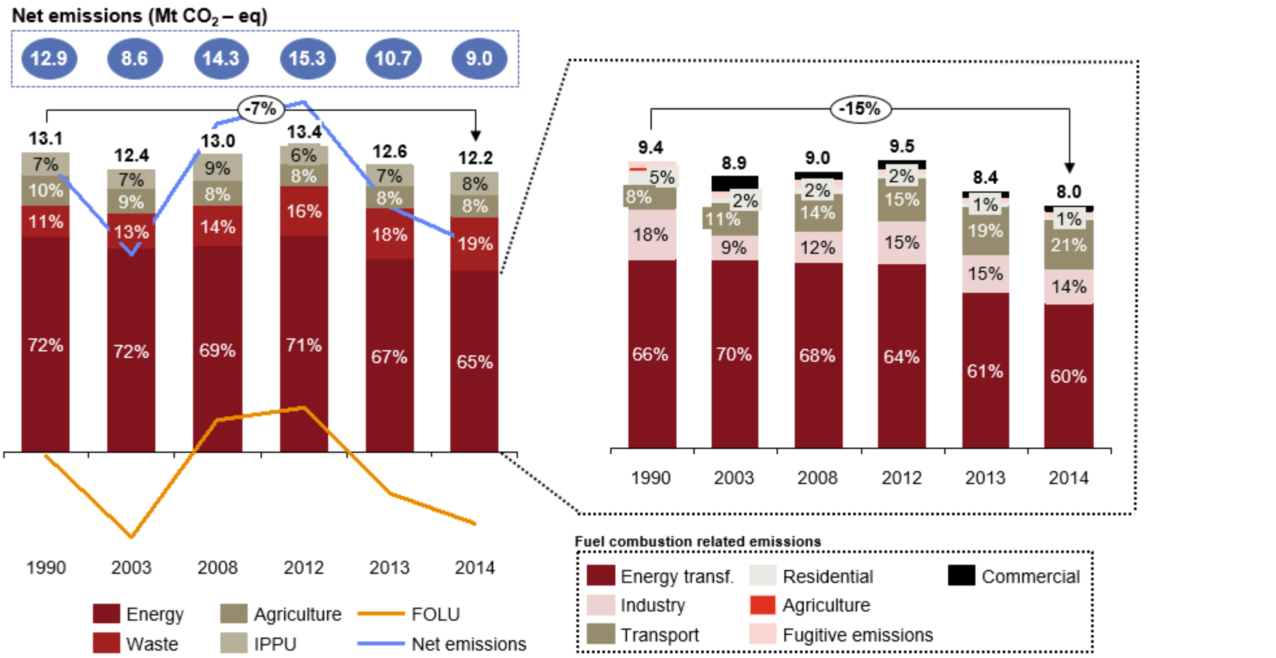
Energy sector has the biggest impact on GHG emissions. The energy sector comprise emissions from fuel combustion in energy transformations, transport, industry, household, commercial and agriculture sub-sectors, as well as fugitive emissions (mines). That accounts for 65% of emissions in 2014 (Figure 1.47), according to the SBUR as the latest adopted document. Due to the significant use of fossil fuels in the country and the dominant use of domestic lignite for electricity production, there is significant potential for GHG emissions reductions. Growing vehicle fleet, with large share of old cars is the main characteristic of the transport sector. According to the latest data (for 2014), the transport sector contributed with 13% (almost 99% came from road transport) in the total national GHG emissions, and with 20.5% in the total emissions in the energy sector. Growing trend in the transport emissions is overwhelming - in 2014, emissions are for 3.6% higher than in 2013 and for 16.4% higher in comparison to 2012 (Figure 1.48). There are ongoing activities for calculations of GHG emission in 2015 and 2016 as part of the Third BUR, but official data are still not available.

Other contributing sectors to emission include waste, industrial processes and product use (IPPU), as well agriculture. The waste sector is the second largest (19% in 2014) and fastest growing source of GHG emissions. The Drisla Landfill, which serves the Skopje region of approximately 590,000 habitants, is the only permitted landfill in North Macedonia and is relatively well managed. The emissions in IPPU (8% in 2014) is primarily driven by the metal industry (ferroalloys), followed by cement production. The agriculture sector contributed 8% in 2014, covering emissions from enteric fermentation, manure management and soils cultivation.

Forestry and other land use (FOLU) is the main sink of CO_2 emissions. Out of a total area of about 2.5 million hectares in the country, forests and forest land cover approximately 1.3 million hectares. Due to intensified forest fires/wildfires, significant fluctuations in the net emissions is evident.

Figure 1.47 GHG emissions by sector, Mt CO_2-eq, 1990 – 2014

Figure 1.48 GHG emissions from energy sector, Mt CO_2-eq, 1990 – 2014



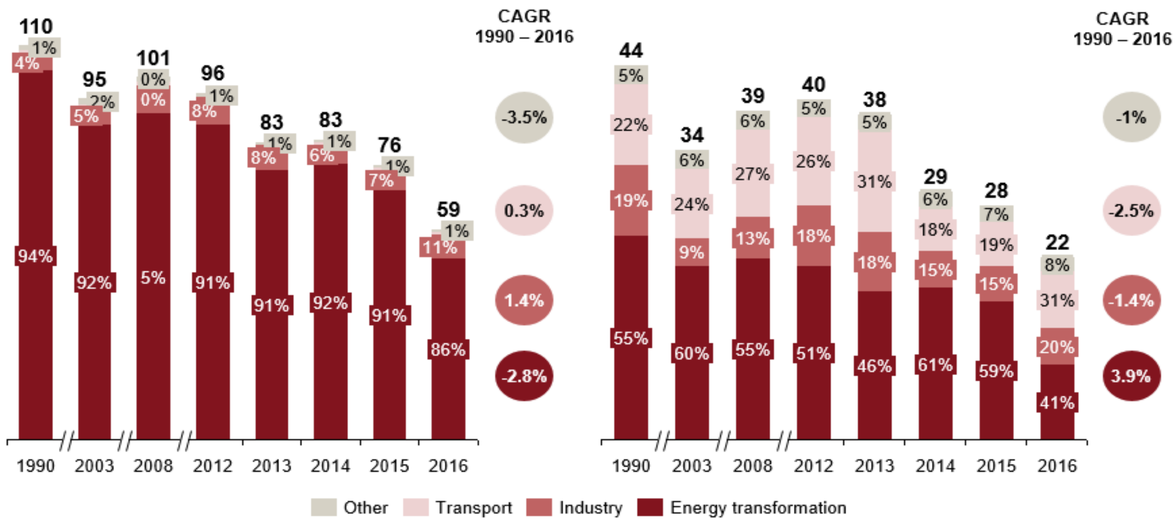
Source: Second Biennial Update Report on Climate Change (SBUR), 2017, Project team analysis

North Macedonia has lower GHG emission per capita by ~30% compared to EU. As to the GHG emissions per capita, Macedonian citizen emits in average 5.9 tonnes CO_2-eq, which is lower for 2.8 tonnes CO_2-eq compared to level of EU citizens in 2014. In terms of GHG emissions per GDP, North Macedonia (1.4 kg CO_2-eq per EUR) has ~5 times higher values compared to EU in 2014 (0.3 kg CO_2-eq per EUR)[3].

Majority of SO_x and NO_x emissions are in the energy sector impacted dominantly by TPP Bitola. The overall SO_2 emissions in 2016 amounted 59 kt and decreased by 47% compared to 1990. In terms of NOx, the trend was similar, where the emissions amounted 21.6 kt in 2016 and declined for 51% compared to 1990 levels. The reduction of emissions after 2012 was mainly due to the reduced amount of burnt coal in TPP Bitola and TPP Oslomej, as well as replacement of heavy fuel oil with natural gas in the heating plants (Figure 1.49 and Figure 1.50).

Figure 1.49 SO_2 emissions by sector, kt, 1990 - 2016

Figure 1.50 NO_x emissions by sector, kt, 1990 - 2016



Note: A significant drop in NO_x levels in the transport sector from 2014 is caused by changes in the methodology and more precise measurements
Source: Ministry of Environment and Physical Planning, Environmental Indicators, 2018, Project team analysis

[3] Based on Eurostat data for EU and Second Biennial Update Report on Climate Change for North Macedonia

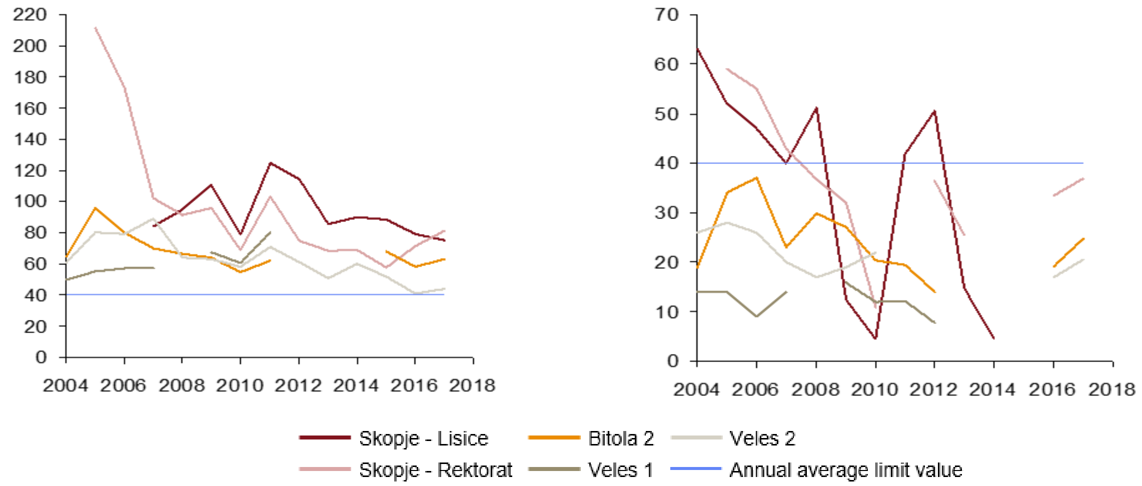
Space heating is the main driver of particulate matters (PM). Overall $PM_{2.5}$ emissions amounted 14kt in 2016, which is lower by 57% compared to 1990 levels. The reason was due to lower emissions from industrial processes (ferroalloy production), energy production and distribution as well as other sectors. In 2016, the main sources of $PM_{2.5}$ emissions were in the following sectors: Households, commercial and institutional (mainly space heating) 63.3%, Industry (mainly ferroalloy production) 22.7%, and Energy production and distribution 6.1%. The situation is similar for PM_{10}. According to the experience in the EU, the relative share of air pollution from households is increasing with stricter emission standards becoming applicable for industry. Therefore, in the short-to-mid term, it can be realistically expected that this share will increase even further and therefore should deserve special focus in combating air pollution.

Most of the population was exposed to PM in excess of the limit values. Increased concentrations of suspended particulate matters can be recorded in urban areas, especially in autumn-winter seasons, which is mostly due to fuels combustion, increased frequency in traffic, and meteorological conditions. The processed data for the period 2004 to 2017 show that during the entire period, most of the population in larger cities were exposed at concentrations of suspended PM that are in excess of the limit value (Figure 1.51).

In general, concentration of SO_2 and NO_x did not exceed the mean limits in the period 2008-2016. SO_2 concentrations were recorded above the limit only in the course of 8 days in Skopje in 2006. NOx levels were above the hourly limit values only during few days in Skopje in 2012 (Figure 1.52).

Figure 1.51 Mean annual concentration of PM_{10}, 2004 – 2018, mg PM_{10}/m^3

Figure 1.52 Mean annual concentration of NO_2, 2004 – 2018, mg NO_2/m^3

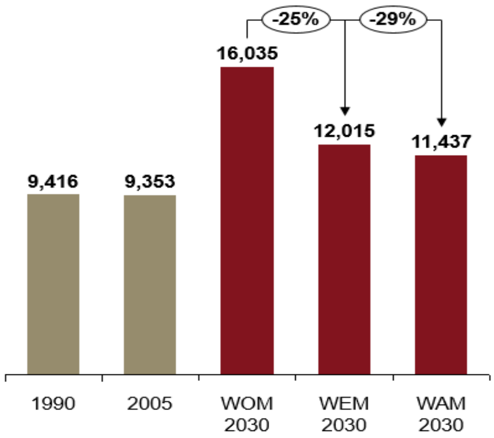


Source: Ministry of Environment and Physical Planning, Environmental Indicators, 2018, Project team analysis

1.4.3.2 GHG emission contributions and local pollutant emission ceilings

The latest calculated GHG emissions reductions till 2030 is up to 29% compared to WOM scenario. In difference to INDC where only Energy sector and only CO_2 emissions are targeted, there are three scenarios for GHG emission levels in SBUR which take into account all IPCC sectors - Energy, IPPU, Waste and Agriculture excluding FOLU. Scenario without Measures (WOM) serves as a reference scenario. Scenario with Existing Measures (WEM) anticipates realization of all the measures included in the current strategic and planning documents, and results with a 25% GHG emissions reduction compared to WOM in 2030. Scenario with Additional Measures (WAM) anticipates realization of current and additional (or enhanced) measures that results in a 29% GHG emission reduction compared to WOM in 2030 (Figure 1.53). The energy sector participates ~70% to the overall GHG emissions in 2030. The SBUR shows more ambitious level of emission reductions from energy sector (34%) in 2030 compared to the INDC goal (30%).

Figure 1.53 Estimations for GHG emission reduction in North Macedonia according to SBUR, Gg CO_2 – eq, 1990 - 2030



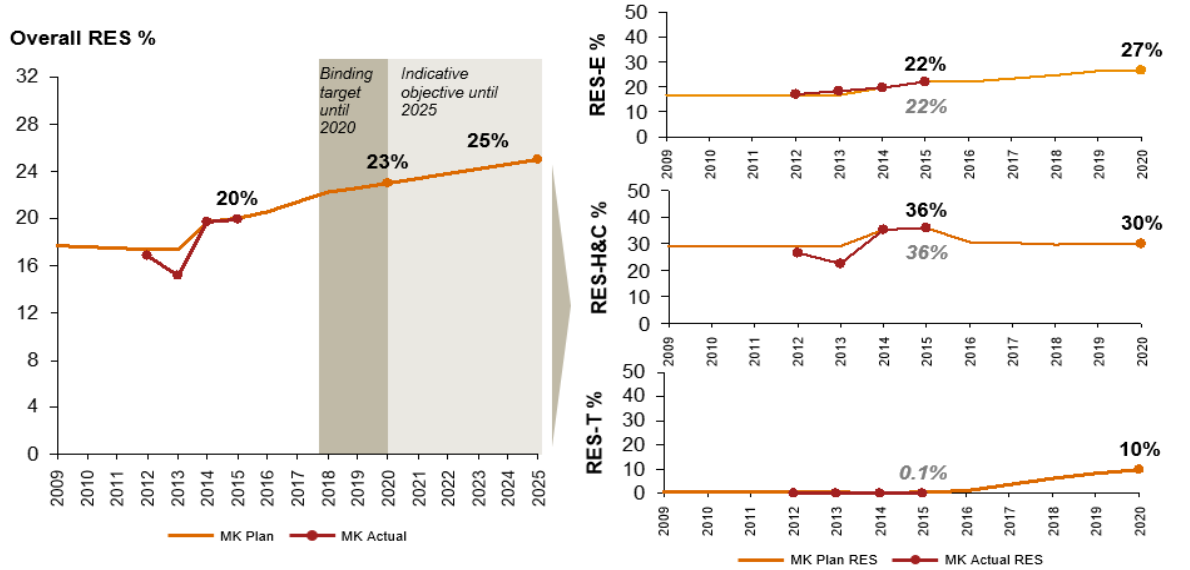
Source: Second Biennial update report on climate change of the Republic of North Macedonia, Project team analysis

The largest reduction of SO_2, NO_x and PM emission levels could be achieved by TPP Bitola. The revised National Emission Reduction Plan (NERP) prescribes the SO_2, NO_x and PM emission ceiling levels until 2027 for nine existing large combustion plants with capacity of more than 50 MW rated thermal input. The document envisages the installation of control equipment and filters to reduce the local pollutant emission levels (based on the Large Combustion Plant Directive and Industrial Emissions Directive), which is also foreseen for TPP Bitola as the largest contributor.

1.4.3.3 Renewable energy sources

RES target for 2020 is 23% in gross final energy consumption according to the Decision 2018/MC-EnC. In terms of RES sectors, it is projected that in 2020, heating and cooling sector (RES-H&C) will achieve the highest RES share of 30%, following with electricity sector (RES-E) of 27% and transport sector (RES-T) of 10% share in gross final energy consumption. Achieving the 2020 RES target is challenging having in mind difficulties in the transport sector regarding biofuels (Figure 1.54).

Figure 1.54 Macedonian RES objectives in gross final energy consumption, %



Source: Decision 2018/MC-EnC; Revised National Renewable Energy Action Plan; NREAP Progress Reports 2015 & 2017 Project team analysis

The highest RES contribution is achieved in H&C sector, while the biggest GHG emission savings are in electricity sector. The H&C sector relies mostly on biomass used in households which represents 90%-95% overall, but due to low efficiency of biomass stoves, its contribution to GHG savings is less impactful. The overall GHG emission savings are constantly increasing by 15% per annum, primarily due to increasing RES-E investments mainly supported with feed-in tariff mechanism (Figure 1.55 and Figure 1.56). At the end of 2017, there were 170 eligible producers with 128 MW installed capacity that are using incentive feed-in tariffs with 67.5 MW hydro, 16.8 MW solar PV, 36.8 MW wind and 7 MW of biogas respectively. The overall payed incentives to eligible producers of electricity have been rising steeply and amounted 35.7 mil. EUR in 2017. The Government plans to continue with the current feed-in tariff mechanism and to introduce market based premiums.

Figure 1.55 RES contribution in gross final energy consumption, per sector, 2012 – 2015, ktoe

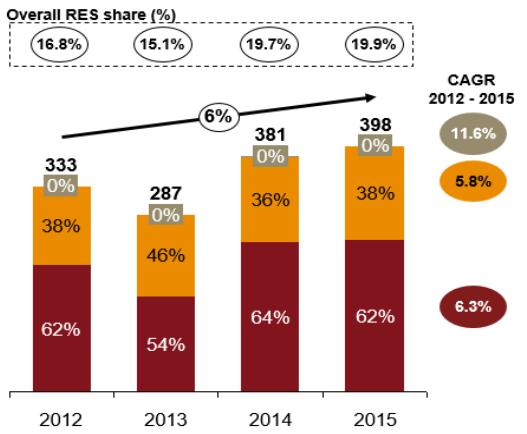
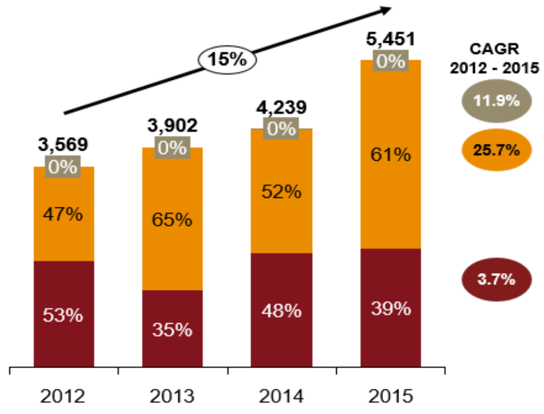


Figure 1.56 Estimated GHG emission savings from RES, per sector, 2012 – 2015, kt CO_2-eq



Source: NREAP Progress Reports 2015 & 2017, Project team analysis

North Macedonia has ~7.3 GW theoretical potential for exploiting RES for electricity, especially solar and wind[4]. The highest share of theoretical potential comes from wind of up to 4.9 GW, followed by solar PV up to 1.4 GW and hydro up to 0.67 GW. The largest cost-competitive solar PV potential is on utility scale, while large-scale hydro potential is mainly located on the Vardar River and to a lesser extent on the Black Drin River. Regarding wind, cost competitive potential could be limited due to wind speed and unreachable terrain in some areas. Geothermal potential for electricity is limited due to the relatively low geothermal gradient in the region. Technological advancements, decrease of costs as well as environmental constrains will have an important role in exploiting the technical potential in the future.

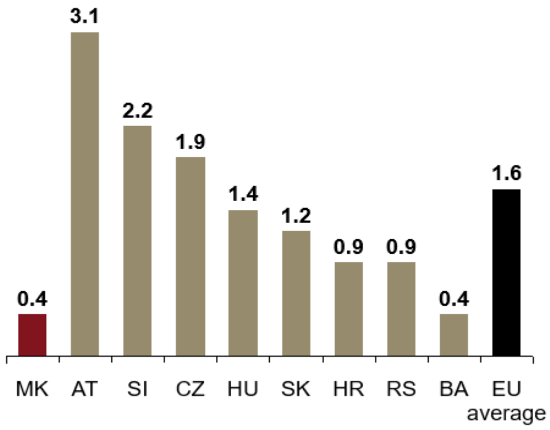
Diesel drives the growth in the transport sector, while usage of RES is negligible. The transport sector has been growing by 9% per annum, while road diesel for 10% in period 2013 – 2017. RES consumption in transport sector is less than 0.2% per year in the transport sector for period 2012 - 2015. Other sources like bioethanol, electricity or biogas in transport are not present in transportation sector. SBUR reported that transportation is one of the most significant contributors to GHG with 8.2%, while trend assessment showed that transportation is responsible for 19.7% of GHG emissions. Since little attention has been paid to transport decarbonisation, it represents one of the major challenges.

1.4.4 Research, innovation and competitiveness

Energy sector could have its role when it comes to boost rather limited R&D spending. North Macedonia is categorized as a "moderate innovator"[5]. Although the analysis identify enhanced export of medium and high technologies and increased public investment in research and development, the total expenditure for R&D as a percentage of the GDP remains significantly low i.e. 0.4% R&D expense from total GDP (Figure 1.57). In addition, ESM as the most important energy stakeholder, spends approximately EUR 0.6 million on annual level or 0.3% from total revenue on R&D costs. Within the Innovation Strategy 2012-2020, as well as the Economic Reform Programme 2018 - 2020 developed by the GoM, utilization of RES and enhancement of energy efficiency are one of the main government priorities and strategic objectives.

[4] IRENA - Cost – competitive renewable power generation: Potential across South East Europe
[5] European Innovation Ranking List, 2017

Figure 1.57 R&D expenditure, 2017, % of GDP



Source: Eurostat, Project team analysis

In the period 2014 – 2018, 57% of total EU contributions under Horizon 2020 for North Macedonia[6] were associated with projects focused on various topics from energy thematic area. Majority of spending was used for the following themes: secure, clean and efficient energy 2.6 mil EUR (13 participants), climate action, environment resource efficiency and raw materials 1.14 mil EUR (4 participants) and smart, green and integrated transport 0.12 mil EUR (1 participant). In terms of sector involvement, majority of spending was used by public sector 1.1 mil EUR, higher education 1.05 mil. EUR and private sector 0.89 mil. EUR. From private sector, only one SME subject participated with used net contributions of 0.06 mil. EUR.

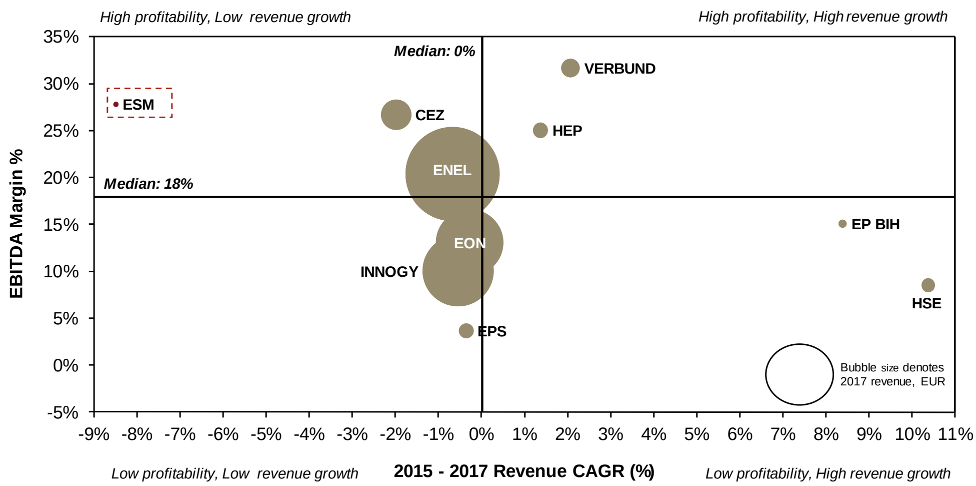
There are several institutions that are focused on energy sector that can stimulate R&I. North Macedonia has a variety range of institutions such as ICEOR – MANU, Faculties of University Ss. Cyril and Methodius (electrical engineering and information technology; mechanical engineering; computer science and engineering), Faculties of University Goce Delcev (electrical engineering and mechanical engineering), Faculty of Technical Sciences at the University St. Kliment Ohridski, University of Southeast Europe (contemporary science and technologies), Faculty for Technical Science at the Mother Theresa University, as well as and NGOs / associations ZEMAK, MACEF, MAKO CIGRE, North Macedonia Innovation Centre, E-Mobilnost, Analitika, Ekosvest, Front 21/42, Go Green, Solar Association, CeProSARD, etc. It will be essential to boost additional investments in the development and deployment of advanced technological solutions (especially RES and EE), as well that the public sector supports key projects including innovative energy technologies. Since responsibilities for innovation policy are shared between different institutions, institutional mechanisms are expected to ensure a coherent approach and effective policy coordination.

The country is eligible to use significant amount of funds from international donors, however there is a large underspend. The country is receiving funds for research and development in the energy field from international donors, national public donors and private sector. Currently, there is lack of national energy fund to manage and plan all investments in the energy sector in North Macedonia. Available international donors' funds which historically have supported energy sector such as EBRD, EIB, EU funds, UNDP, KfW, UNIDO, USAID, World Bank, are underutilized due to weak organizational structures, inadequate skills and limited facilities and resources. There is also the national public fund for SMEs, the Fund for innovation and technology development. The Fund offers technical assistance via tech accelerators, offers co-financed grants for improvement for innovation, co-financed grants for newly established start-up and spin-off companies, as well as co-financed grants and conditioned loans for innovation commercialisation for different sectors.

ESM might expect greater risk and pressure on revenues and profitability given the current situation in Europe, where liberalization and decarbonisation brings challenges for power utilities. Following liberalization and increased competitiveness in European energy market, there is a potential risk where ESM could face similar situation what other European and regional utilities have where growth in revenue and profit is reduced. As a matter a fact, ESM is already facing decrease in revenue (Figure 1.58). Some of recent trends in Western Europe were the transformation and spin-off of RWE and E.ON with the goal to separate their conventional and renewable portfolio. In addition, E.ON and RWE are reshuffling their businesses within a recent complex asset swap, where E.ON will acquire Innogy's retail and gird business while selling back its renewable portfolio to RWE. Both companies are seeking to adapt to decarbonisation trends.

[6] Horizon 2020 Dashboard - North Macedonia

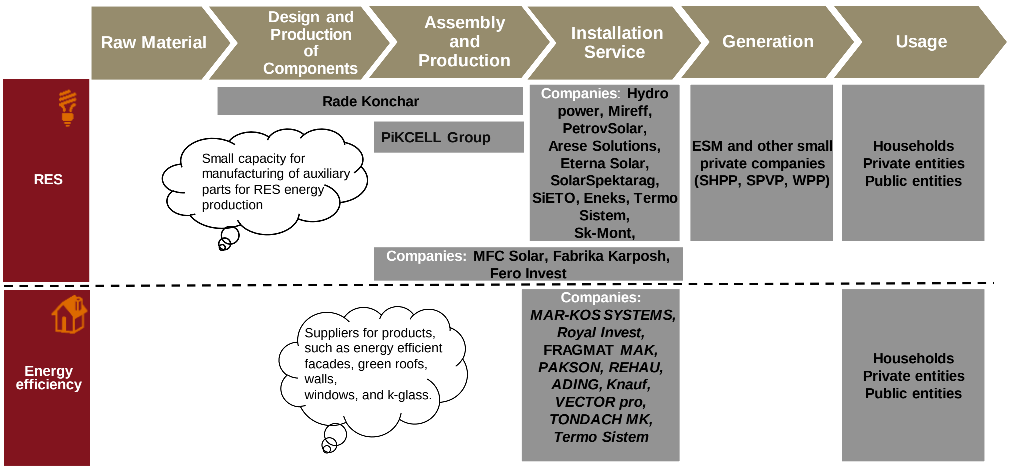
Figure 1.58 Profitability and revenue growth trends for ESM and Peer Groups, 2015 – 2017



Source: Company Annual Reports, Project team analysis

Low carbon transition could stimulate SME segment in North Macedonia. In terms of SME contribution to energy sector, most offer only installation services, mainly in RES and EE. There is a significant growth potential, from scaling-up low carbon, economy efficient solutions starting from the demonstration stage to the market in the field of renewable energy technologies and greater energy savings. These projects require high levels of investment and as the risk with respect to costs, performance and market integration are high, the public sector is expected to employ mitigation mechanisms and thus, support the private investors (Figure 1.59).

Figure 1.59 SMEs contribution to energy development across the value chain in North Macedonia



Source: Companies website, Project team analysis

1.4.5 Legal and regulatory aspects

With adoption of the Energy Law, the Third Energy Package is fully transposed in electricity and natural gas sectors. For electricity sector, both TSO and DSO are legally and functionally unbundled. Network access is in line with the EU legislation which means that network tariffs are approved and published by ERC. Interconnection capacities are allocated in accordance with auction rules approved by ERC including auctions with Greece organized by SEE CAO. Access to the system and the network are in line with the acquis, encompassing the access to the network at regulated network tariffs. In 2020, it is expected that balancing services will be procured by MEPSO on market based principles. The Energy Law enables all electricity generators to participate at the wholesale market. Households and small customers can select their supplier, including the supplier of the universal supply. Also, according to this Law, ESM as the biggest electricity generator, is obliged to offer a portion of electricity demand under the universal supply up to 2025. Still, the ongoing developments in the regulatory framework for establishment of organized energy markets is yet to be completed.

Regarding the natural gas market, North Macedonia has full deregulated wholesale and retail market. The unbundling of the TSO has not been carried out due to the unresolved ownership status of the TSO, while the regulatory regime regarding the DSO is compliant with the acquis. The Tariff System for transmission of natural gas and organization and management of the natural gas, which also regulates the entry/ exit tariff methodology, has been adopted end of 2018, while its application is envisaged to start from 2020. In order to achieve better interconnectivity, the current technical agreement with the Bulgarian TSO needs to be aligned with Regulation (EU) 2015/73. Furthermore, a Memorandum of Understanding was signed with the Greek TSO for the future interconnection.

North Macedonia has transposed the Directive for compulsory oil reserves, with next step to develop an Action Plan. North Macedonia is obliged to maintain compulsory petroleum products reserves that correspond to at least 90 days of average daily net imports or 61 days of average daily consumption whichever is greater. In 2017, county's oil stock corresponded to 70 days of average daily consumption, while in 2018 oil stock decreased to 65 days. Macedonian Compulsory Oil Reserves Agency is responsible for establishment, maintenance, storage and sale of compulsory oil and petroleum products reserves. North Macedonia has the aim to have 70% of required compulsory reserves stored in North Macedonia and 30% in EU countries. The compulsory oil reserves should be formed by 31.12.2022, based on an Action Plan. This plan should include the dynamics of formation of reserves, necessary storage volumes per product, location of storage capacities, roadmap to achieving necessary storage capacities, and financing options considering the impact on the final consumers.

The support for RES will continue to develop in line with the Directive 2009/28/EC. The Directive is transposed with the adoption of the Energy Law and by-laws. Macedonian Energy Law contains requirements for a competitive bidding process for feed-in premium that will enable support to renewable energy producers and market integration of renewables. Priority network access and dispatch of RES and high efficient cogeneration plants is stipulated in the Law with a dedicated article, as well as in the grid codes of the electricity TSO and DSO. The prosumer concept is introduced in the Energy Law and further regulated with secondary legislation. Legal framework for the RES in transport is yet to be harmonized with the Directive 2009/28/EC, including the adoption of sustainability criteria for biofuels and bio liquids.

Relevant obligations under the EnC Treaty to ensure compliance with the energy efficiency acquis are in different levels of implementation. North Macedonia has invested lot of work in drafting of legislation by the relevant institutions, with the support of donors and the EnC Secretariat. With the new Energy Efficiency Law and by-laws, the transposition of the EE Directive 2012/27/EU will be completed. Considering the obligations under this Directive, in July 2017, the Government of the Republic of North Macedonia adopted the Third National Energy Efficiency Action Plan (NEEAP). The preparation of new NEEAP 2019 – 2021, in line with reporting requirements of Directive 2012/27/EU is ongoing. The transposition of the Energy Labelling Directive 2010/30/EU is considered to be completed since a Rulebook on Labelling of Energy-Related Products was adopted in September 2016. The transposition of the Energy Performance of Buildings Directive 2010/31/EU is partially realized. A Rulebook on Energy Audit was adopted in July 2013. Also, in July 2013, a Rulebook on Energy Performance of Buildings was adopted which was amended in January and October 2015. The remaining obligations from this Directive will be implemented in the new Law on Energy Efficiency.

North Macedonia as a non-Annex I Party to the UNFCCC ratified the Paris Agreement and is also converting legislative and regulatory framework according to EU 2030 Climate and Energy Framework. Macedonian Intended Nationally Determined Contribution (INDC) includes reduction of CO_2 emission from fossil fuels combustion for 30% (or 36% at higher level of ambition) by 2030 compared to the BAU scenario. The Law on Environment incorporates articles that stipulate general obligations and responsibilities regarding greenhouse gases (GHG) inventories and national plan for climate change. GHG Inventory was prepared within First, Second and Third National Communication as well as the First and Second Biannual Update Report and Inventories at city level (Resilient Skopje Strategy, Second BUR). The latest GHG inventory database covers the period 1990 – 2014, and includes five direct gases - CO_2, CH_4, N_2O, PFCs and HFCs, and four indirect gases - CO, NO_x, NMVOC and SO_2.The country will need to adopt a long-term climate action strategy and a Law on Climate Action. In terms of the Sustainable Development Goals, a gap analysis on SDG Mainstreaming into the National Sustainable Development Planning for the Period from 2016 to 2030 was undertaken in 2016. The results show that the SDG 13: "Take urgent action to combat climate change and its impacts" has been adequately covered into the national strategic documents in the areas of mitigation, vulnerability assessments, awareness and dissemination. Gaps have been identified with regards to the adaptation and resilience sectoral planning, appropriate monitoring framework, as well as quantifiable and measurable indicators of achievements in both mitigation and adaptation.

North Macedonia has set the regulatory and legal framework for limiting local pollutants. The Republic of North Macedonia has reached a high level of transposition of the EnC acquis, with certain amendments related to large combustion plants still to be adopted. The Environmental Impact Assessment Directive was transposed into national law by the Environmental Law and by-laws following closely the structure and content of the Directive. The legal framework regarding Sulphur in Fuels Directive is in place specifying maximum thresholds for the Sulphur content of heavy fuel oil and gas oil compliant with those of the Directive. Also, Wild Birds Directive is transposed by the Law on Nature Protection. The Large Combustion Plants Directive is transposed by the Rulebook on the Limit Values for the Permissible Levels of Emissions and Types of Pollutants in the Exhaust Gases and Vapour Emitted into the Air from Stationary Sources. The emission limit values for new and existing plants are aligned with those of the Directive. Amendments to the Rulebook are being prepared to transpose the Industrial Emissions Directive. The Law on Control of Emissions from Industry is in the process of being drafted and the Government adopted NERP in 2017.

With the Energy Law, roles and responsibilities of ERC are strengthened. ERC now has the expanded role of market monitoring and resolving irregularities, especially in case of market competition. ERC also adopted the methodology and criteria for evaluation of risks and prioritization of investments in electricity and natural gas infrastructure projects that are on PECI and PMI list of the contracting parties and/or participants in the Energy Community Treaty.

Implementation of the statistics is achieved. Publishing and collection of annual and monthly data is in compliance with the acquis. According to Annex C of the Regulation 1099/2008, the monthly data on oil, gas and electricity are transferred to EUROSTAT on time.

Institutional capacity is rather low. As per current functional analysis of the Ministry of Economy and Energy Agency, there is lack of human capacities including skilled and experienced workforce. In addition, in the Ministry of Environment and Physical Planning, almost all subsectors have some linkages to energy but lacking institutional coordination. The positive step is the coordinative Climate and Energy Working Group, created by the decision of the Government in 2018. Members of the body are representatives from Ministry of Economy, Ministry of Environment and Physical Planning, Ministry of Transport and Communications, Ministry of Finance, Ministry of Agriculture, Forestry and Water Economy, Cabinet of Deputy Prime Minister for Economic Affairs, Secretariat for European Affairs, Energy Agency, ESM and MANU. Expected outputs is better collaboration between the institutions which should result in efficient and effective decision for the improvement of the energy sector.

2 ENERGY VISION AND STRATEGIC GOALS UNTIL 2040

The Strategy for Energy Development of the Republic of North Macedonia until 2040 (the Strategy) relies on relevant global, EU energy policies and trends, and particularly Energy Community *acquis*. Specifically, North Macedonia is willing to follow good practice of EU RES and EE policies, as well as decarbonisation, taking into consideration targets and trajectories with realistic dynamics that are tailor- made to domestic specifics and priorities of the Government of the Republic of North Macedonia.

The Energy Law stipulates that the Strategy should ensure:

- Secure, safe and quality supply of all types of energy to the consumers;
- Stability, competitiveness and economic functionality of the energy sector;
- Efficient provision of services and protection and promotion of consumers rights;
- Reduction of energy poverty and protection of vulnerable consumers;
- Inclusion of the energy markets of the Republic of North Macedonia in the regional and international energy markets;
- Use of energy sources in a manner that provides sustainable energy development;
- Promotion of energy efficiency;
- Reduction of the use of fossil fuels for energy generation;
- Promotion of the use of renewable energy sources;
- Protection of public health, the environment and mitigation of climate change from the harmful effects arising from the performance of energy activities and
- Fulfilment of commitments assumed by the Republic of North Macedonia under ratified international agreements

According to article 11, paragraph 3 of the Law, the Strategy should cover a period of at least 20 years. Given that the previously adopted energy strategy covers the period 2010 – 2030 and the draft version of the Energy strategy that was not adopted covers the period 2015 – 2035, the decided period of this Strategy is 2020 – 2040.[7]

Accordingly, the 2040 vision of the Strategy is:

Secure, efficient, environmentally friendly and competitive energy system that is capable to support the sustainable economic growth of the country.

In order to achieve the 2040 vision, the Strategy depicts three scenarios: Reference, Moderate Transition and Green (Figure 2.1). The three scenario reflect different dynamics of energy transition and enable flexibility into Macedonian response to relevant EU policies and governance for modern, competitive and climate-neutral economy by 2050. The scenarios are based on years of research in the areas of strategic energy planning and climate change within the energy strategies, EE and RES plans, national communications and biennial update reports for climate change, particularly the climate change mitigation analyses conducted as a part of the SBUR.

Figure 2.1 Overview of scenarios for the development of Macedonian energy system until 2040

		Reference scenario	Moderate Transition scenario	Green scenario
	Vision	**Transition from conventional energy based on current policy and least cost principles**	**Progressive transition from conventional energy based on new policy and least cost principle**	**Radical transition from conventional energy based on new policy and lignite phase out**
Assumption highlights	**Demand drivers**	• Macedonian GDP growth to reach neighboring EU countries' GDP per capita levels of today by 2040 • Current energy efficiency policies • Penetration of EVs	• Same GDP growth as for reference • Energy efficiency based on enhanced policy (in line with EU Directives / EnC guidelines) • Higher penetration of EVs	• Same GDP growth as for reference • Same as moderate transition but more incentives and advanced technologies • Highest penetration of EVs
	Generation investments focus	• Lignite PP revitalization choice based on least cost principles • High focus on RES	• Lignite PP revitalization choice based on least cost principles • Further focus on RES technology investments	• Lignite PP revitalization choice based on least cost principles • Extreme focus on RES investments
	Carbon price at ETS level	2027	2025	2023
	Commodity prices (WEO 2017)[1]	Based on current policies scenario	Based on new policy scenario	Based on the sustainable development scenario
	Fuel Supply / Availability	• Lignite production capped at a maximum level of annual supply expected (~ 5 M tons 2018-2035, ~ 3 M tons 2035-2040) • Hydro production and wind/solar in line with historical trends and adjusted for new entering power plants • Cross Border Capacities (electricity and gas) evolution in line with the ENTSO-E, ENTSO-G and EnC • Sustainable consumption of biomass[2] • Battery storage (EVs and pump storage)		

1) World Energy Outlook, 2017
2) Does not exceed the annual growth of biomass, and includes utilization of residual biomass
Source: Project team analysis

[7] The ToR included the preparation of the projections till 2040.

To translate the vision statement into clear objectives, the Strategy defines five energy pillars with six strategic goals (Figure 2.2), closely interlinked with the five dimensions of the European Energy Union Strategy[8] respectively:

- Security, solidarity and trust;
- A fully integrated internal energy market;
- Energy efficiency;
- Decarbonizing the economy;
- Research, innovation and competitiveness.

Each energy pillar has an important role in the energy system planning, but has to be seen in a holistic manner, in order to understand synergies and trade-offs. For energy efficiency pillar, the maximization of energy savings is much needed as it directly impacts emission reductions, decrease of import dependence, and stimulate the domestic economy with local job opportunities. In terms of integration and security of energy markets (second pillar), the goal is to maintain today's energy import level, with the key focus areas in electricity, oil products and natural gas via new infrastructure and regional cooperation. The main lever in the decarbonisation pillar is the shift towards low-carbon fuels and technologies, which can be achieved by a combination of GHG emission reductions in conventionally-fired production capacities and dependent sectors, and higher usage of RES technologies in a sustainable manner. The selected future options for meeting the decarbonisation agenda need to be achieved in as cost effective way. Therefore, the R&I and competitiveness pillar emphasizes the role of science and innovation to use the best technologies at lowest cost. Lastly, the legal and regulatory aspects are the baseline for effective and transparent market functioning, with North Macedonia's focus being on the EnC acquis' harmonisation and implementation.

Each strategic goal is accompanied by an indicator used to evaluate and compare results of different scenarios, as well as to monitor the progress.

Figure 2.2 Overview of energy development strategy goals and indicators for North Macedonia

Energy pillar	Indicator	STRATEGIC GOALS	Metric
1 Energy efficiency	Energy efficiency	Maximize energy savings	• Reduction of primary and final energy consumption vs. BAU scenario
2 Integration and security of energy markets	Energy dependence	Maintain current energy dependence around today's level (54% net import), while improving overall integration in European markets	• Net import share in primary energy consumption
3 Decarbonisation	GHG emissions	Limit the increase of GHG emissions	• Absolute amount of GHG emissions (CO_2, CH_4 and NO_2) vs. BAU scenario and vs. 2005
	RES share	Strongly increase RES share in gross final consumption from today's level (19% of RES) in a sustainable manner	• RES share (heating & cooling, electricity, transport) in gross final energy consumption
4 R&I and competitiveness	Total system costs	Minimize system costs based on least cost optimization	• System costs per annum & cumulative in euros incl. overall annualized investments, O&M costs, delivery costs & fuel supply costs
5 Legal & regulatory aspects	Legal & regulatory compliance	Ensure continuous harmonisation EnC acquis and its implementation	• Harmonisation of national legislation with EnC acquis and its implementation in practice

Note: BAU or Business as Usual scenario is a scenario with the purpose to show energy sector evolution with energy measures realised until 2016. For details see Appendix I, which is an integral part of this strategy.
Source: Project team analysis

[8] Policy Guidelines (draft) by the Energy Community Secretariat on the development of National Energy and Climate Plans as part of recommendation 2018/01/MC-EnC

3 INTEGRATED ENERGY RESULTS AND POLICIES

3.1 Integrated energy results until 2040

The six strategic goals have been integrated as a cornerstone into the energy model employed in the Strategy, delivering integrated energy results that will shape the development of the Macedonian energy system until 2040.

Integrated energy results show a progressive energy transition from today's level and business as usual perspective in all three scenarios. Energy efficiency results indicate that the undertaken measures are effective in achieving energy savings in primary and final energy consumption compared to BAU. The biggest savings could be achieved on the primary demand side, up to -34.5% in 2030 and up to -51.8% in 2040 for the Green scenario.

Net Import in primary energy consumption will remain similar as of today's levels (54% of net import) in the Reference and Green scenarios, while the Moderate transition scenario will slightly increase the import dependence.

In Green scenario, GHG emissions level could be halved compared to BAU in 2030, and reduced by two thirds in 2040. When compared with 2005 levels, all scenarios exhibit reduction of GHG emission levels in 2030 and 2040.

In terms of RES penetration, all scenarios envisage a high contribution of RES in gross final energy consumption. Even the Reference scenario stimulates high amounts of RES in 2030 and 2040.

Having in mind specific assumptions of regional market development and country specific circumstances, the results show that the energy transformation will create a win-win situation - stronger economy, secure energy supply and cleaner environment at lower energy system costs. The Green scenario has the lowest total system cost in 2030 and 2040, which means that with this scenario the vision of the Strategy is achieved in a cheapest way (Figure 3.1).

Figure 3.1 Summary of integrated energy results in 2030 and 2040

			Year 2030			Year 2040		
Energy pillar	Indicator	Metric	Reference	Moderate Transition	Green	Reference	Moderate Transition	Green
1 Energy efficiency	Energy efficiency	% reduction of primary & final energy consumption vs. BAU	-15.3% primary -10.3% final	-31.2% primary -16.6% final	-34.5% primary -20.8% final	-34.9% primary -14.2% final	-47.9% primary -21.7% final	-51.8% primary -27.5% final
2 Integration and security of energy markets	Energy dependence	% of net import in primary energy consumption	48.7%	61.9%	59.1%	51.0%	61.9%	55.3%
3 Decarbonisation	GHG emissions	% reduction vs. 2005 and vs. BAU	-20.9% -22.9% vs. BAU	-57.2% -58.3% vs. BAU	-64.7% -65.3% vs. BAU	-8.1% -35.6% vs. BAU	-43.3% -60.2% vs. BAU	-61.5% -72.8% vs. BAU
3 Decarbonisation	RES share	% of RES in gross final energy consumption	33%	38%	40%	35%	39%	45%
4 R&I and competitiveness	Total system costs	Bn. EUR in 2030 and 2040 with cumulative	3.8 41.0	3.3 38.3	3.2 37.3	5.1 86.5	4.8 81.2	4.5 78.1
5 Legal & regulatory aspects	Legal & regulatory compliance	EnC acquis harmonisation & implementation	Full compliance			Full compliance		

Note: RES share results include heat pumps
Source: Project team analysis

The results for GHG emissions and RES are in line with 2030 EnC indicative targets for all three scenarios, while results for energy efficiency depend whether it is expressed in absolute or relative terms. EnC facilitates the process of determining the 2030 targets for Contracting Parties. At the moment, the 2030 EnC targets are indicative and are in process of finalization with Contracting Parties.

Regarding EE targets, there is a difference in underlying assumption of EnC's BAU scenario and Strategy's BAU scenario. The consequences are different relative and absolute values between the EE results for North Macedonia (EnC vs. Strategy), where relative value of Reference and Moderate transition does not or almost achieves the 2030 EnC target. This is less pronounced in absolute terms where the Reference scenario almost achieves the EnC target, while the Moderate transition is compliant. The Green scenario fulfils the targets in both cases. In addition, EE Directive provides an option whether the EE targets should be imposed on primary or final energy consumption. When observing the results, it is recommended to set the future EE targets rather on primary energy consumption. The reason of more pronounced differences between primary and final energy consumption is due to dominant reliance on coal production capacities, as well as overall primary to final conversion efficiency. Therefore, any intervention in efficiency improvements would be more visible through primary energy.

The situation for GHG emission is positive where all scenarios are more progressive in the reduction of GHG emissions when compared to 2030 EnC target. However, it should be noted that the coverage of EnC GHG targets in absolute terms lacks clarity. In addition, the Strategy takes into account emission associated with the imported electricity in the overall GHG emissions. Therefore, further harmonisation among North Macedonia, other Contracting Parties and EnC is envisaged in the future (Figure 3.2).

Figure 3.2 Summary of integrated energy results vs. 2030 EnC targets

		Year 2030 (relative terms)				Year 2030 (absolute terms)			
Energy pillar	Indicator	EnC target	Reference	Moderate Transition	Green	EnC target	Reference	Moderate Transition	Green
1 Energy efficiency	Energy efficiency	-32.5% primary OR final vs. BAU	-15.3% primary -10.3% final	-31.2% primary -16.6% final	-34.5% primary -20.8% final	2,862 ktoe primary 1,996 ktoe final	2,975 ktoe primary 2,301 ktoe final	2,414 ktoe primary 2,138 ktoe final	2,300 ktoe primary 2,030 ktoe final
3 Decarbonisation	GHG emissions	+13% vs. 2005	-11.4% (-20.9%)	-37.6% (-57.2%)	-43.0% (-64.7%)	14.7 Mt CO_2-eq	11.5 Mt (7.4 Mt) CO_2-eq	8.1 Mt (4.0 Mt) CO_2-eq	7.4 Mt (3.3 Mt) CO_2-eq
	RES share	33.9% at least	33%	38%	40%	n/a	n/a	n/a	n/a

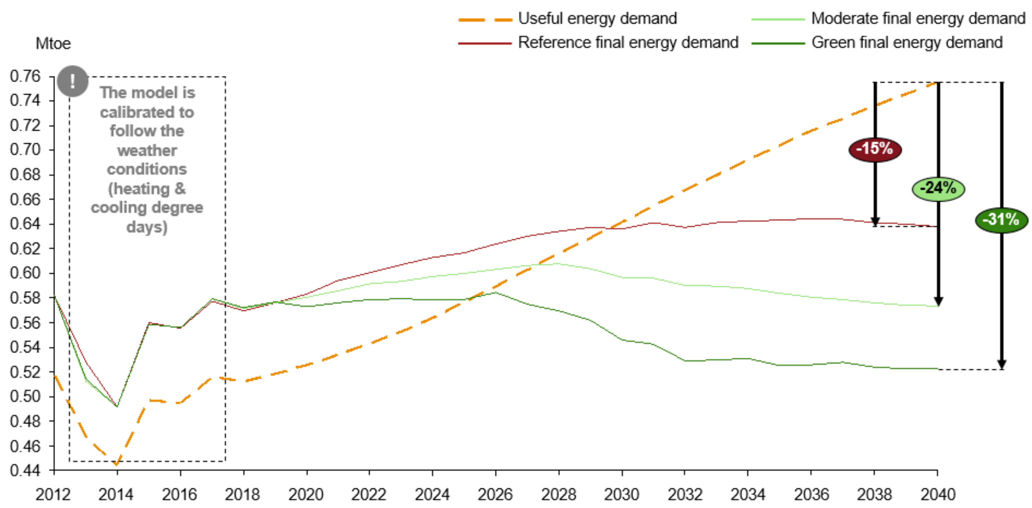
Results vs. EnC targets EnC 2030 achieved; EnC 2030 almost achieved; EnC 2030 not achieved; Targets not available

Note: The indicative 2030 EnC targets have not been formally adopted during the process of development of the Strategy. The GHG emissions target defined in the EnC Study is economy-wide (covering all IPCC sectors - Energy, IPPU, Waste and Agriculture excluding FOLU), and for North Macedonia it reads: in 2030 13% increase of total GHG emissions compared to 2005 emission level. In our Strategy only Energy sector is targeted, so in order to compare EnC GHG target and the Strategy consistent economy-wide target, it is assumed that emissions in all sectors except Energy in 2030 will increase for 13% compared to 2005. The upper values of GHG emissions correspond to Strategy consistent economy-wide figures, while the numbers in brackets correspond to Energy sector figures. RES share results include heat pumps.
Source: Project team analysis

3.1.1 Energy efficiency indicator

In all three scenarios, North Macedonia will use less resources to cover the same needs. Even though the useful energy consumption is projected to grow, the final energy consumption does not follow this trend since more efficient technologies are being implemented in each of the scenarios (Figure 3.3). This shown on the case of household sector will reveal 15% lower final energy consumption compared to useful energy consumption in 2040 under the Reference scenario, and even higher deviation of 24% and 31% under the Moderate transition and Green scenario, respectively. The decoupling of the energy consumption curves starts from 2020 for all scenarios, but with different rates per each scenario until 2040. For the period 2012 – 2017 the model is calibrated to reflect the consumption according to the actual weather conditions.

Figure 3.3. Useful vs. final energy consumption in household sector, by scenario

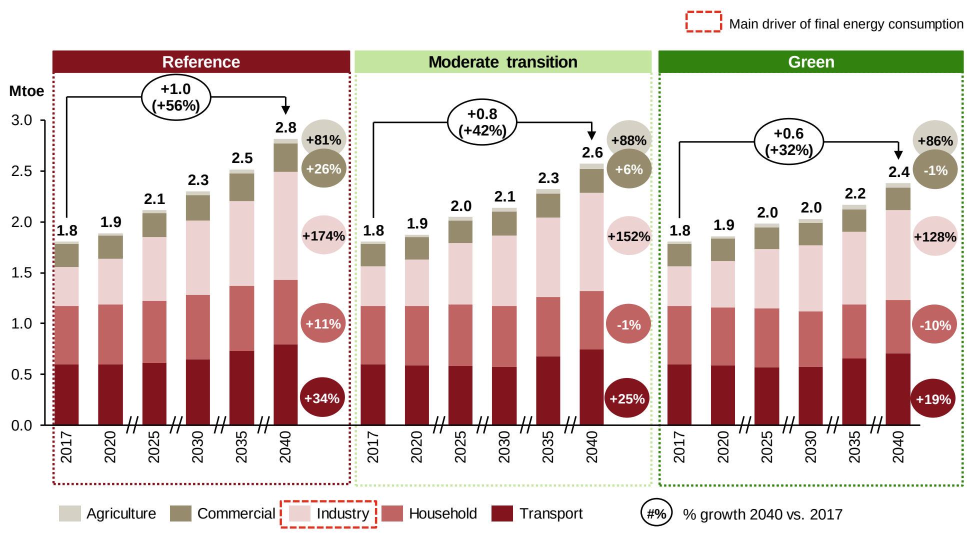


Source: MARKAL model

In all three scenarios, the final energy consumption will increase, but at considerably lower rates in the Moderate transition and Green scenarios. In the Reference scenario the overall growth is estimated to 56% in 2040 vs 2017, while in the other two scenarios the growth takes a slower pace (Figure 3.4).

In all three scenarios, the industrial sector is the main driver of the final energy consumption. The final energy consumption in the industry will follow the projected economic development of the country. In the Moderate transition scenario, the utilization of technologies with better efficiency in the household sector is expected to gradually decrease the final energy. This effect is expected to be more pronounced in the Green scenario and to be reflected in other relevant sectors, like the commercial sector (Figure 3.4).

Figure 3.4 Final energy consumption per sector

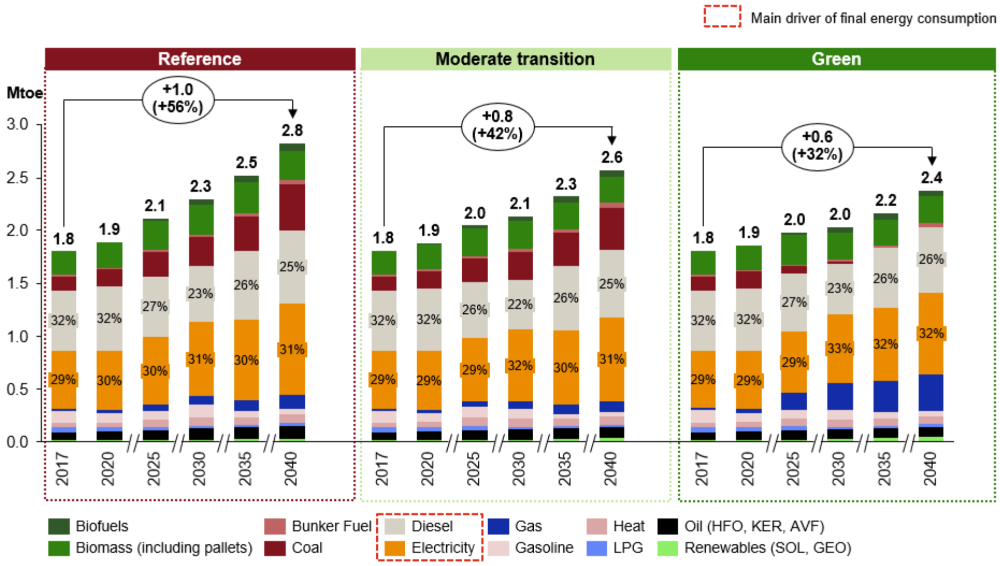


Source: MARKAL model

Electricity & diesel have the highest share in the final energy consumption (55-60%). In all three scenarios, electricity and diesel will remain key commodities to satisfy the final energy needs (Figure 3.5). However, their consumption will be reduced in Moderate transition scenario, resulting with 0.2 Mtoe less compared to the Reference scenario (Figure 3.6).

Additionally, other commodities, such as natural gas and renewables, are expected to become more available for final consumption. Therefore, in the Green scenario, the final energy consumption is 0.4 Mtoe lower than in the Reference scenario, owing to the substitution of coal with gas in the industry (Figure 3.7).

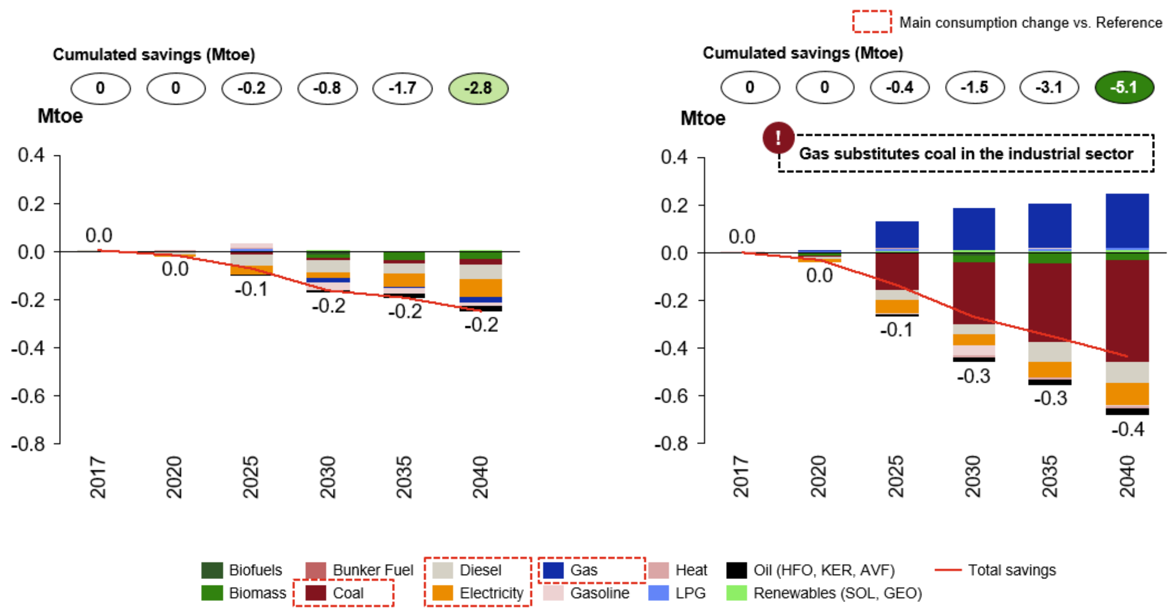
Figure 3.5 Final energy consumption by fuel



Source: MARKAL model

Figure 3.6 Final energy consumption reduction by fuel - Moderate vs. Reference

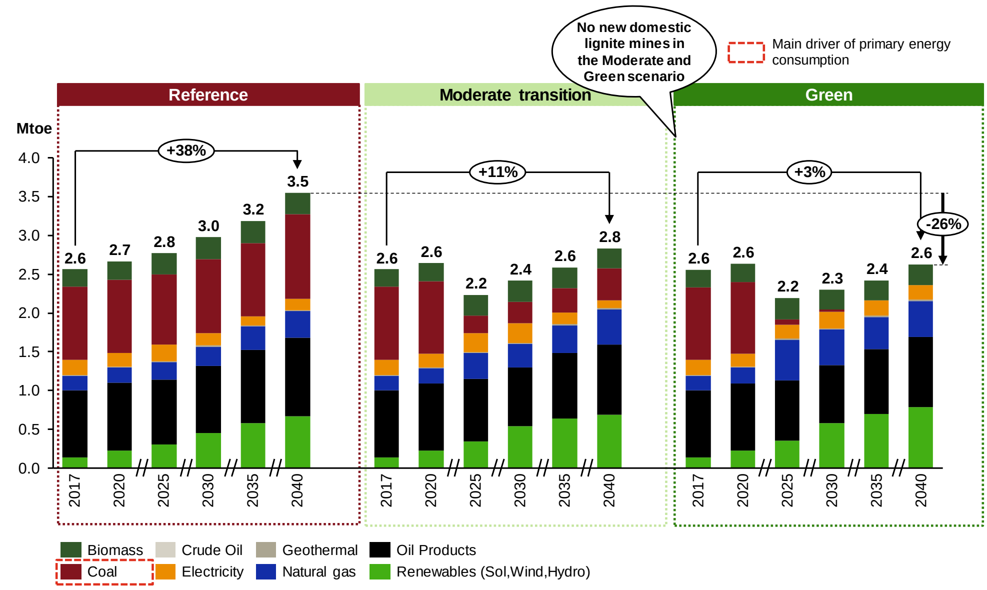
Figure 3.7 Final energy consumption reduction by fuel - Green vs. Reference



Source: MARKAL model

The decrease of coal consumption is the main driver for reduction of primary energy demand. The primary energy demand in the Reference scenario is projected to grow for 38% by 2040, driven by the coal consumption. However, due to higher CO_2 price, new domestic lignite mines will not be a viable option in the Moderate and Green scenario and coal technologies are replaced with more efficient gas and RES technologies. This will reflect on the primary energy consumption, which in the Green scenario in 2040 will be 26% less than the Reference scenario (Figure 3.10).

Figure 3.8 Primary energy consumption per fuel

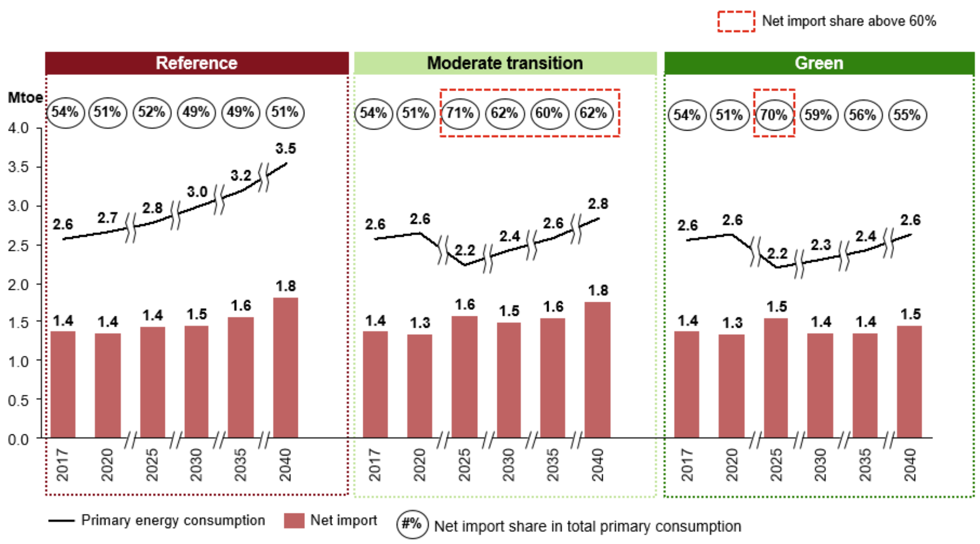


Source: MARKAL mode

3.1.2 Energy dependence indicator

Considering the energy dependence, in the Reference and Green scenario the share of net import remains at current level, while in the Moderate transition it increases to ~60% by 2040. From this aspect, in Moderate transition and Green scenarios, a critical year is 2025 when the existing lignite power plants will be decommissioned and the remaining generation capacity in the country will not be enough to satisfy the electricity consumption, so additional import of electricity and natural gas will be needed (increasing its share to around 70%) (Figure 3.9).

Figure 3.9 Net import share in total primary consumption

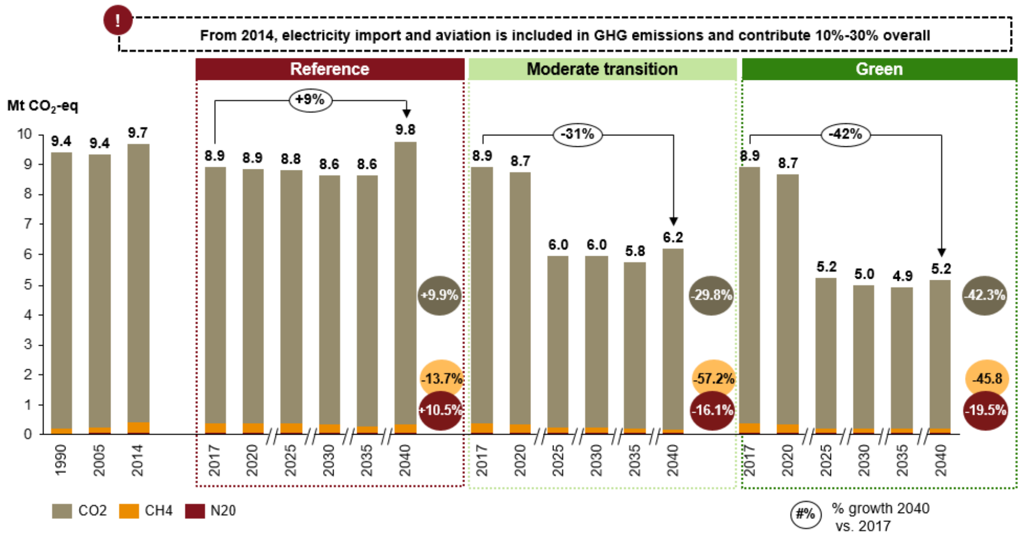


Source: MARKAL model

3.1.3 GHG emissions indicator

GHG emission reduction is achieved in two out of three scenarios, driven by the decline in the coal utilization and mining. CO_2 represents the majority of GHG emissions in all three scenarios (~96% of total). In the Moderate transition scenario the CO_2 emissions decrease for nearly 30% in 2040 relative to 2017 and in the Green scenario for 42%. For the same scenarios, a significant reduction of CH_4 emissions can be noticed, mainly due to the elimination of the fugitive emissions from the coal mines (no new mines). If using the IPCC methodology (excludes emissions from electricity import and international aviation) to compare the results with 1990 and 2005, the results show that emissions in 2030 are lower for all scenarios compared to 1990 and 2005 levels - Reference scenario ~21%, Moderate transition ~57% and Green scenario ~65%. The comparison is made relative to several years because for the EnC countries the base year is still not defined.

Figure 3.10 Reduction of GHG emissions by gas

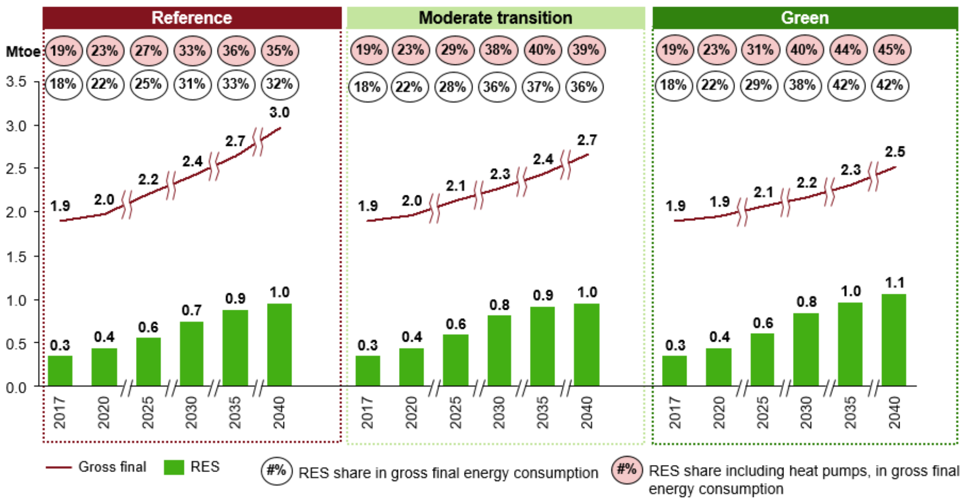


Note: 1990 and 2005 GHG emissions are taken from National GHG Inventory
Source: MARKAL model

3.1.4 RES share indicator

RES share in the gross final energy consumption increases in all scenarios, landing in the range of 35 – 45% in 2040. The utilization level of the renewables as an important factor for decarbonisation of the energy sector, has been considered relevant even in the Reference scenario, where 33% RES share is projected after 2030. According to the method for RES share calculation established by the Renewable Energy Directive 2009/28/EC, a minimum threshold is defined for the seasonal performance factor (SPF) of the heat pumps, above which the heat pumps can be considered as a renewable source. Thus, by taking into account the heat pumps, the RES share in gross final energy consumption will become even higher, reaching almost 40% in the Moderate transition scenario and 45% in the Green scenario (Figure 3.11).

Figure 3.11 RES share in gross final energy consumption

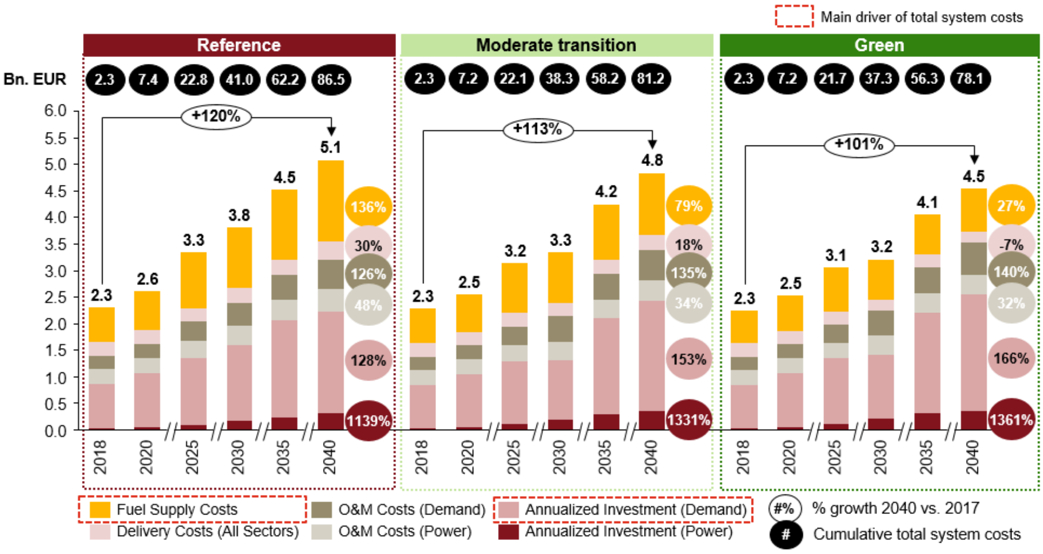


Source: MARKAL model

3.1.5 Total system costs indicator

In the Reference scenario, the annual energy system costs will be more than double by 2040. Additional 2.8 billion EUR will be needed in 2040 (Figure 3.12). The majority of the annual expenditures in the Reference scenario are investments in the demand technologies and the fuel costs, both consisting 65% of the total costs in 2018 and slightly increasing to 68% in 2040. Also, investments in power generation technologies will occur, especially after 2030.

Figure 3.12 Annual expenditures breakdown

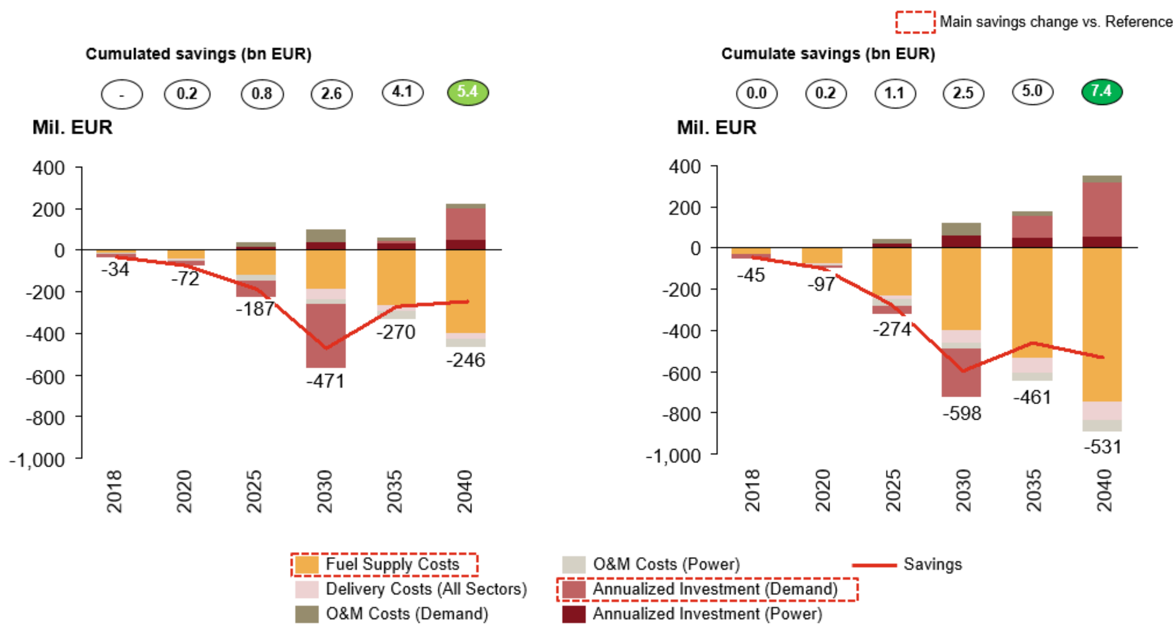


Source: MARKAL model

The Green scenario is most cost-effective scenario. The cumulative savings in the Moderate transition scenario are estimated at 5.4 billion EUR (Figure 3.13), while in the Green scenario the estimate is at 7.4 billion EUR (Figure 3.14). The main driver for the savings is the lower cost of fuel supply, although more investment in new technologies are needed.

Figure 3.13 Annual expenditure savings by element – Moderate transition vs. Reference

Figure 3.14 Annual expenditure savings by element – Green vs. Reference



Source: MARKAL model

3.2 Policies and strategic measures

In order to fulfil the priorities stipulated in the Energy Law as well as to make necessary steps to reach the 2040 vision, the Strategy sets policies and strategic measures grouped in pillars in line with European Energy Union Strategy. In addition, all policies and strategic measures are clearly cross-referenced with the priorities from Energy Law in order to emphasize their relevance and contribution.

3.2.1 Energy efficiency

Covered priorities from the Energy Law: ▪ *Use of energy sources in a manner that provides sustainable energy development;* ▪ *Promotion of energy efficiency;*

Set the national EE targets (2020 and 2030). The analyses presented in this Strategy will be used as a basis for defining of the national EE targets for 2020 and 2030. By closely following the rigorous, streamlined and inclusive process of the EnC for establishment of energy efficiency, renewables and greenhouse gas emissions reduction targets for 2030 at EnC level, the Strategy proposes national EE targets for 2020, 2030 and 2040 (Figure 3.15 and Figure 3.16).

Figure 3.15 Energy efficiency trajectory and targets for primary energy compared to BAU scenario

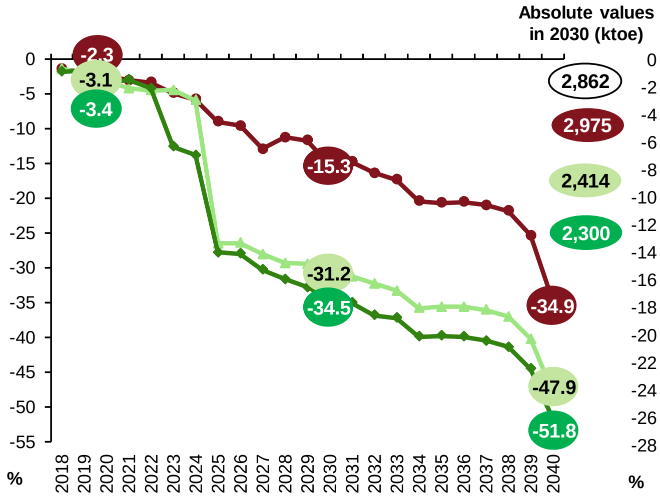
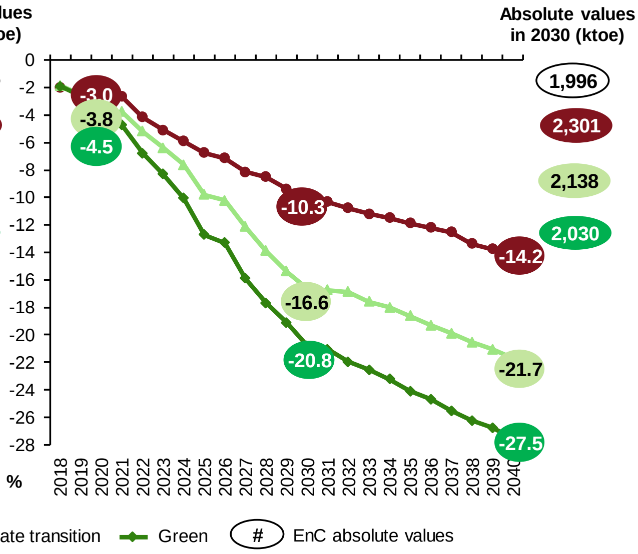


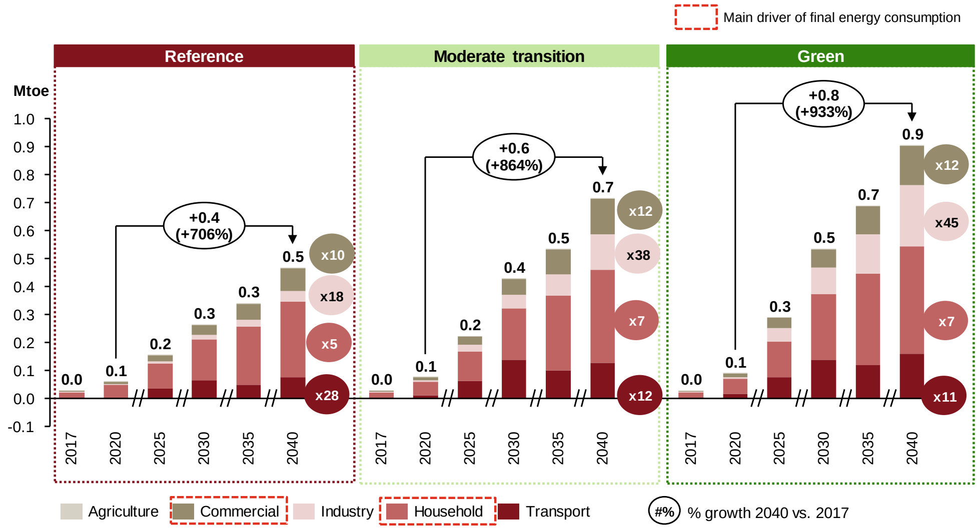
Figure 3.16 Energy efficiency trajectory and targets for final energy compared to BAU scenario



Source: MARKAL model

Continue the usage of existing and introduce new EE measures in final energy consumption for household and commercial sector. The results show that the highest EE savings in final energy consumption can be achieved in household and commercial sector (Figure 3.17). Majority of savings could rely on existing measures with greater penetration in the country, and with introduction of new ones. These include highly efficient appliances in household, commercial and public sectors, exemplary role of public buildings (retrofit measures), insulation of existing and new residential buildings with introduction of nearly zero buildings, energy audits, energy management, promotion of higher utilization and expansion of district heating systems, as well as electrification of heat sector (heat pumps). Financing energy efficiency projects is the key to successful implementation and could be supported with development of ESCO market as well as other financing mechanisms (e.g. revolving energy efficiency fund, financial programmes on municipality levels, public private partnerships, energy cooperatives etc.). The operationalisation of ESCO market should follow the recommendations from the recent “Legal Gap Analysis”, which identified gaps in terms of deficits in three functional areas, namely lack of supportive organizational/institutional structures, lack of flexibility in order for public authorities to fully benefit from the innovative and tailor-made ESCO energy efficiency investments and lack of commercial/economic viability for carrying out ESCO projects in North Macedonia. Detailed measures for the household and commercial sector are given in Table 3.1, Table 3.2 and Table 3.3. It is important to note that the implementation of the obligation schemes will increase the cost of energy in average for ~0.015 EUR/MWh.

Figure 3.17 Final energy consumption efficiency savings per sectors vs. BAU



Source: MARKAL model

Put additional focus on EE measures in final energy consumption for industry and transport sector. Industry and transport sector have the highest growth rates in the overall energy savings compared to 2020, ranging 18 –45 times for industry and 11-28 times for transport depending on the scenario. The role of these sectors in energy savings will become increasingly important after 2025 (Figure 3.17). The highest contribution in the industry can be achieved with measures in efficient technologies that will enable fuel switch (from coal to gas), as well as use of efficient electric motors. In terms of transport EE savings, replacement of old vehicles with energy-efficient ones, electrification of road transport (EVs), as well as modal shift from road to rail for freight transport and from car to bus for passenger transport, and more biking / walking in urban areas are seen as the most important measures. Detailed measures for the industry and transport sector are given in Table 3.4 and Table 3.5.

Monitor the effect of EE measures. It is important that energy savings are measurable and could be monitored. In that way, the measures that prove to have more impact on energy consumption could be further stimulated for implementation.

Implement further relevant technical measures to decrease continuously transmission and distribution network losses. The most impactful savings potential can be achieved by reducing losses in the distribution network for electricity and DH network for heat sector (Figure 3.18). Technical measures for reducing distribution electricity losses comprise of overhead lines replacement with underground (where possible), transition to 20 kV voltage level, installation of new transformation stations to shorten the low voltage lines, as well as automation and remote network management. All these improvements will contribute to better SAIDI and SAIFI indicators. For the heating sector, technical measures include continuous replacement of existing heat pipelines with pre-insulated ones and optimization of the substation operations through automatic control. Detailed measures for the transmission and distribution networks are given in Table 3.7.

Figure 3.18 Reduction of district heating system losses

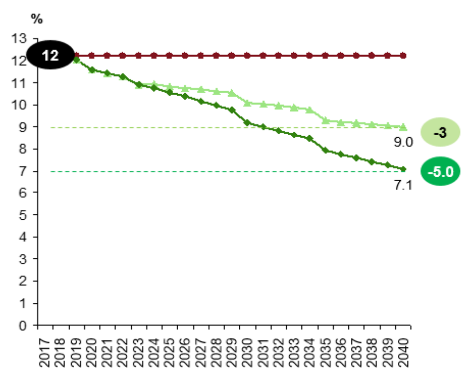
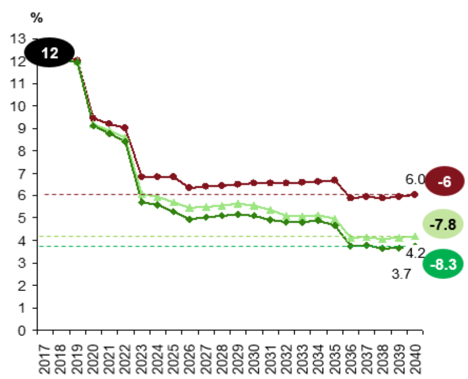


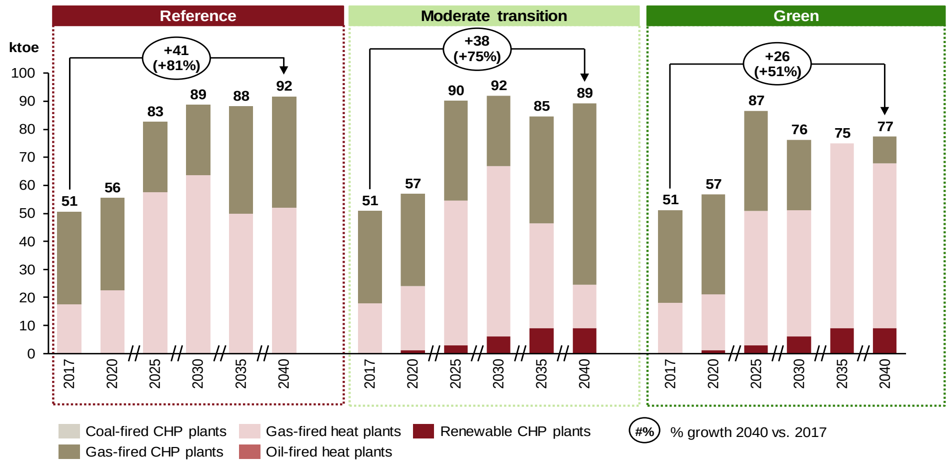
Figure 3.19 Reduction of electricity transmission and distribution losses



Source: MARKAL model

Revitalize or replace existing generation capacities to enable higher energy transformation efficiency. The role of gas-fired CHPs will remain important in Reference and Moderate transition scenarios, while Green scenario shifts to gas-fired heat plants due to high CO_2 price, which makes electricity generation from gas not competitive. The existing CHP capacities are revitalized after 2033. In addition, more efficient new biomass fired CHP plants (using FiT for generated electricity) are selected as a viable option in both Moderate transition and Green scenarios (Figure 3.20). The last could be used for generation capacity in small district heating systems. For the electricity generation, the revitalization of TPP Bitola in the Reference scenario assumes the increase of plants net efficiency from 30% to 32%.

Figure 3.20 Heat generation by plant type



Source: MARKAL model

Enable modernization and expansion of existing and new DH systems taking into account development of other alternatives. For existing DH systems, the goal should be to improve the energy efficiency at production level by using CHP plant, heat pumps and RES, decrease losses via systematical reconstructions of distribution network and connection of new consumers, particularly public and commercial, as well as promotion of installment of individual heat metering system in multi-apartment buildings. The last, will particularly contribute to energy efficiency improvements of the apartments. There is a possibility for introduction of new small-scale DH systems where high-efficiency combined facilities and RES could be used having in mind technical, economic and environmental aspects in contrast to other heating options, especially considering the planning of distribution systems of natural gas. This stands for areas with high concentration of heat energy consumption. Detailed measures are given in Table 3.6.

It is important to note that the energy consumption reduction presented in the following tables are indicative and indicates how much a given measure/policy will contribute to the reduction independently. As a result of the interdependence between the measures/policies in the scenarios, the total reductions of energy consumption cannot be calculated as a simple sum of the reductions of each measure/policy individually. To avoid the interdependence, the measures/policies are grouped in different scenarios.

Table 3.1 Horizontal measures

#	EE policies and measures	Scenario	Assumptions	Final energy savings (ktoe)			Primary energy savings (ktoe)			Budget (MEuro)
				2020	2030	2040	2020	2030	2040	
1	Energy efficiency obligation schemes	Reference Moderate Green	**1.** Final energy saving targets of: - 0.5% in 2017; - 0.7% in 2018-2020; - 0.35% in 2021-2030; - 0.2% in 2031-2040 of the average annual energy sales of final customers in the period 2014-2016 excluding the customers in the transport sector as well as industries according to Annex I of the Directive 2003/87/EC. **2.** 30% of the costs will be covered by the distribution companies or suppliers	13.2	44.4	87.6	10.8	67.8	306.6	182
2	Public awareness campaigns and network of energy efficiency (EE) info centers	Reference	Investment in public awareness rising campaigns that will increase the share of more efficient appliances (with higher class of efficiency) by 2040 to - 20% in Reference - 30% in Moderate and - 40% in Green scenario	15.6	48.2	90	12.7	75.3	345.9	2
		Moderate		17.8	53.2	96.3	14.6	81.8	379.1	4
		Green		24.3	67.8	110.4	20.2	99.7	416.3	8

Table 3.2 Energy efficiency in buildings

#	EE policies and measures	Scenario	Assumptions	Final energy savings (ktoe)			Primary energy savings (ktoe)			Budget (MEuro)
				2020	2030	2040	2020	2030	2040	
1	Solar rooftop power plants	Reference	The following capacities are envisioned to be constructed by 2040: - 250 MW in Reference; - 350 MW in Moderate and - 400 MW in Green scenario	n/a	n/a	n/a	0	18.9	195	227.1
		Moderate		n/a	n/a	n/a	0	26.3	276.2	318
		Green		n/a	n/a	n/a	0	29.9	311.1	263.4
2	Labeling of electric appliances and equipment	Reference Moderate Green	As a result of this measure it is expected that by 2040 the share of EE technologies will be 6%	4.6	19	40	4.1	28.1	137.9	71
3	Retrofitting of existing residential buildings	Reference	Annual renovation rate of 1%, while meeting the standard for at least C class (90 kWh/m2)	3.7	27.9	57.9	3.8	33.6	126.3	941.8
		Moderate		3.7	27.9	57.9	3.8	33.6	126.3	941.8
		Green		8.1	42	107.2	8.3	50.4	255	1708.2
4	Retrofitting of existing commercial buildings	Reference Moderate Green	Annual renovation rate of 1.5% of the existing commercial buildings	11.2	26.5	48.1	10.8	35.7	179.4	530
5	Construction of new buildings	Reference	Construction of new residential buildings, while meeting the standard for at least C class (90 kWh/m2)	2.1	15.9	30.5	2.2	19.2	65.6	474.1
		Moderate		2	12	15.6	2.1	14.3	26.9	282.7
		Green		2	12	15.6	2.1	14.3	26.9	282.7
6	Construction of passive buildings	Reference	Construction of new passive buildings, while meeting the standard for at least A+ class (15 kWh/m2) starting from 2020 and continuously increasing their number so that in 2040, 85% of new buildings are assumed to be passive.	0	0	0	0	0	0	0
		Moderate		0	8.5	30	0	10.5	86.9	1068
		Green		0	8.5	30	0	10.5	86.9	1068
7	Phasing out of incandescent lights	Reference	Regulation will be adopted on prohibiting sales of incandescent light bulbs, starting from 2020, with 2-3 years transition period	5.8	17.9	32.6	4.6	32	186	177.6
		Moderate		20.7	66	119.4	15.9	118.4	667.7	558
		Green		20.7	66	119.4	15.9	118.4	667.7	558

Table 3.3 Energy efficiency in public sector

#	EE policies and measures	Scenario	Assumptions	Final energy savings (ktoe)			Primary energy savings (ktoe)			Budget (MEuro)
				2020	2030	2040	2020	2030	2040	
1	Retrofitting of existing central government buildings	Reference	Annual renovation rate of: - 1% in Reference; - 2% in Moderate and - 3% in Green scenario of the existing central government buildings	0.1	1.5	3.3	0.1	2.1	9.6	55
		Moderate		0.3	3.2	6.7	0.3	4.3	20.8	155
		Green		0.4	4.8	10.1	0.4	6.6	32.2	170
2	Retrofitting of existing local self-government buildings	Reference	Annual renovation rate of: - 0.5% in Reference; - 1% in Moderate and - 1.5% in Green scenario of the existing local self-government buildings	0.1	1.6	3.3	0.1	2.2	14.1	50
		Moderate		0.3	3.1	6.7	0.3	4.4	27	100
		Green		0.4	4.7	10.1	0.4	6.7	39.5	150
3	"Green procurements"	Reference	Increase of advanced energy efficiency technologies due to green procurements of: - 5% in Reference; - 5% in Moderate and - 7% in Green scenario	0.2	1.8	4.2	0.2	2.4	14.2	16
		Moderate		0.2	1.8	4.2	0.2	2.4	14.2	16
		Green		0.3	2.5	5.9	0.3	3.4	20.3	24
4	Improvement of the street lighting in the municipalities	Reference	Improvement rate of street lighting by 2040 of: - 60% in Reference; - 60% in Moderate and - 100% in Green scenario	2.5	6.6	9.1	2.3	12.1	55.1	19.5
		Moderate		2.5	6.6	9.1	2.3	12.1	55.1	19.5
		Green		3.2	7.8	9.6	2.7	14.2	57.7	25.3

Table 3.4 Energy efficiency in industry

#	EE policies and measures	Scenario	Assumptions	Final energy savings (ktoe)			Primary energy savings (ktoe)			Budget (MEuro)
				2020	2030	2040	2020	2030	2040	
1	Energy management in manufacturing industries	Reference / Moderate / Green	Improvement of the systems efficiency in manufacturing industries at annual rate of 0.15%	0.9	15.7	43.4	0.9	18.8	103.7	Negligible
2	Introduction of efficient electric motors	Reference	The share of efficient electric motors by 2040 will be: - 40% in Reference; - 40% in Moderate and - 60% in Green scenario	0.1	2.5	7.1	0.2	4.1	35.6	99.7
		Moderate		0.1	2.5	7.1	0.2	4.1	35.6	99.7
		Green		0.3	5	7.9	0.3	7.8	39.9	113
3	Introduction of more advanced technologies	Reference	The share of more advanced technologies by 2040 is: - 15% in Reference; - 30% in Moderate and - 60% in Green	1.8	13.4	32.5	1.8	15.3	58.8	141.8
		Moderate		4.1	38.7	89	4.2	40.9	124	344.8
		Green		6.7	59.4	119.2	6.7	62.5	1075	438.6

Table 3.5 Energy efficiency in transport

#	EE policies and measures	Scenario	Assumptions	Final energy savings (ktoe)			Primary energy savings (ktoe)			Budget (MEuro)
				2020	2030	2040	2020	2030	2040	
1	Renewing of the national car fleet	Reference	It is assumed that only new vehicles and vehicles not older than eight years will be sold, i.e. vehicles that meet EU standards such as CO2 emissions in 2020 of 95 g CO2/km, and 70 g CO2/km by 2025. In addition, advanced technologies such as diesel and gasoline HEV will be used with the following shares in the total passenger km from cars by 2040: - 6% in the Reference; -14% in the Moderate and -35% in the Green scenario	7.4	5.0	15.4	7.4	5.1	28.6	1599.5
		Moderate		8.4	7.5	23.5	8.4	7.5	39.8	1659.5
		Green		10.2	13.9	31.1	10.2	13.9	47.3	2167.7
2	Renewing of other national road fleet (light duty and heavy goods vehicles and buses)	Reference	It is assumed that only new advanced vehicles, such as HEVs that meet EU standards for exhaust fumes will be sold.	0.2	20.3	46.5	0.2	20.3	43.4	~2300
		Moderate		0.2	20.3	46.5	0.2	20.3	43.4	
		Green		0.2	20.8	47.9	0.2	20.8	44.9	
3	Advanced mobility	Reference Moderate Green	By 2040, 3% of short distance passenger kilometres will be replaced by walking, using bicycles or electric scooters.	0.7	1.2	2.0	0.7	1.2	2.0	/
4	Increased use of the railway	Reference Moderate Green	By 2040 3% of the passenger kilometers of cars, 1% of passenger kilometers of busses and 6.6% of tonnes kilometers of heavy duty vehicles will be realized by railway transport.	7.9	14.8	23.2	7.9	12.3	4.3	180.6
5	Construction of the railway to Republic of Bulgaria	Reference Moderate Green	By 2040 up to 5% of the tonne kilometers (to the Republic of Bulgaria) of the heavy goods vehicles will be replaced by the railroad transport.	5.1	10.2	14.4	5.0	8.2	4.7	720
6	Electrification of the transport	Reference	It is envisaged that by 2040 the share of electric vehicles and "plug-in" hybrid electric vehicles in the total passanger km from cars will be: - 10% in the Reference; - 40% in the Moderate and - 45% in the Green scenario	0.6	5.2	12.8	0.6	3.6	-10.5	1201.7
		Moderate		2.5	22.5	53.6	2.5	14.6	-67.3	5058.5
		Green		3.4	30.5	61.3	3.4	20.9	-75.1	8292.3

Table 3.6 Promotion of efficient heating and cooling

#	EE policies and measures	Scenario	Assumptions	Final energy savings (ktoe)			Primary energy savings (ktoe)			Budget (MEuro)
				2020	2030	2040	2020	2030	2040	
1	Solar thermal collectors	Reference	Share of solar thermal collectors in hot water useful demand in households/commercial sector by 2040 of: - 10%/8% in Reference; - 25%/16% in Moderate and - 45%/30% in Green scenario	0.9	2.9	5.2	0.9	2.6	33	16.2
		Moderate		1	4.5	9.3	1	5.4	59.8	70
		Green		1.5	7.5	16	1.4	10.7	98.1	34.8
2	Increased use of heat pumps	Reference	It is assumed that heating devices with resistive heaters will be gradually replaced. The share of heat pumps in the useful heat demand is: - 14% in the Reference; - 40% in the Moderate and - 55% in the Green scenario	21.4	56.1	114.4	20.3	98.4	395.6	235
		Moderate		31.9	84.7	176.3	34.5	137.5	413.7	330.6
		Green		48	139.3	256.1	46.5	186.1	519.2	474.4
3	Increased use of central heating systems	Reference Moderate Green	Information campaigns will contribute to maximize the utilization of the existing network as well as to enable construction of new network.	0.4	1.3	13.3	0.7	2.1	26.3	3.2
4	Biomass power plants (CHP optional)	Reference Moderate Green	Through stimulation with feed-in tariffs, it is envisaged that by 2040 a biomass power plants with capacity of 15 MW of will be constructed.	n/a	n/a	n/a	0	3	18.4	24.3

Table 3.7 Energy transformation, transmission, distribution and demand response

#	EE policies and measures	Scenario	Assumptions	Final energy savings (ktoe)			Primary energy savings (ktoe)			Budget (MEuro)
				2020	2030	2040	2020	2030	2040	
1	Reduction of distribution losses	Reference Moderate Green	Technical interventions will reduce the electricity transmission and distribution losses from 12% to 8%, while the district heating system losses will be reduced from 12% to at least 3%.	n/a			11	28.9	263.7	170
2	Large hydro power plants + small hydro power plants without feed-in tariffs	Reference Moderate Green	It is envisaged construction of large hydro power plants according to the following dynamics: • small hydro on Vardar valley – 2025-2030 (without feed-in tariffs) • Chebren – 2029 • Tunnel Vardar – Kozjak– 2030 • Veles – 2030 • Gradec – 2030 • Globochica II – 2035	n/a			0	28.9	263.7	1716.2
3	Incentives feed-in tariff	Reference Moderate Green	By 2040 additional capacity of 86 MW wind power plants, 13 MW biogas power plants and 92.5 MW small hydro power plants will be constructed with feed-in tariffs (including those that are in a construction phase or have a temporary status of preferential producer).	n/a			1.8	24.5	169.6	356.9
4	Incentives feed-in premium	Reference Moderate Green	By 2040 additional capacity of 200 MW solar power plants, 64 MW wind power plants will be constructed with feed-in premium.	n/a			0	21.5	175.7	240.6
5	RES without incentives	Reference	The following installed capacities are assumed: - 350 MW - Wind; 400 MW - Solar; 10 MW - Biogas in the Reference; - 450 MW - Wind; 600 MW - Solar; 10 MW - Biogas in the Moderate and - 600 MW - Wind; 750 MW - Solar; 10 MW - Biogas in the Green scenario	n/a			0	17.9	515.5	777
		Moderate					0	27.5	656.8	1046
		Green					0	29.4	846.4	1325.4

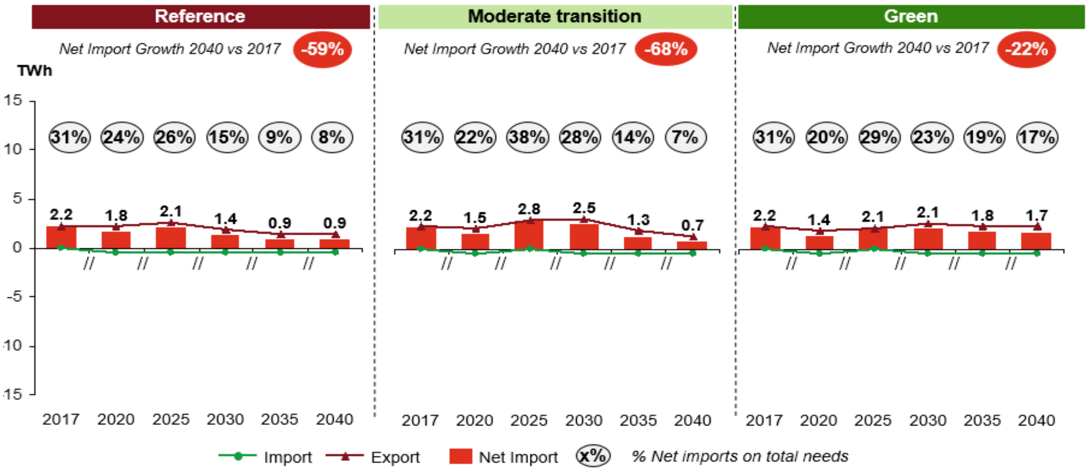
3.2.2 *Integration and security of energy markets*

> *Covered priorities from the Energy Law:*
> - *Secure, safe and quality supply of all types of energy to the consumers;*
> - *Stability, competitiveness and economic functionality of the energy sector;*
> - *Inclusion of the energy markets of the Republic of North Macedonia in the regional & international energy markets.*

3.2.2.1 Electricity

Pursue regional and EU electricity market integration including implementation of domestic organized market. Together with the electricity import, it will serve primarily as a lever for internal market security, competitiveness and affordability. It is anticipated that day ahead market coupling, and development of power exchange is playing an important role in the future for North Macedonia and EnC market integration initiatives (WB6). In developed scenarios, future potential domestic capacities for electricity generation are considered in the context of integrated regional and European market. For projects which have transboundary impact, consultations with affected countries should be undertaken. In addition, a well-integrated regional market will serve as a control indicator for price competitiveness and steer future capital investment decisions. As a result, net import is decreasing in all three scenarios due to increased competitiveness of domestic generation. CO_2 price is the determinant that makes the trade-off between building own capacities or importing. The import dependency is highest in the period 2025-2030 in the Moderate scenario, as a result of decommissioning of TPP Bitola. Additionally, TPP Oslomej is decommissioned in all three scenarios, so that one of the transformation solutions could be solar power plant (80 – 120 MW) which will use the same infrastructure (site and transmission network) and employees. The same approach could be applied for TPP Bitola. In terms of security of supply, the situation in this period is better in Green scenario due to higher RES generation. The Reference scenario exhibits least import dependency since TPP Bitola is revitalized in 2025 (Figure 3.21).

Figure 3.21 Electricity net import level in different scenarios



Note: For detailed electricity exchange including regional integration is given in Appendix I (Figure 5.60*)*
Source: MARKAL model

Enable continuous improvements in transmission system network. Developed scenarios are in line with MEPSO's Strategic Plan until 2040. In order to provide reliable physical integration and system functioning, it is necessary to continuously improve the grid through soft measures, but also plans for new investments and revitalizations of the transmission system network. With new interconnection point towards Albania and increased electricity demand in the region, North Macedonia will have an important role in transit flows to neighbouring countries. For example, in the Green scenario, the most important cross-border country partners will be Albania and Greece due to huge generation from new RES technologies (Figure 3.22 and Figure 3.23).

Figure 3.22 Neighbour countries installed capacities – Green scenario, GW

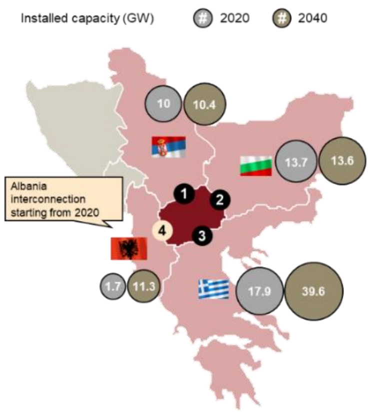
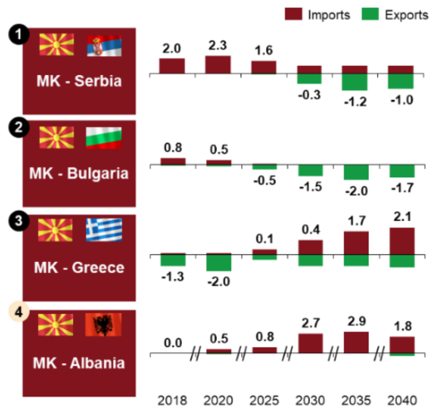


Figure 3.23 Evolution of MK import/export – Green scenario



Source: MEPSO, ENTSO-E, Power 2 Sim model

Develop further distribution system network to integrate more RES, as well as continuously improve network reliability. The scenarios envisage a huge amount of solar PVs up to 1,400 MW, out of which 250 – 400 MW being rooftop PVs. Such trend indicates an important role of the distribution network system to service growing decentaralised systems. In addition, European practice shows that regulators are imposing additional pressure and incentive to improve the operational performance and results of distribution system operators. The key changes that should be considered in the future are related in introducing new quality indicators in the tariff methodology (voltage quality, quality of supply, customer relationship quality etc.), as well as additional revisions on investment decisions (CAPEX and regulated asset base), operating efficiency and expected returns for DSOs. These changes in the regulatory framework will indirectly contribute to improvements in asset management, workforce management, automation and roll out of "behind the meter" services in the future.

Manage system flexibility to integrate more variable RES. Besides huge amount of solar PVs (up to 1,400 MW), the scenarios envisage up to 750 MW of wind, which are less predictable in terms of hourly generation. This will create additional complexity in daily operations for grid management:

- The next short term steps are to set and implement a balancing mechanism (including system services for secondary and fast tertiary regulation) and to establish a regional market coupling as one of the crucial measure for integration of RES. In this direction, the ongoing initiative of SMM control block for cross-border balancing will enable a cost-effective solution in mid-term to partially supply secondary and tertiary reserves;
- The mid and long term steps include use of existing and construction of new power plants such as storage hydro power plants (Gradec, Veles, Globocica 2 and tunnel Tenovo - Kozjak project are selected by the model in all three scenarios), hydro-pumped storage power plants (Cebren project is selected by the model in all three scenarios) or gas fired power plants (including CHP) used also for peak demand management. Additional flexibility could be gained from biomass and biogas small-scale plants (15 MW of biomass and 23 MW of additional biogas plant projects have been selected in all three scenarios, except the biomass plants in Reference scenario);
- Implementation of viable demand response options, including vehicle-to-grid, power-to-heat and battery storage.

Although the average available capacity is similar in Reference and Green scenarios, the differences in spread between peak demand and maximum theoretical available capacity (-23% for Green scenario vs. -8% for Reference scenario) emphasizes the critical need for investments in flexibility in the Green scenario (Figure 3.24 and Figure 3.25).

Figure 3.24 North Macedonia merit order curve in 2040 - Reference scenario

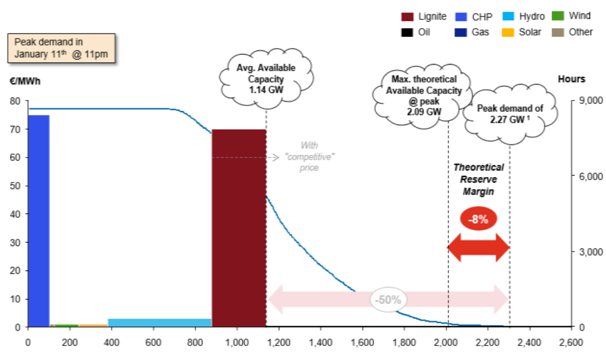
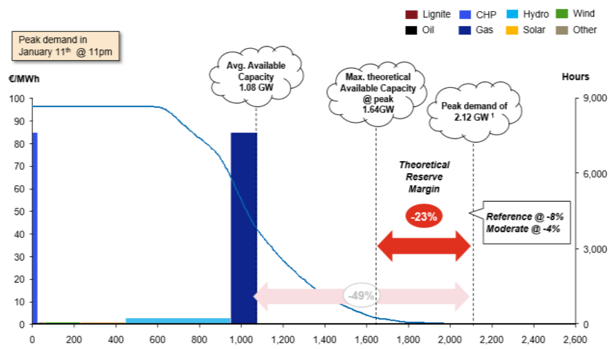


Figure 3.25 North Macedonia merit order curve in 2040 – Green scenario

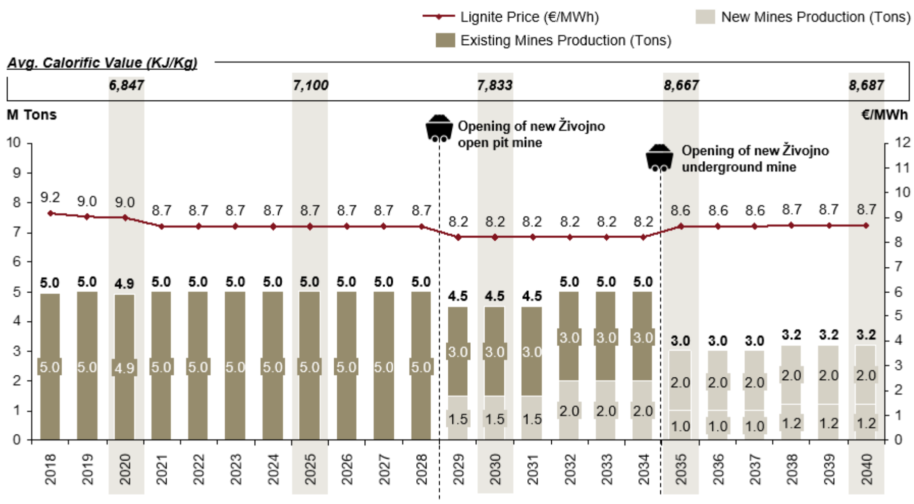


Note: the chart shows short run marginal cost of the available generation capacity, excluding O&M variable costs, with RES reported slightly above 0 for graphic purposes only; 1) Gas, coal and hydro reservoir are assumed to be available at peak at their full capacity
Source: ENTSO-E, MANU, Power 2 Sim model

Invest in smart grids to enable seamless energy sharing. This includes smart energy and information infrastructures, bidirectional communication, advanced management systems, standards and legislation, and sustainable integration with prosumers.

Align mine exploitation to future generation needs at competitive coal price. Based on the least cost optimization, revitalization of TPP Bitola is selected only in the Reference scenario, since in this case the CO_2 prices are assumed to follow WEO 2017 current policy scenario (projects the lowest level of CO_2 prices). To enable continuous supply of coal in next 30 years, opening of new Zivojno mines is necessary. This will increase the quality of lignite and compensate the costs related to opening of new mines. Hence, the lignite prices will remain within the 9 €/MWh range. However, in order to maintain Macedonian lignite competitiveness in the region once carbon price reaches the ETS level, a rationalisation of the operational costs is needed to lower the electricity production cost of TPP Bitola (Figure 3.26).

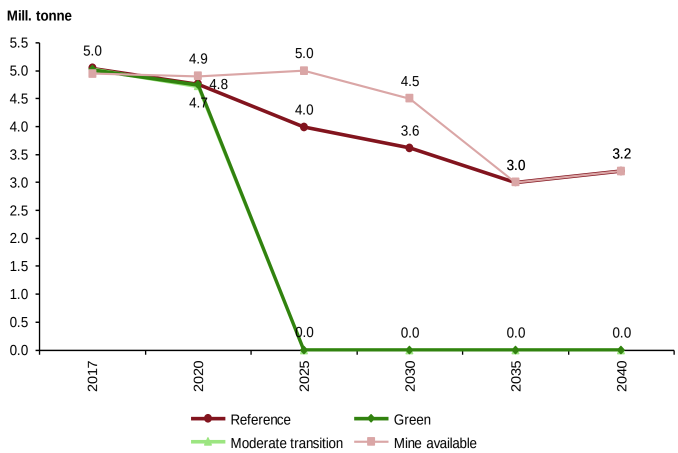
Figure 3.26 Lignite price and supply



Note: The price of lignite is stands at ~17 €/Ton
Source: MANU, ERC North Macedonia, Project team analysis

Even in the Reference scenario, the whole mine production capacity is not being used given the introduced CO_2 price which will downsize the generation potential (Figure 3.27).

Figure 3.27 Lignite mine used and available

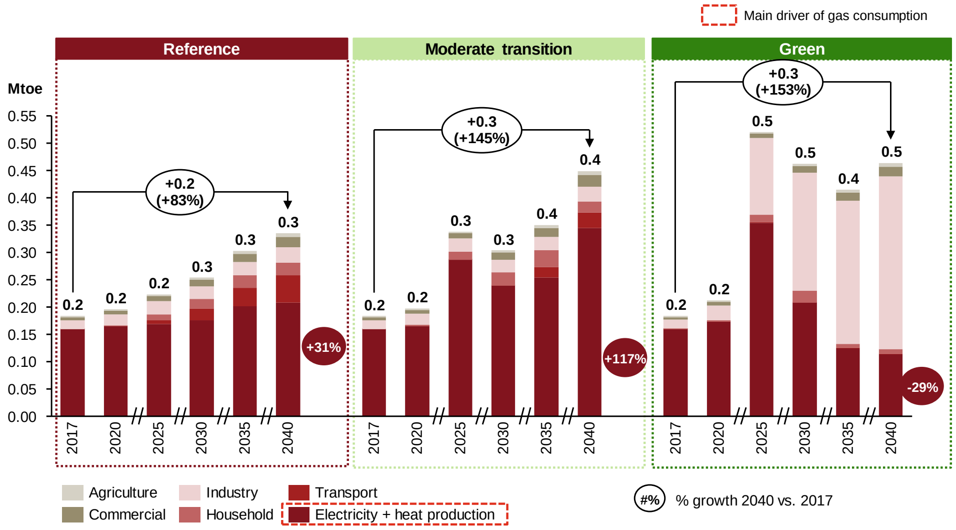


Source: MARKAL model

3.2.2.2 Natural gas

Develop natural gas cross-border infrastructure to diversify supply routes and increase market competitiveness. The results show that the highest yearly consumption amounts up to 650 mil. Nm^3 or 521 ktoe (Figure 3.28). Having in mind that most of the consumption is during winter period, the capacity of the pipeline should be at least two times higher than yearly consumption. The capacity of the current pipeline is not sufficient to build new large capacities for production of electricity and heat. Therefore, there is a need for additional regional interconnection through completion of interconnection projects with Greece, as well as other neighbouring countries. Development of infrastructure will grant access to liquid markets, and stimulate entrance of natural gas traders into the Macedonian market. This will grant higher competition and market based setting of gas price securing sustainability of the gas sector at a competitive price.

Figure 3.28. Gas consumption by sector



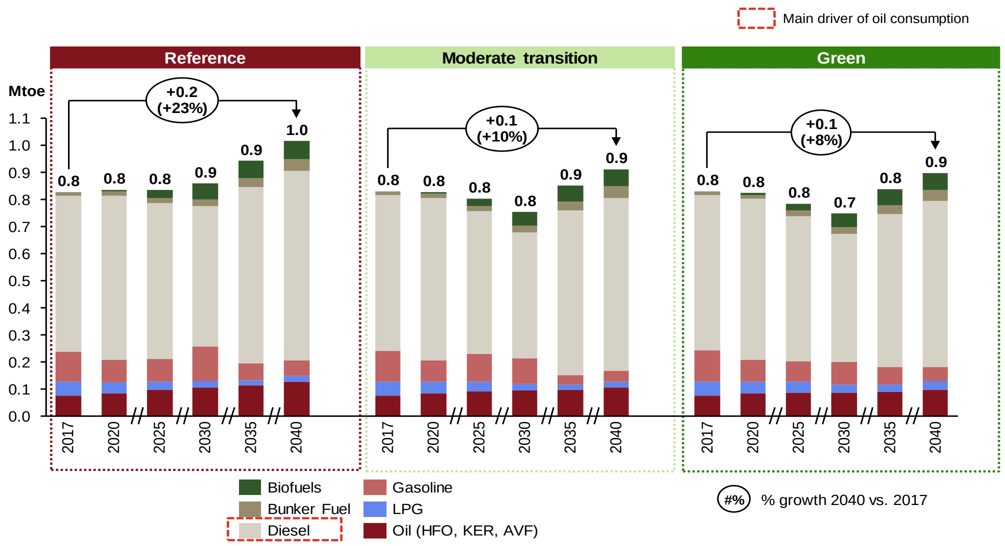
Source: MARKAL model

Develop gas transmission and distribution network to support potential fuel switch from coal to gas. Gas consumption growth is primarily driven by TPPs for electricity and heat production in the Reference and Moderate Transition scenario (Figure 3.28). As a result of high CO_2 price in the Green scenario, the gas consumption is higher than in the Moderate Transition, and fuel switch from coal to gas is occurring in the industry. Additionally, the electricity price from gas power plants is higher than electricity price from RES, so the gas consumption for electricity generation is insignificant. The indicative projections show that the largest future consumption could come from Skopje, Kumanovo, Tetovo, Stip and Bitola. In order to assure a holistic approach for development of gas distribution networks, it is necessary to create an action plan. Coordination of the Government and municipalities, as well as political willingness, are needed for successful completion.

3.2.2.3 Oil and Petroleum Products Sector

Ensure availability of necessary infrastructure for stock keeping via action plan. Projected growing consumption of the petroleum products in all scenarios will create the need for larger volumes of storage capacities for petroleum products in the future (Figure 3.29). Therefore, an analysis of future capacities should be carried out in order to assure that infrastructure will not be the limiting factor. The action plan for formation of compulsory oil stocks will define the dynamics of formation of reserves until 31.12.2022, necessary storage volumes per product, location of storage capacities, roadmap to achieving necessary storage capacities, and financing options considering the impact on the final consumers.

Figure 3.29 Consumption of oil products by fuel



Source: MARKAL model

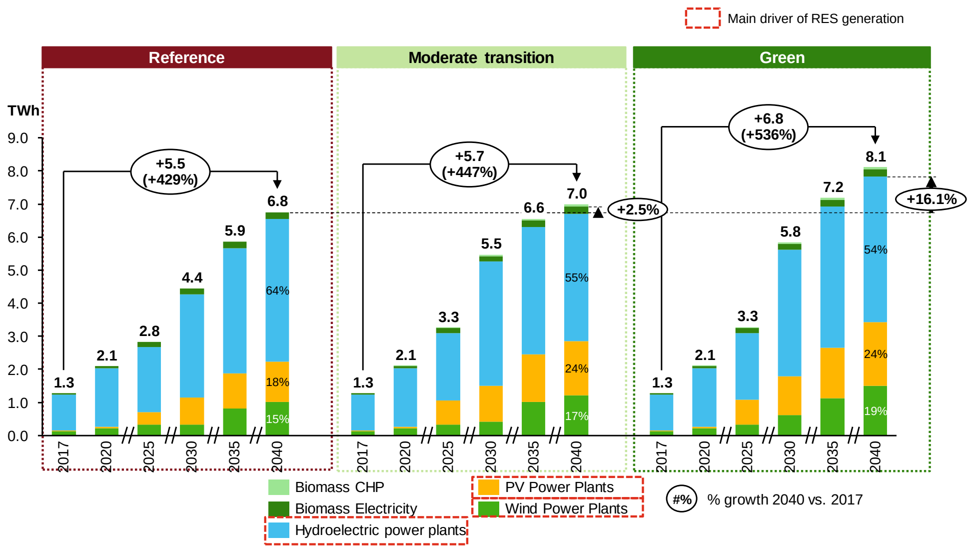
3.2.3 Decarbonisation

Covered priorities from the Energy Law:

- *Use of energy sources in a manner that provides sustainable energy development;*
- *Reduction of the use of fossil fuels for energy generation;*
- *Promotion of the use of renewable energy sources;*
- *Protection of public health, the environment and mitigation of climate change from the harmful effects arising from the performance of energy activities.*

Utilize the RES potential while ensuring environmental sustainability specific for each RES technology. All three scenarios will have a steep growth of electricity generated from RES (~7 times more in 2040 vs. 2017). Hydro will maintain its largest share in electricity generation, but PV and wind will be the fastest growing technology (Figure 3.30). The Strategy does not consider hydro projects in protected areas – Boskov Most and Lukovo Pole. Construction of new small hydropower plants should be carefully assessed to avoid the risk of disproportionate environmental impact compared to electricity generated. In addition to this, the capacity of the water supply systems should be used for small hydropower plants if justified based on economic and technical aspects.

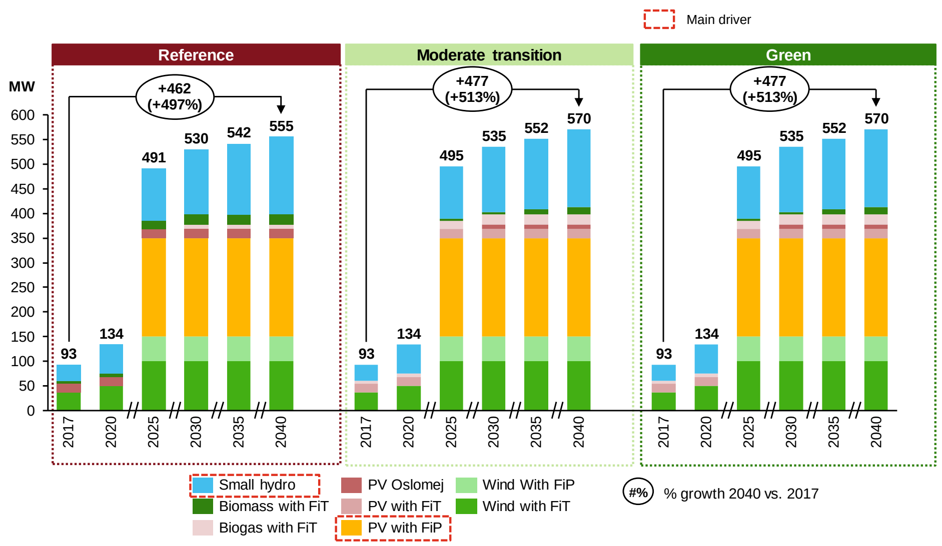
Figure 3.30 Electricity generation by RES technologies



Source: MARKAL model

Promote further RES via financial support mechanisms. To boost domestic RES production and local businesses, the Strategy envisages two types of financial mechanisms, feed-in tariffs and feed-in premiums. According to the Decree for RES by the Government, which takes into account EnC State-aid Guidelines, all feed-in premiums will be granted in the tendering procedure. The highest support should come in the period 2020 – 2025 in all three scenarios. The maximum supported RES capacity is 570 MW including the existing one in 2017. The highest support is for PV with FiP of 200 MW, followed by small hydro of 160 MW and wind 150 MW.

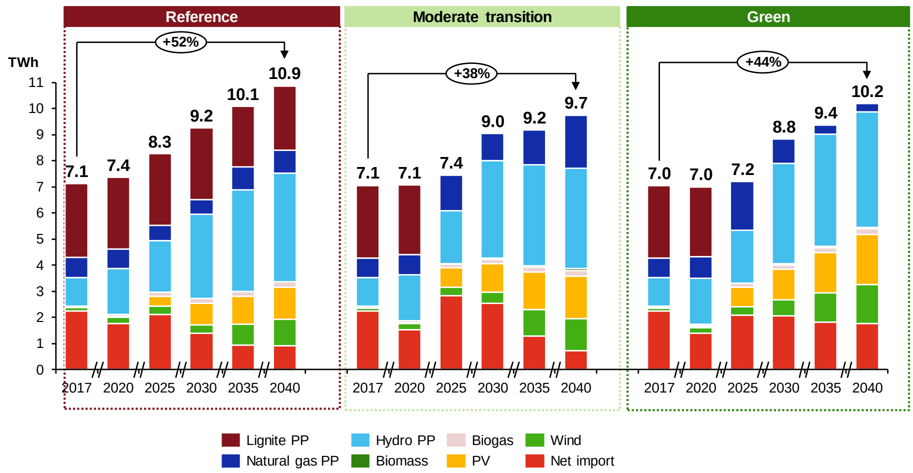
Figure 3.31 RES installed capacities that are backed by financial support



Source: MARKAL model

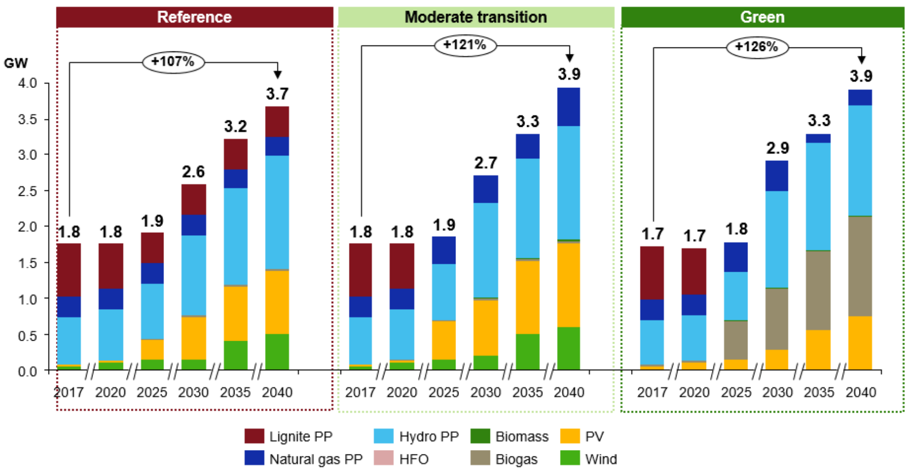
Develop a roadmap for decarbonisation influencing the investment plans and programs for socially responsible and just transition. The Strategy provides several scenario options of different ambition level of decarbonisation in the energy sector, especially for coal fired power plants. The Moderate Transition and Green scenario show coal-phase out after 2025. When planning new investments, it is important to closely monitor and adjust current investment decisions to avoid the risk of stranded and underutilised assets given the expected trends - local pollutants requirements and potential CO_2 price. In addition, depending on selected level of transition from conventional energy, it is important to develop programs for socially responsible and just transition to mitigate negative effects of associated job losses. Such programs should provide an answer how to redeploy employees to other jobs and stimulate new job opportunities by investing in low carbon technologies and services.

Figure 3.32 Electricity generation by type of technology



Source: MARKAL model

Figure 3.33 Installed capacity by type of technology

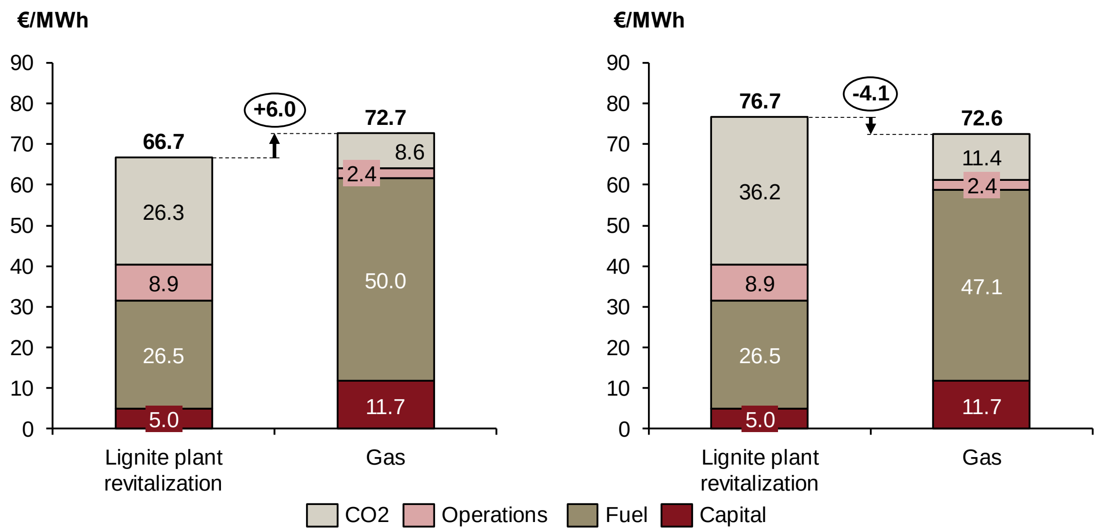


Source: MARKAL model

Introduction of carbon price and its convergence to ETS level. Even though North Macedonia currently is not obliged to impose CO_2 pricing to its conventional generation portfolio, the Strategy follows the common view of progressive introduction of carbon price. This is in line with carbon border adjustment mechanism from the latest European Green Deal (from 2019). The results clearly show that the introduction of CO_2 price offsets the financial feasibility of TPP Bitola revitalization against gas electricity generation (Figure 3.34). The introduction of carbon price should be seen as an important strategic measure to tackle CO_2 reduction in the electricity and heat production (Figure 3.36). The collected funds from CO_2 taxation could serve as a basis for establishment of EE fund and/or can be used to support RES investments. Compared to BAU scenario with no measures, the GHG savings in 2040 amounted to 60% or 66% for the Moderate transition and Green scenario, respectively, including emission from electricity import and international aviation (Figure 3.37).

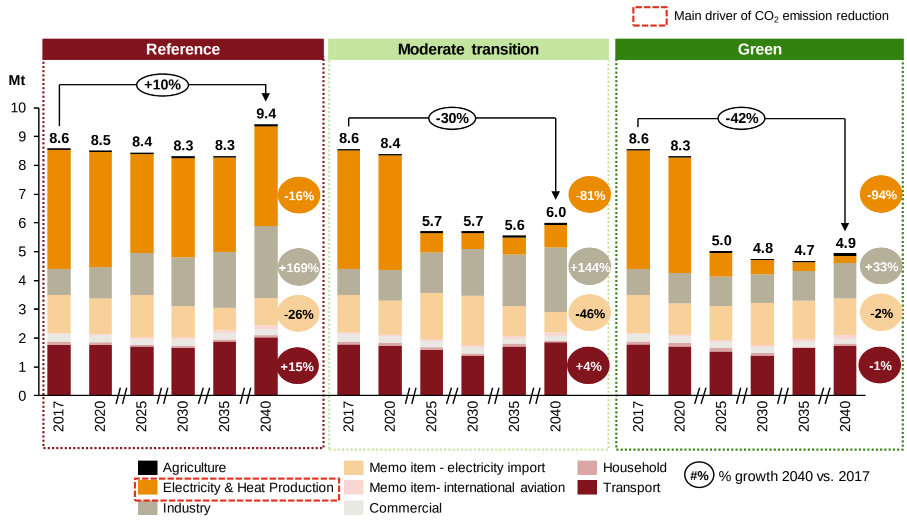
Figure 3.34 Impact of CO_2 tax on coal fired PPs – Reference scenario

Figure 3.35 Impact of CO_2 tax on coal fired PPs – Moderate transition scenario



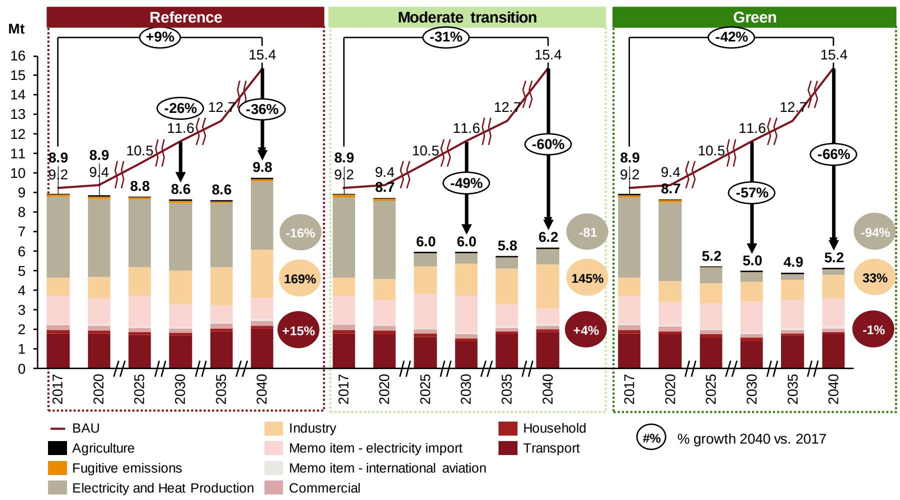
Source: MARKAL model

Figure 3.36 Reduction of CO_2 emissions per sector



Source: MARKAL model

Figure 3.37 GHG emissions development by sector and targets in 2030 and 2040 per scenarios

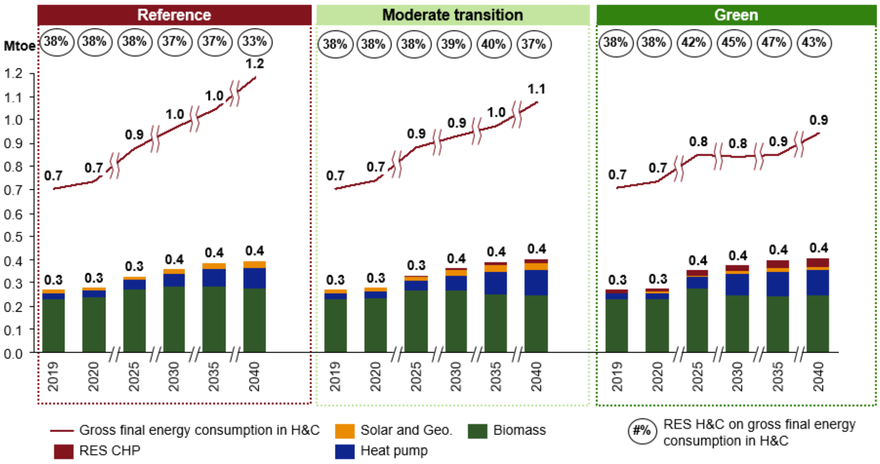


Source: MARKAL model

Install control equipment for local pollutants in TPP Bitola. Revitalization of TPP Bitola in the Reference scenario includes control equipment installation to meet the requirements from Large Combustion Plants Directive (dust 50 mg/m^3; NO_x 200 mg/m^3; SO_2 400 mg/m^3), as well as the Industrial Emissions Directive (dust 25 mg/m^3; NO_x 200 mg/m^3; SO_2 250 mg/m^3).

Electrification of the heating & cooling sector will enable more efficient RES technologies to gradually replace inefficient use of biomass. The scenarios show that the role of heat pumps and biomass used for CHP plants could reduce biomass share used for heating share from 86% in 2017 up to 61% in 2040 (Figure 3.38). To maximize the expansion of these RES options, it is recommended to explore small district heating systems based on RES in small areas. In addition, North Macedonia can stimulate domestic production of efficient biomass technologies for heating, as well as usage of residual biomass and other by-products by supporting local manufacturers and industry, especially on small and medium scale. Pellets are a good option to decrease local pollutant emissions, but it is necessary to establish a standardized quality framework. It is important to enhance these options with EE for better synergy potential (e.g. fuel wood stoves with 70-80% efficiency, pellets and briquettes stoves with 80-90% efficiency, insulation).

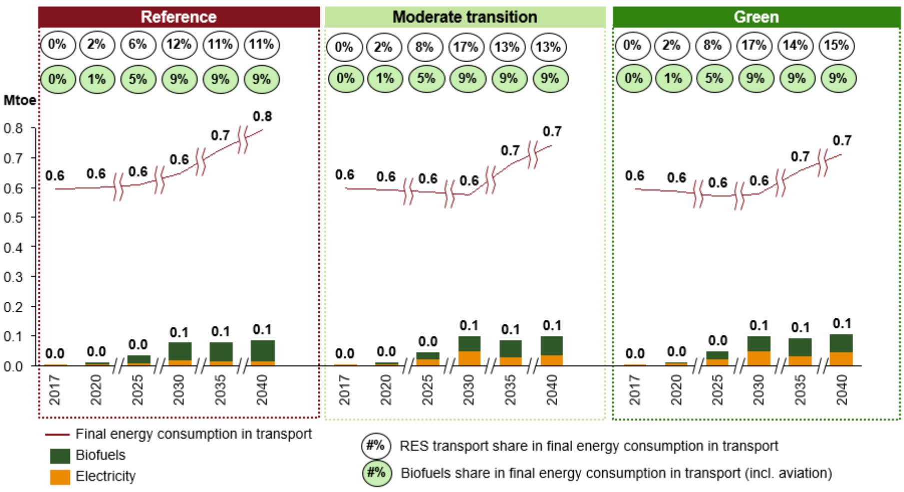
Figure 3.38 RES gross final energy consumption in heating and cooling



Source: MARKAL model

Accelerate RES and electricity consumption in transport. In all three scenarios, the changes of the RES Directive are taken into account. The share of biofuels in transport sector increases from 1.25% in 2020 up to 10% in 2030 and 2040. Electric vehicles will also have an important role in penetration of environmental friendly technologies for transport sector (Figure 3.39). Examples of policies and measures that support RES in transport include those that encourage the adoption, development and use of fuels produced from RES. An important element is to financially incentivize the purchases or operation of transport technologies and modes (vehicles) that use RES fuels. Public country-wide and local entities can have an important role in usage of electric vehicles, rollout of alternative fuelling or charging infrastructure in practice. It is important to drive progressive upgrades of future national action plans to stimulate and use biofuels and electricity in transport with the overarching goal of decreasing GHG emissions and local pollutants (especially NOx levels). The projection of final energy consumption in transport will largely depend on transit of vehicles through North Macedonia and on the fuel prices in North Macedonia and neighbouring countries.

Figure 3.39 RES final energy consumption in transport



Source: MARKAL model

Improve waste management practices. There is no waste-to-energy potential on existing landfills due to insufficient waste. Therefore, one of the top priorities is to cover existing non-compliant landfills, supplemented by gas extraction and flaring, which will convert the CH_4 emissions into CO_2 emissions. In parallel it is necessary to open new regional landfills in all planning regions with installed system for mechanical and biological treatment. If the whole mechanical and biological treatment is applied on all new landfills, the amount of overall waste still won't be sufficient for electricity generation. Therefore, it is more appropriate to improve practice of waste management via composting. Also, waste selection should be widely promoted by installation of containers for collection of selected waste, mainly paper, in all cities in North Macedonia in parallel with campaigns for reduction of paper consumption.

Include municipalities in local energy planning and transition. Expansion of RES including prosumers, exemplary role of public buildings, development of different types of distribution networks (district heating, electricity and natural gas), as well as reduction of local pollutants often add additional complexity and might impose less understanding how to transpose national objectives on local levels in practice. Involvement of all relevant governance levels is of utmost importance especially in designing and implementing action plans and detailed measures. The Government should facilitate a greater link with local authorities for local energy planning to combine top-down and bottom-up planning approach. This encompasses a combination of identifying local specific gaps and opportunities, as well as development of specific action plans at local levels.

3.2.4 Research, innovation and competitiveness

Covered priorities from the Energy Law:

- *Stability, competitiveness and economic functionality of the energy sector;*
- *Promotion of energy efficiency;*
- *Promotion of the use of renewable energy sources.*

Streamline energy transition technologies and measures into national R&I priorities. Specifically, when developing sectoral strategies and plans for science and R&I, the cooperation between Ministry of Education and Science and relevant energy stakeholders is needed to prioritize energy transition technologies and measures. Same is needed for the programmes in the Fund for Innovation and Technology Development.

Adjust energy related curricula at all educational levels to make them responsive to energy transition trends. The development of consciousness for sustainable energy needs to be addressed from the earliest education levels and incorporated in the curricula of all primary, secondary and tertiary educational levels. Moreover, stimulating science and education in energy transition will help mobilization of the existing and building of new research capacities, as well as better integration into European Research Area (ERA) in energy themes.

Develop pilots for smart communities. Smart academic campuses could have an exemplary role where all advanced concepts and principles from smart energy systems can be tested with the goal for roll-out on larger scale.

Encourage inter-sectoral and geographical mobility of researchers. Knowledge and experience transfer among researchers from industry and academia, as well as incoming and outgoing mobility is needed to build internal capacities. For example, at highest educational level, industrial doctorates can be promoted as a tool to support industry driven science.

Stimulate cooperation of R&I sector with policy makers, industry, utilities, municipalities and associations. Joint research projects will be encouraged orchestrating demand driven and supply driven innovation solutions. Following the EU example, the aim is to improve the likelihood of capturing, supporting and scaling up energy solutions gathered in bottom-up and interdisciplinary manner, based on advanced energy, transport and information and communication technologies. Also, science-policy making partnerships will lead to robust and more effective policy design and execution.

Increase competence in pulling international donor funds. In order to support increase in donor funds absorption, the responsible ministries are to ensure that effective project management units are established and comprised of multidisciplinary officers which will be involved in the planning, evaluation and monitoring procedures.

Encourage SME sector to diversify their portfolio of services and products in RES and EE. To support greater involvement of local SME in energy transition, it is necessary to promote further expansion of RES projects and EE measures overall, especially via financial mechanisms, as well as green public procurement for innovative products. Private investments in RES and EE will be encouraged by structuring financing instruments with grant components to lower the risk of private investments in untested but promising clean energy technologies or business models. In addition, provision of technical assistance for SMEs in order to facilitate the access of enterprises to external services is needed. This covers the areas of external research and development, testing, design, instruction and training, market research, business consulting, etc.

Support key energy players in revising their business models to ensure competitiveness. In order to exercise smooth transition, adaptability and response to changing business environment is one of the key areas where concrete action can be strengthened. New "green" opportunities on the market could contribute to growth and increased competitiveness in the local and regional market, but will require development of new capabilities and investment needs in the future. A proactive approach is needed to anticipate those opportunities on time.

3.2.5 Legal and regulatory aspects

Covered priorities from the Energy Law:

- *Stability, competitiveness and economic functionality of the energy sector;*
- *Efficient provision of services and protection and promotion of consumers rights;*
- *Reduction of energy poverty and protection of vulnerable consumers;*
- *Fulfilment of commitments assumed by the Republic of North Macedonia under ratified international agreements.*

Transpose and implement Clean Energy Package. This package is composed primarily of the following elements: energy efficiency first, more renewables, a better governance, more rights for consumers, a smarter and more efficient electricity market.

Adopt the new Energy Efficiency Law followed by transposition of EU Directives in the secondary legislation.. The Law should finalize the transposition of the Energy Efficiency Directive 2012/27/EU, thus enabling environment to create a secondary legislation (by-laws, regulations, decrees etc.) for progress monitoring and reporting, exemplary role of public buildings, ESCO market development, energy audits and management systems, efficiency improvement in energy supply, CHP and heating/cooling processes and establishment of appropriate financing mechanisms (e.g. a revolving energy efficiency fund). The Law also will transpose certain provisions related to Directive 2010/31/EU and Energy Labelling Regulation and will bring North Macedonia in compliance with the EnC acquis.

Complete the remaining RES (including biofuels) legal and regulatory obligations. Considering the grid integration, rules on renewable energy self-consumption must be introduced, following the adoption of the remaining secondary legislation. In order to achieve 10% of biofuels in 2030 the Law on biofuels and Action plan must be adopted in the next two years.

Align with the infrastructure acquis and determine a national competent authority in the area of infrastructure. Regulation (EU) 347/2013 has to be introduced in the national legislation to improve the transposition and implementation of EU legislation in this subsector.

Strengthen the human resource capacities in Ministry of Economy – Department of Energy and Energy Agency. Hire skilled and experienced workforce to improve institutional capacities to effectively implement the Strategy and other energy related topics.

Adopt Long-Term Climate Action Strategy and Law on Climate Action. The Strategy and Law are instrumental to strengthen the accession process in the field of climate change, as well as to support national initiatives in climate mitigation and adaptation. Specifically, the Strategy and Law should ensure the three overarching long-term objectives of climate action: a) Full transposition and implementation EU acquis relevant for climate; b) Achieving a competitive low carbon economy; and c) Achieving a climate resilient economy/society. Work on the upcoming Strategy should be closely coordinated among ministries in order to identify synergies and prevent inconsistencies among national strategies on energy and climate.

Implement core topics defined by EnC Climate Action Group. They include:

- Core Topic 1: Monitoring Mechanism Regulation (MMR), Regulation (EU) No 525/2013 - transposition and implementation
- Core Topic 2: Mainstream climate related obligations across sectors
- Core Topic 3: Integrated National Energy and Climate Plans
- Core Topic 4: Setting 2030 targets (and possibly beyond)

MMR includes a number of important provisions for monitoring and reporting greenhouse gas emissions, including, but not limited to: establishing GHG emission inventories, developing low-carbon development strategies, improving national systems for reporting on mitigation and adaptation policies and measures and for reporting on projections of anthropogenic greenhouse gas emissions. More clearly defined competences and responsibilities of the relevant institutions are necessary to align with the MMR. North Macedonia shall launch a process of closer collaboration in and among ministries to contribute to a higher quality of legislation in this field. The country should put efforts to introduce climate considerations into national development strategies, considering the impact climate change may have on a wide range of sectors and proposing opportunities to promote greener, cleaner approaches.

North Macedonia should start elaborating a streamlined and inclusive process to establish integrated national energy and climate plans. Planning, reporting and monitoring obligations of the EnC energy and climate acquis are currently scattered across a wide range of legislation and targets, approved at different times in order to meet various objectives. By integrating a number of existing planning, reporting and monitoring obligations on renewables, energy efficiency and greenhouse gas emissions, the administrative burden will be significantly reduced, taking into account at the same time specific national circumstances and preferences. Stable national energy and climate plans up to 2030 (and possibly beyond) should be accompanied by targets for renewables, energy efficiency and greenhouse gas emissions reduction. This will provide higher regulatory stability, transparency of national efforts and increased investment certainty. Due to foreseen significant transformation of sectors of economy, including the energy sector, analysis and forward planning is needed to avoid large scale stranded assets and expensive policy failures. North Macedonia should leverage on the work done within these EnC climate related products to map the targets and steps ahead to implement its commitment to the Paris Agreement (NDCs) and fulfil the reporting obligations under UNFCCC (NCs and BURs).

Enhance implementation of the EnC acquis in the area of environment. In the field of emission control from large combustion plants, enforcing the Large Combustion Plants Directive and Industrial Emissions Directive in practice is the key priority. In order to achieve compliance, it is key that adequate financing is allocated for emissions abatement. Furthermore, the competent authorities shall have emission reporting systems in place. The country should also proceed with the adoption of the Law on Control of Emissions from Industry and the related secondary legislation to transpose and implement the relevant requirements of the Industrial Emissions Directive (with a deadline 1 January 2028 for the existing plants). With regard to environmental impact assessment, further improvement of the administrative capacities, both at central and local level, is necessary. Furthermore, public participation needs to be strengthened, with particular regard to the hydropower and mining sectors. As regards the legislation on the Sulphur content of liquid fuels, the competent authorities have to ensure that the sampling and analysis of the fuels falling under the scope of the Directive takes place in accordance with the standards stipulated therein. As for nature protection and wild birds, effective measures against the deliberate killing or hunting of wild birds, deliberate destruction or damaging nests and eggs and/or removal of their nests are to be established for the protection of endangered species. The amendment to the Law on Nature Protection, aimed at increasing the human resources dedicated to this area, shall also be adopted. Furthermore, the obligation to protect the habitats of wild birds shall be respected and taken into account when developing new projects related to network energy.

Complete the remaining natural gas sector legal and regulatory obligations. This includes:

- Unbundle gas TSO GAMA based on Ownership Unbundling model as stipulated in the Energy Law
- Apply entry/exit transmission tariff methodology from 2020
- Align technical agreement with the Bulgarian TSO with Regulation (EU) 703/2015
- Adopt and implement balancing and network code.

Adopt a program for vulnerable customers. The program for vulnerable costumers is related to safe and secure supply of energy. Therefore, it needs to define categories of vulnerable costumers and associated measures, including financial supports and responsible institutions for realization of the program.

Complete the remaining electricity market regulatory obligations and related supporting legislation. This will be ensure effective balancing and organized markets, regional market integration, introduction of prosumer concept and distributed generation, as well as security of supply and solidarity. The supporting legislation to be completed includes VAT, public procurements, confidentiality, cybersecurity, etc.

4 INSTITUTIONAL RESPONSIBILITY, FUNDING AND STRATEGIC ROADMAP

4.1 Access to Finance

North Macedonia has an opportunity to benefit from increasing access of funds that support green energy. In general, there are several options at disposal to finance the development of the energy sector in North Macedonia (Figure 4.1). With the growing development of small-scale RES and EE measures, financial support via national budget will play an important role for stimulating households and SMEs. In terms of European funds, North Macedonia as a pre-accession country can benefit from multiple donor funds that support RES and EE, as well as support for regional connectivity initiatives under EnC. Although the country is eligible to use significant amount of funds from international institutions and donors, access to EU funds and programs will substantially increase after North Macedonia joins the EU. Funding programs of international financial institutions and donors (e.g. EBRD, WB-IFC, USAID, GIZ, UNDP and EIB) have been used in the past by the country for development and construction of energy projects. As these institutions are closely interlinked with EUs policy objectives for decarbonisation, the country could benefit from such funds even further, and especially for capital intensive projects in both public and private sector. In addition, commercial banks have also recognized the importance of targeting RES and EE businesses, and have started to actively participate in such projects. Despite being the most expensive option, equity financing has an additional advantage where energy projects could benefit not only from monetary contributions, but also from receiving additional know-how. This is particularly the case for large scale and complex projects, where experienced investors could provide their expertise during development, construction and operation phases.

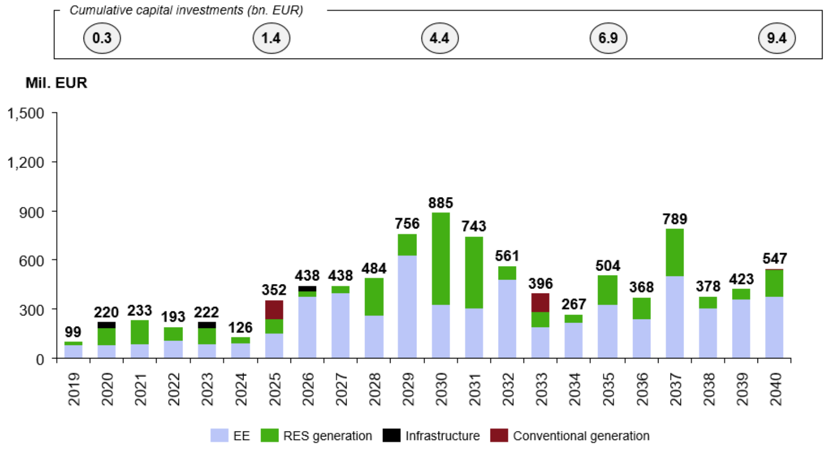
Figure 4.1 Financing options in the energy sector for North Macedonia (illustrative)

Financing options	Institutions	Typical areas covered in energy sector	+ Pros	- Cons
National budget	• State / Ministries (including funds) • Municipalities	• RES and EE projects, development of new technologies, etc. • *Beneficiaries:* public, private entities and natural persons	• Rapid procedure • More suitable for simple tenders and clear objectives	• Restricted budget • Lack of flexibility in form and number of bidders
European funds	• Pre-accession funds • Post-accession funds	• RES and EE projects, infrastructure projects, regulatory and market functioning improvement • *Beneficiaries:* public and private entities	• High added-value to project profitability • Large amount of funds available after accession to EU	• Complex and strict process to receive and spend funds • Lack of flexibility
International financial institutions and donors	• WB-IFC • USAID • GIZ • EBRD, EIB • Others	• RES and EE projects, infrastructure projects, regulatory and market functioning improvement • *Beneficiaries:* public and private entities (incl. SMEs)	• Convenient for capital intensive projects • Financial leverage and cheaper interest rate vs. commercial banks	• Complex and strict process • Risk of insolvency
Commercial banks	• National banks • International banks	• RES and EE measures, conventional source projects, etc. • *Beneficiaries:* public and private entities	• Convenient also for smaller investments • Financial leverage	• Complex and strict process • Higher interest rates • Risk of insolvency • Larger collateral needed
Equity	• Domestic and international co. • Private and public co. • ESCO	• Could cover wide range of energy projects • *Beneficiaries:* public and private entities	• Enable private and public partnerships • Leverage from sharing know-how and experience	• Complex process

Source: European Commission, Energy Community, EBRD, EIB, Project team analysis

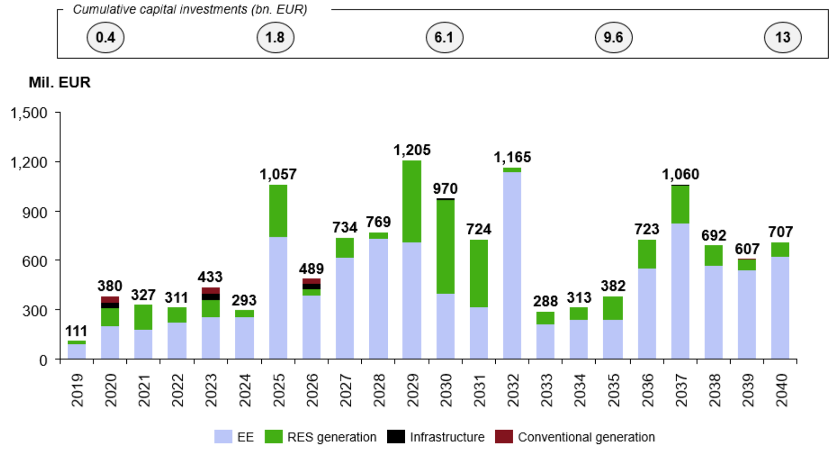
Investments must significantly increase to enable energy transition. In order to achieve a cost competitive transition, the system would need cumulative overnight capital investments in range 9.4 – 17.5 billion EUR until 2040, depending on the selected scenario (Figure 4.2, Figure 4.3 and Figure 4.4). It can be clearly seen that the energy efficiency capital investments, followed by investments in RES generation are the main focus of all three scenarios. This can be recognized as a great opportunity to leverage on support and financing programmes of European funds, as well as international financial institutions and donors, as they also identify the importance of such investments. In addition, considerably higher investment requirements would be needed after 2025, which leaves enough time for relevant energy stakeholders to react and start the preparation activities at all levels of governance. Furthermore, many stakeholders with different purchasing power will be involved in investment process (e.g. EE in households, commercial sector, small scale RES), which makes the process difficult to manage. Therefore, new business models and approaches should be adopted, along with behavioural changes.

Figure 4.2 Capital investments (overnight) per category - Reference scenario, 2019 - 2040, mil. EUR



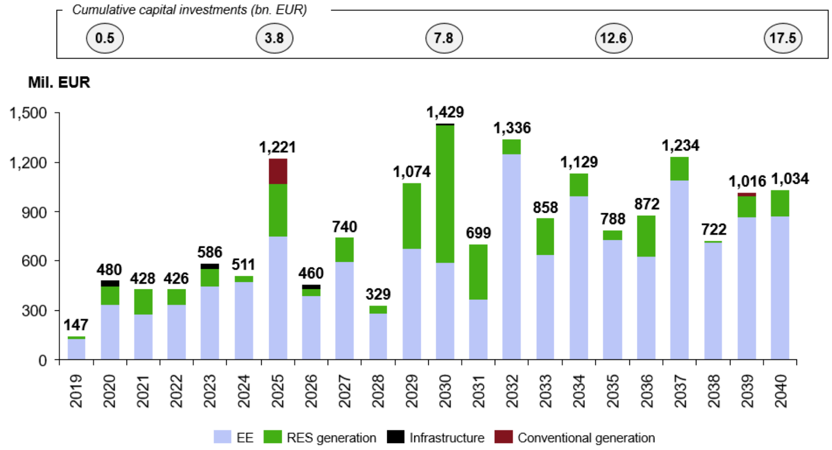
Source: MARKAL model

Figure 4.3 Capital investments (overnight) per category - Moderate transition scenario, 2019 - 2040, mil. EUR



Source: MARKAL model

Figure 4.4 Capital investments (overnight) per category - Green scenario, 2019 - 2040, mil. EUR



Source: MARKAL model

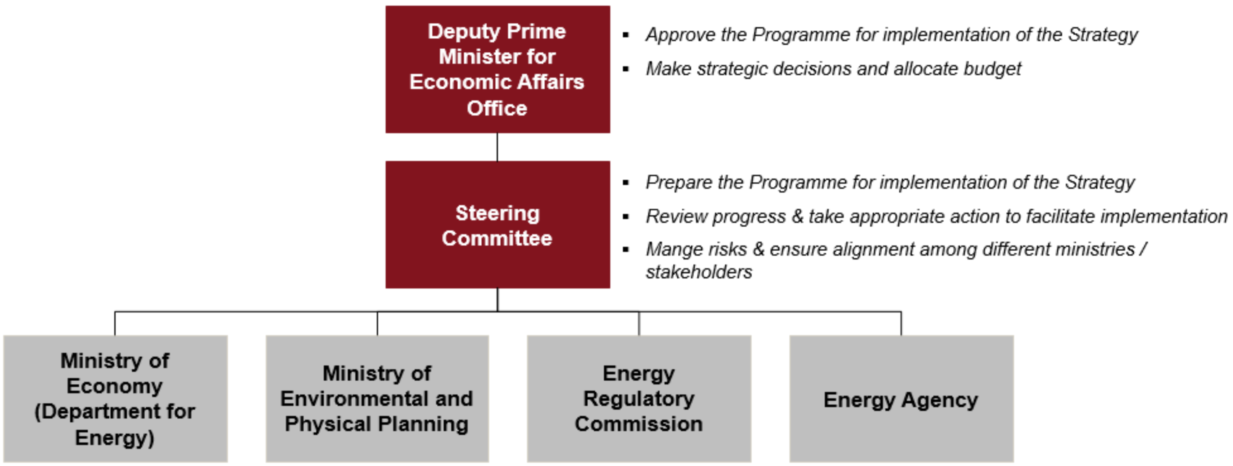
4.2 Strategic Roadmap with Institutional Responsibility

4.2.1 Institutional framework

The Government has to prepare a Programme for implementation of the Strategy within six months from the day of adoption of the Strategy. Policies and strategic measures are developed in a way to provide robust directions, while still providing room for further refinement as part of future action plans and programmes. As stipulated by the Energy Law, the Programme should be prepared by the Ministry of Economy and should cover a five-year period. The Programme should outline assumptions, financing options, short-term and long-term outcomes, roles and responsibilities (local, national, company level), as well as budget. In addition, all relevant state-owned companies (ESM, MEPSO, GAMA, MER, etc.) should align their development plans with the Strategy and the Programme. According to the draft version of the Energy Efficiency Law, the Programme should also include the potential for the application of high efficient cogeneration and efficient district heating and cooling, and cost-benefit analyses.

It is recommended to establish a Steering Committee responsible for the implementation of the Strategy, chaired by the Deputy Prime Minister for Economic Affairs. Policies and strategic measures are composed of various interconnected parts. Even though many institutions in the energy sector have specific agendas, they need to pursue them in harmony and within a larger common agenda. Therefore, good governance practice indicates that a Steering Committee is needed at the highest levels of the Government to ensure that right economic and managerial resources are applied for strategy implementation, and that appropriate coordination occurs among Ministries and other stakeholders. It is recommended that the members of the Steering Committee are representatives from the Ministry of Economy and Ministry of Environment and Physical Planning, Regulatory commission and Energy Agency (Figure 4.5). The members would meet on a regular basis to provide progress reports, identify and address risks and obstacles encountered, resolve issues of coordination between ministries and secure agreement on any changes in initiatives or schedules that are developed in the Programme. The constitution of the Steering Committee will contribute to the improvement of the energy sector by better coordination and cooperation between the institutions.

Figure 4.5 Governing structure for implementation of the Strategy



Source: Project team analysis

4.2.2 Strategic roadmap

All strategic measures and policies are provided in the strategic roadmap with the purpose to determine for each associated strategic measure and policy the following:

- Level of priority per scenario - from low to highest;
- Estimated time frame for implementation - short-term (S, for the period until 2023), mid-term (M, for the period 2024-2030) and long-term period (L, for the period beyond 2030). It is important to note that time categories do not limit earlier completion or implementation of a particular strategic measure;
- Responsible administrative level for implementation - state level, local level and other (ERC, ESM, MEPSO, EVN, GAMA, MER, business sector, academia and NGOs).

Energy pillar	#	Policies and strategic measures	Level of priority per scenario			Time frame	Key stakeholders for implementation		
			Reference	Moderate transition	Green		National level	Local level	Other
Energy efficiency	1	Set the national EE targets (2020 and 2030)	●	●	●	S	✓	✓	
	2	Continue the usage of existing and introduce new EE measures in final energy consumption for household and commercial sector	◑	◕	●	M	✓	✓	✓
	3	Put additional focus on EE measures in final energy consumption for industry and transport sector	◔	◑	◕	M		✓	✓
	4	Monitor the effect of EE measures	●	●	●	S	✓	✓	
	5	Implement further relevant technical measures to decrease continuously transmission and distribution network losses	◑	◕	●	M, L			✓
	6	Revitalize or replace existing generation capacities to enable higher energy transformation efficiency	●	◑	◔	S, M	✓		✓
	7	Enable modernization and expansion of existing and new DH systems taking into account development of other alternatives	◑	◑	◕	S, M, L	✓	✓	✓
Integration and security of energy markets	8	Pursue regional electricity market integration	●	●	●	S	✓		✓
	9	Enable continuous improvements in transmission system network	◔	◑	◕	S, M, L			✓
	10	Develop further distribution system network to integrate more RES, including prosumers and more electric vehicles (EVs), as well as continuously improve network reliability	◑	◕	●	S, M, L			✓
	11	Manage system flexibility to integrate more variable RES	◑	◕	●	S, M, L			✓

	12	Align mine exploitation to future generation needs at competitive coal price	●			M	✓		✓
	13	Develop natural gas cross-border infrastructure to diversify supply routes and increase market competitiveness	◐	◕	●	S, M	✓		
	14	Develop gas transmission and distribution network to support potential fuel switch from coal to gas	◐	●	●	S, M	✓	✓	✓
	15	Ensure availability of necessary infrastructure for stock keeping via action plan	◐	◕	●	S	✓		
Decarbonisation	16	Utilize the RES potential while ensuring environmental sustainability specific for each RES technology	◕	◕	●	S, M, L	✓	✓	
	17	Promote further RES via financial support mechanisms	◕	●	●	S, M	✓	✓	
	18	Develop a roadmap for decarbonisation influencing the investment plans and socially responsible transition programs	◐	●	●	S	✓	✓	
	19	Introduction of carbon price and its convergence to ETS level	◐	◕	●	S, M	✓		
	20	Install control equipment for local pollutants in TPP Bitola	●			S	✓		✓
	21	Stimulate more efficient RES technologies to gradually replace inefficient use of biomass	◐	◕	●	S, M	✓	✓	
	22	Accelerate RES consumption in transport	●	●	●	S, M	✓	✓	✓
	23	Improve waste management practices	◐	◐	◐	S, M	✓	✓	✓

	24	Include municipalities in local energy planning and transition	◐	◕	◕	S	✓		
Research, innovation and competitiveness	25	Streamline energy transition technologies and measures into national R&I priorities	◐	◕	●	S	✓		
	26	Adjust energy related curricula at all educational levels to make them responsive to energy transition trends	◕	◕	◕	S	✓	✓	✓
	27	Develop pilots for smart communities	◔	◐	◐	S, M		✓	✓
	28	Encourage inter-sectoral and geographical mobility of researchers	◔	◐	◐	S	✓		✓
	29	Stimulate cooperation of R&I sector with policy makers, industry, utilities, municipalities and associations	◕	◕	◕	S	✓	✓	✓
	30	Increase competence in pulling international donor funds	●	●	●	S	✓	✓	✓
	31	Encourage SME sector to diversify their portfolio of services and products in RES and EE	◕	●	●	S, M	✓	✓	
	32	Support key energy players in revising their business models to ensure competitiveness	◐	●	●	S	✓		
Legal and regulatory aspects	33	Complete the remaining natural gas sector legal and regulatory obligations	●	●	●	S	✓		✓
	34	Complete the remaining RES legal and regulatory obligations	●	●	●	S	✓		
	35	Adopt the new Energy Efficiency Law followed by transposition of EU Directives in the secondary legislation	●	●	●	S	✓		

	36	Adopt a program for vulnerable customers	●	●	●	S	✓		
	37	Adopt Long-Term Climate Action Strategy and Law on Climate Action	●	●	●	S	✓	✓	
	38	Implement core topics defined by EnC Climate Action Group	●	●	●	S, M	✓		✓
	39	Enhance implementation of the EnC acquis in the area of environment	●	●	●	S, M	✓		
	40	Align with the infrastructure acquis and determine a national competent authority in the area of infrastructure	◕	◕	◕	S, M	✓		
	41	Strengthen the human resource capacities in Ministry of Economy – Department of Energy and Energy Agency	●	●	●	S	✓		✓

Source: Project team analysis

Legend:

Implementation time frame: S – short term, M – medium term, L – long term

Level of priority: ◔ - low; ◑ - medium; ◕ - high; ● - highest

4.3 Publication in the Official Gazette

This strategy is published in the “Official Gazette of the Republic of North Macedonia”.

No. 45-11053/1
December, 28 2019
Skopje

President of the Government
of the Republic of North Macedonia,
Zoran Zaev

5 APPENDIX I – MODEL APPROACH AND DETAILED RESULTS

5.1 Modelling methodology and approach

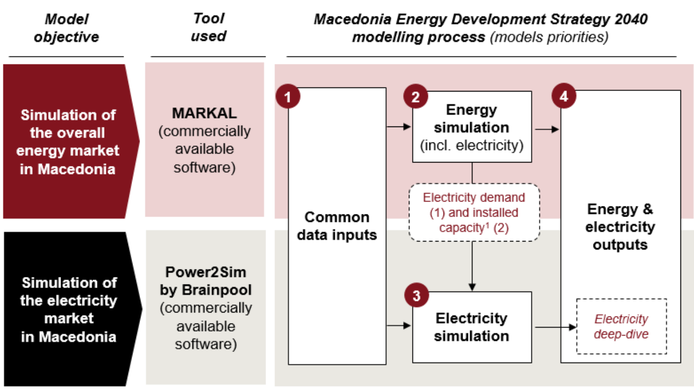
The modelling of the Strategy's quantitative results is developed using two commercially available software tools - MARKAL and Power2Sim. The objective of the MARKAL model is to simulate the overall energy market in North Macedonia based on least cost optimisation, while the objective of the Power2Sim model is used to deep-dive and confirm the electricity market results of the more comprehensive energy market model MARKAL (Figure 5.1).

The overall modelling process was as follows:

1. Collection of common data inputs between both models to ensure consistency;
2. Energy simulation (including electricity) based on least cost optimization principle run by MARKAL;
3. Electricity simulation using the Power2Sim additional features to simulate Macedonian electricity market in the integrated European market on a very high level of details (hourly basis). The key inputs used from the MARKAL model were the projected electricity demand and installed capacity build-up;
4. Preparation of energy and electricity outputs from both models.

More details of the above mentioned steps are provided in the following chapters.

Figure 5.1 Modelling framework of the Strategy



1) Installed capacity projections identified based on the least cost optimization principle run by MARKAL
Source: Project team analysis

5.1.1 Model inputs and assumptions

Both models simulate three different scenarios based on a set of commonly agreed hypothesis (Figure 5.2).

Figure 5.2 Overview of scenarios for the development of Macedonian energy system until 2040

		Reference scenario	Moderate Transition scenario	Green scenario
Vision		Transition from conventional energy based on current policy and least cost principles	Progressive transition from conventional energy based on new policy and least cost principle	Radical transition from conventional energy based on new policy and lignite phase out
Assumption highlights	Demand drivers	• Macedonian GDP growth to reach neighboring EU countries' GDP per capita levels of today by 2040 • Current energy efficiency policies • Penetration of EVs	• Same GDP growth as for reference • Energy efficiency based on enhanced policy (in line with EU Directives / EnC guidelines) • Higher penetration of EVs	• Same GDP growth as for reference • Same as moderate transition but more incentives and advanced technologies • Highest penetration of EVs
	Generation investments focus	• Lignite PP revitalization choice based on least cost principles • High focus on RES	• Lignite PP revitalization choice based on least cost principles • Further focus on RES technology investments	• Lignite PP revitalization choice based on least cost principles • Extreme focus on RES investments
	Carbon price at ETS level	2027	2025	2023
	Commodity prices (WEO 2017)[1]	Based on current policies scenario	Based on new policy scenario	Based on the sustainable development scenario
	Fuel Supply / Availability	• Lignite production capped at a maximum level of annual supply expected (~ 5 M tons 2018-2035, ~ 3 M tons 2035-2040) • Hydro production and wind/solar in line with historical trends and adjusted for new entering power plants • Cross Border Capacities (electricity and gas) evolution in line with the ENTSO-E, ENTSO-G and EnC • Sustainable consumption of biomass[2] • Battery storage (EVs and pump storage)		

1) World Energy Outlook, 2017
2) Does not exceed the annual growth of biomass, and includes utilization of residual biomass
Source: Project team analysis

All inputs and assumptions used have been either agreed within the enlarged Working Group (including ESM, MEPSO and Government of North Macedonia representatives) or taken from publicly available and reliable sources such as UN, WEO, ENTSO-E, ENTSO-G or Eurostat (Figure 5.3).

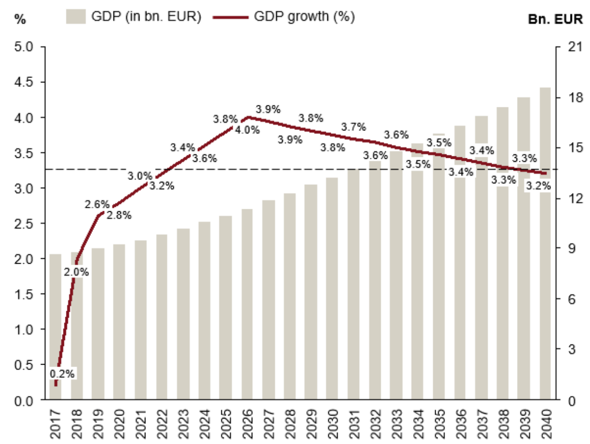
Figure 5.3 Energy modelling sources

Area	Assumption	Sources: Historical	Sources: Projections
Demand	Macedonia GDP projections	Gov. of Macedonia, IMF, own estimation	
	Population growth	State Statistical Office	UN
	Transport and industry	State Statistical Office	*MAKRAL model calculation*
	Energy balance	State Statistical Office	*MAKRAL model calculation*
	Technology specs	State Statistical Office	IEA-ETSAP, market analysis
	Macedonia electricity demand	MEPSO	*MARKAL model calculation*
	Rest of Europe demand	ENTSO-E, Eurostat	ENTSO-E TYNDP '18 (ST scenario)
Generation	Macedonia installed capacities	ESM, MEPSO, ERC	ESM / working groups
	Macedonia technology specs	ESM, MEPSO, ERC, BEG, TETO	ESM / working groups
	Rest of Europe installed capacities	ENTSO-E, Eurostat	ENTSO-E
	Rest of Europe technology specs	Eurostat, ENTSO-E	ENTSO-E, Energy Brainpool
Carbon price at ETS level	Macedonia	Working group	
	Other non-EU countries		
Commodity prices	Commodity prices	EEX, BAFA, Nordpool, EIA, ERC, HUPX	IEA World Energy Outlook 2017
	Projections for lignite price	ESM, Model estimation	
Fuel Supply / Availability (incl. electricity)	Lignite supply availability	ESM	ESM, model estimation
	Cross Border Capacities	MEPSO, GAMA, MER	ENTSO-E TYNDP 2018, GAMA, MER
	CO_2 and Local Pollutants emission rates	ESM, team analysis	
	Current wholesale electricity & gas prices	ERC	

Source: Project team analysis

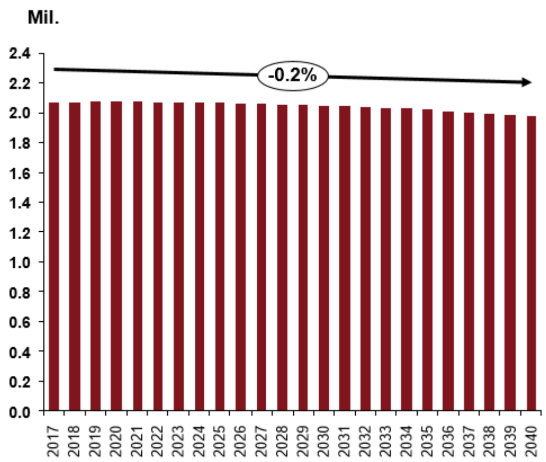
Demand projection modelling is based on common GDP projection and population growth assumptions for all scenarios, which are the most important parameters (**Figure** 5.4 and Figure 5.5). In addition with other specific factors, such as production index growth in industry, heating and cooling degree days, person per households, elasticity factors and others, demand projections by sectors were determined.

Figure 5.4 North Macedonia GDP projections



Source: IMF + Project team estimations after 2024

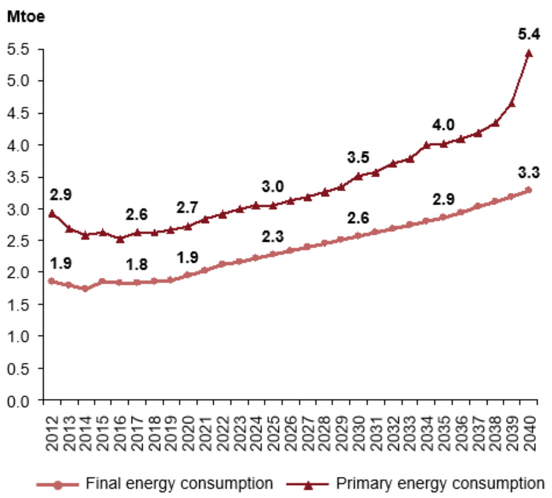
Figure 5.5 North Macedonia population growth



Source: State Statistical Office, UN

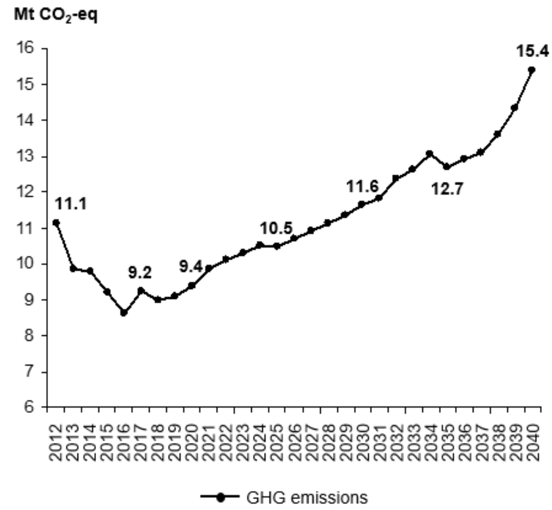
With respect to calculate energy efficiency savings, as well as reduction of GHG emissions, the modelling included the preparation of BAU scenario. The BAU scenario shows the energy sector evolution with energy measures realised until 2016, and is used for comparison against other scenarios. Based on the EnC methodology, the energy savings in primary and final energy consumption were calculated compared to BAU scenario (Figure 5.6). Same applies for the calculation of GHG emission reductions in line with UNFCCC Non-Annex I country practices, where the reductions were identified against the same BAU scenario (Figure 5.7).

Figure 5.6 Primary and final energy consumption - BAU scenario, 2018 – 2040, Mtoe



Source: MARKAL model

Figure 5.7 GHG emissions - BAU scenario, 2012 - 2040, CO_2-eq



Source: MARKAL model

Existing generation portfolio including preferential producers is included in the model inputs with their respective technical specification (Figure 5.8).

Figure 5.8 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 generation portfolio investments, a long list of 29 potential investment options was collected from the Working Group. Based on least cost optimization principles and underlying assumptions (e.g. commodity prices), the MARKAL model selects the best projects into consideration for construction (Figure 5.9).

Figure 5.9 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%	295	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	Gas CHP	2025	30	450	52%	80%	436	8.1	1.4
5	Exist. CHP (revitalization)	Gas CHP	2021	15	260	52%	80%	436		
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%	800-600	31.4	-
28	PV without FiP	PV	2020	40	400-800[1]	-	16%	800-600	31.4	-
29	PV rooftop	PV	2019	40	250-400[1]	-	16%	1,000-700	31.4	-

Note:1) depending from the scenario; 2) the overall capacity including existing small HPPs; 3) includes waste transport costs, etc.
Source: Project team analysis

As to the convergence of carbon price to ETS level, the timing differs in different scenarios, and assumption is made that this will hold true for all other countries from the region which are currently not part of the ETS (Bosnia and Herzegovina, Serbia, Albania, Montenegro and Kosovo). A common agreement with the Working Group was made that the carbon price will reach ETS level in 2027 for Reference, in 2025 for Moderate transition and in 2023 for Green scenario.

Commodity projections for CO_2 and gas prices used in both models are based on WEO 2017 and interpolated on today YTD prices. Reference scenario refers to the current policy scenario, Moderate transition scenario uses the new policy scenario, while the Green scenario applies the sustainable development policy scenario of the WEO 2017 (Figure 5.10 and Figure 5.11).

Figure 5.10 Gas price projection, 2018 – 2040

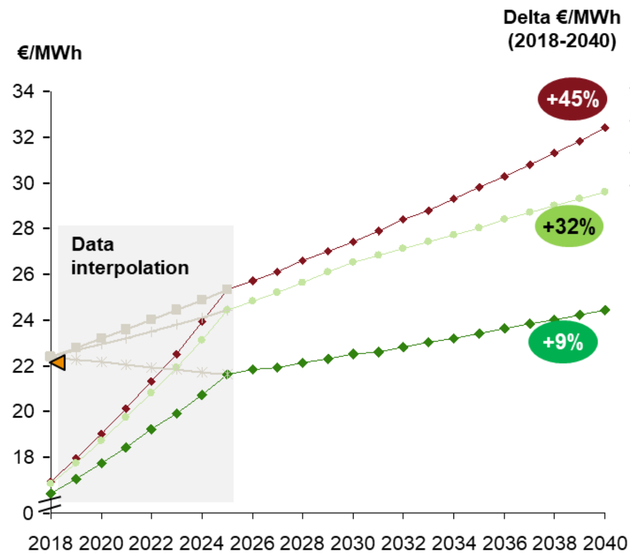
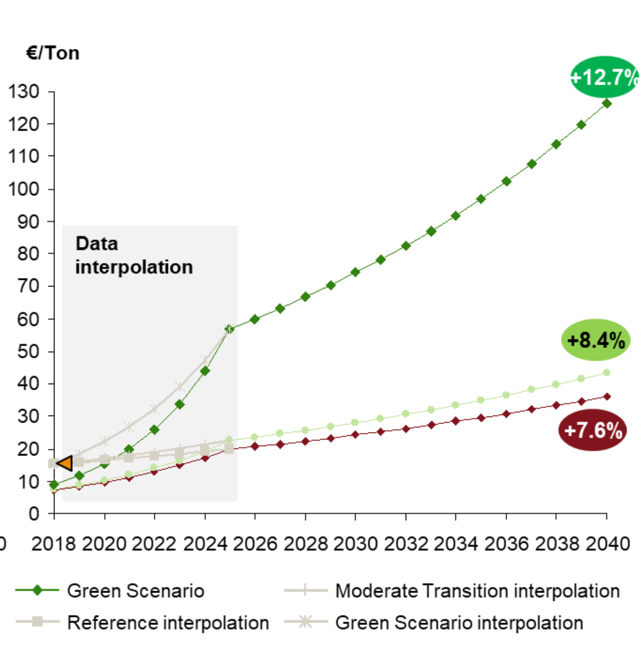


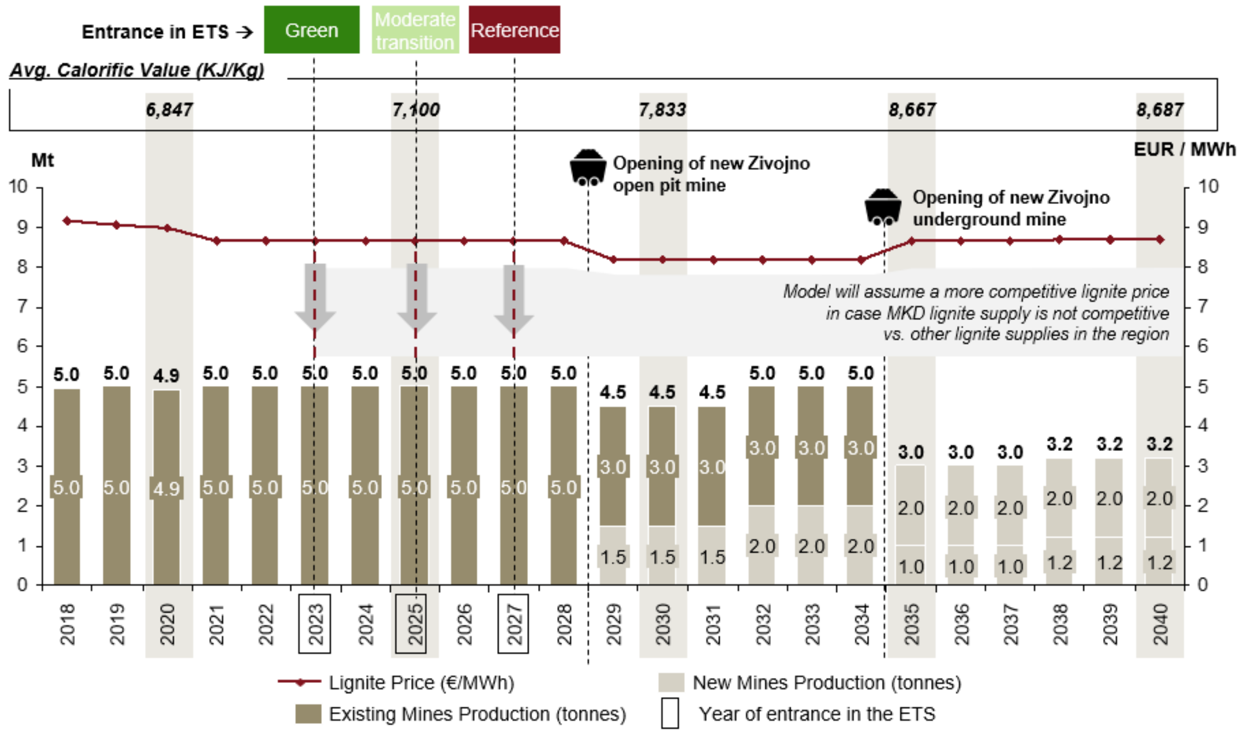
Figure 5.11 CO_2 price projections, 2018 - 2040



Source: WEO 2017, IEA; Project team analysis

Macedonian lignite supply has been projected to increase in quality towards 2035 due to opening of new mines. Their annual utilization is limited at ~ 5Mn tons until 2034 and ~3Mn tons over the period 2035 – 2040 (Figure 5.12). The increased quality of lignite compensates the costs related to opening of new mines as well as utilization of the remaining deeper layers in the existing mines. Hence, the lignite prices will remain within the 9 €/MWh range. However, in order to maintain Macedonian lignite competitiveness in the region once carbon price reaches the ETS level, a rationalisation of the operational costs is needed to lower the electricity production cost.

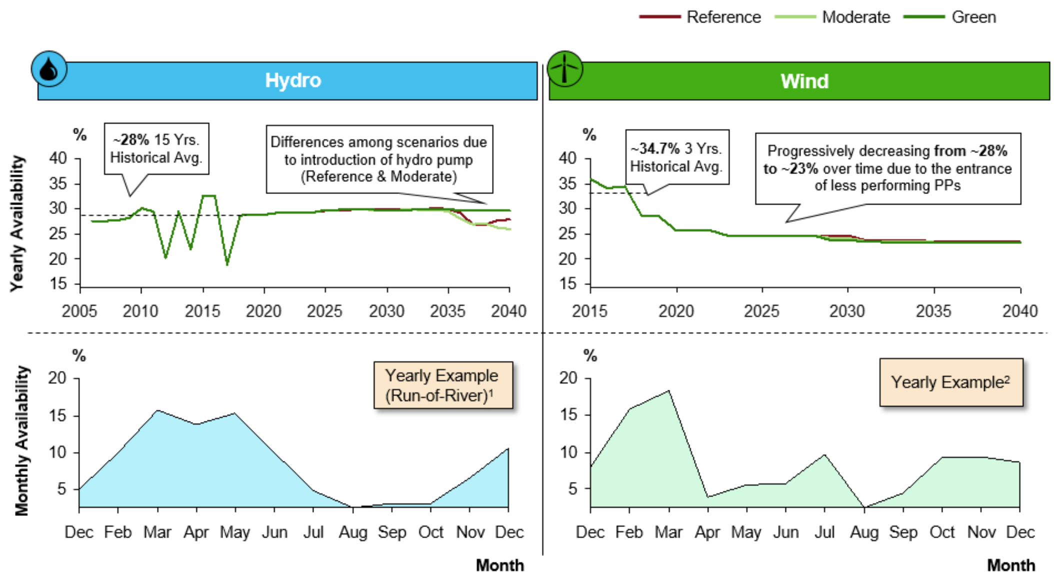
Figure 5.12 Lignite supply and price projections



Source: MANU, ERC North Macedonia, Project team analysis

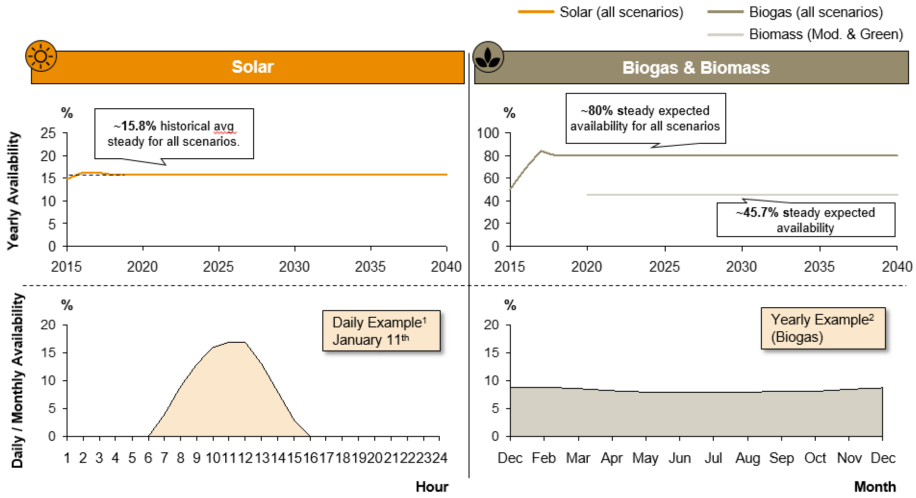
Hydro and wind availability are projected according to their historical trends, adjusted in some cases for new entering power plants (Figure 5.13). To calculate the availability of the existing wind and hydro power plants, the methodology from RES Directive is applied, which takes into account the variations in the hydrology, affecting the electricity production. This methodology is based on 3-year and 15-year historical average of electricity generation and installed capacity from wind and hydro, respectively. For the new power plants the availability is based on the specific project documents. Moreover, solar, biogas and biomass have been projected to follow a steadier pattern, based on historical or expected availabilities (Figure 5.14).

Figure 5.13 RES availability projections, hydro and wind



Source: Project team analysis

Figure 5.14 RES availability projections, solar, biogas & biomass



Note: 1) Solar generation load curve based on normalized reference year meteo data 2) Biogas and Biomass generation load based on historical / P2SIM model standard data
Source: Project team analysis

5.1.2 Energy simulation - MARKAL

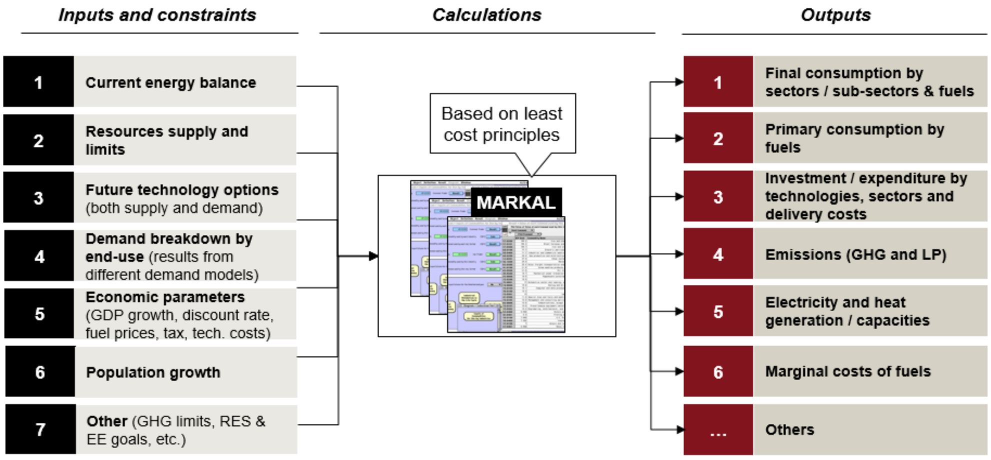
MARKAL is a widely used, commercially available, linear programming energy systems modelling framework that is well suited to examine interlocking uncertainties through a systematic approach. The MARKAL models produce robust, scenario-based projections of a country's energy balance, fuel mix and energy system expenditures over time. The models relate economic growth to the necessary energy system resources, trades and investments, while satisfying national environmental standards (or goals), to identify the least-cost energy future for the country that satisfies all the requirements. Thus, the models provide a comparative framework for examining the impact of variations in key assumptions (e.g., fuel price, availability of natural gas etc.), policies (e.g. RE targets, climate change mitigation goals) and programs to advise informed decision-making and policy formulation.

Using the MARKAL model and all software tools that come with it, the energy model for North Macedonia was developed in order to support policy making and analysis of future energy system development options. MARKAL-North Macedonia model includes the whole energy system starting from recourses through conversion technologies to end use sectors. The base year in the model is 2012 and it is run to 2040 on yearly basis.

The MARKAL objective is to minimize the total cost of the system, adequately discounted over the planning horizon. While minimizing total discounted cost, the MARKAL model takes into account large number of input data as well as potential constraints (e.g. limits for GHG emissions, goals for RES share and EE level) which express the physical and logical relationships that must be satisfied in order to properly depict the associated energy system. In MARKAL North Macedonia model, only constraints related to resource potential are used.

MARKAL analyses not only show what is to be constructed (and also what is not), but also when and for how much. Based on the engineering and economic representations of energy supply, conversion plants and end-use devices in each country, the least cost energy supply and demand balance that can satisfy the physical and policy requirements can be explored by national experts (Figure 5.15).

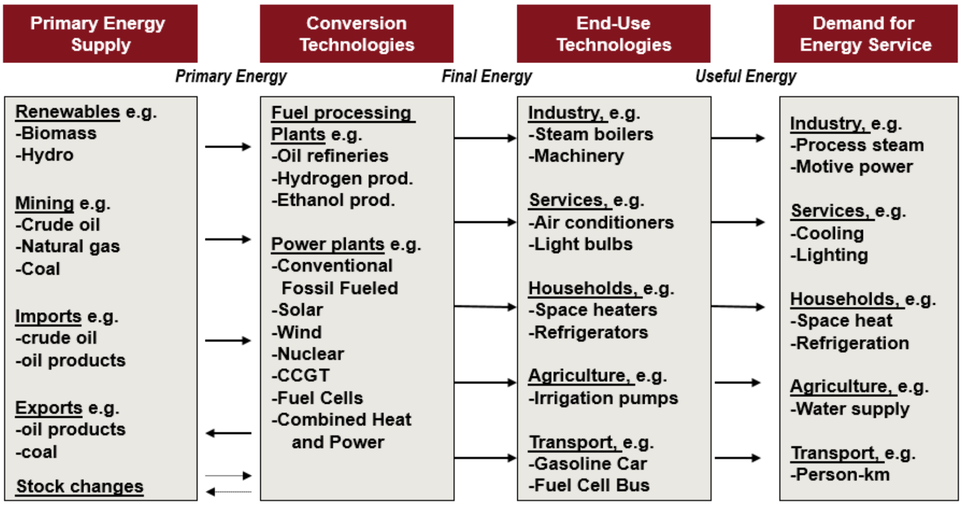
Figure 5.15. MARKAL model energy structure



Source: MARKAL model

Demand side of the MARKAL North Macedonia model is divided in five sectors: household, commercial, industry, transport and agriculture. Each of these sectors, except agriculture, is divided in sub-sectors, in order to calculate useful energy demand more precisely. Furthermore, for each of the subsectors, end-use services are defined (Figure 5.16). Useful energy demand projection for each sector is calculated using the key drivers as GDP and population growths. For the household sector, the parameter of person per household is also used in order to calculate the number of households.

Figure 5.16 MARKAL model key components

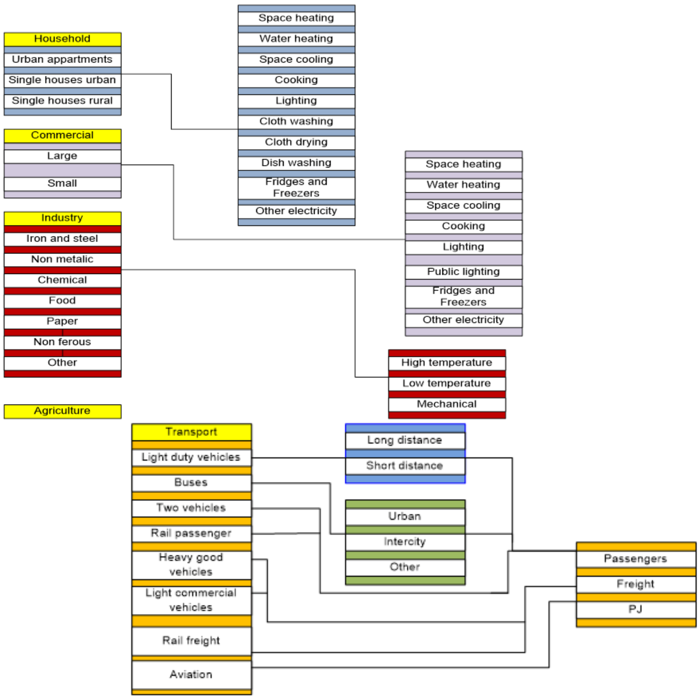


Source: MARKAL model

To satisfy the useful energy demand, the model includes a considerable number of technologies on the demand side, including high-efficient, that use different fuels (Figure 5.17). 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 gas are included, as well as hydro, wind, PV and biomass/biogas technologies (all described in details in chapter Model inputs and assumptions)

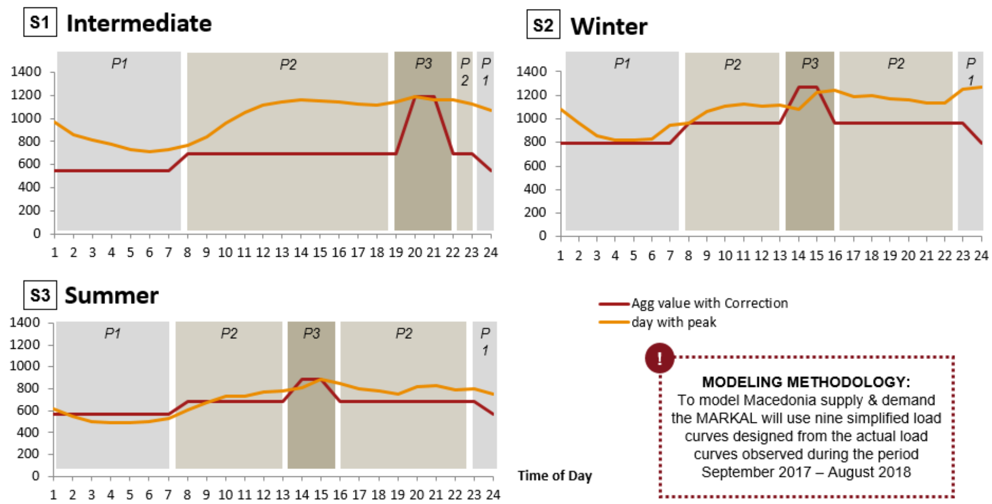
Figure 5.17 Organization at the energy demand side



Source: MARKAL model

In order to cover the variations in the electricity demand in different seasons, in the MARKAL model nine specific periods which cover daily (P2), night (P1) and peak (P3) consumption of electricity in the three periods of the year (winter, summer and spring-autumn) were analysed. In order to distribute the electricity demand over the specific periods, one of the key issues is the load curve, which in the MARKAL model was entered for the period September 2017 - August 2018, (Figure 5.18).

Figure 5.18 Hourly load profile, MW

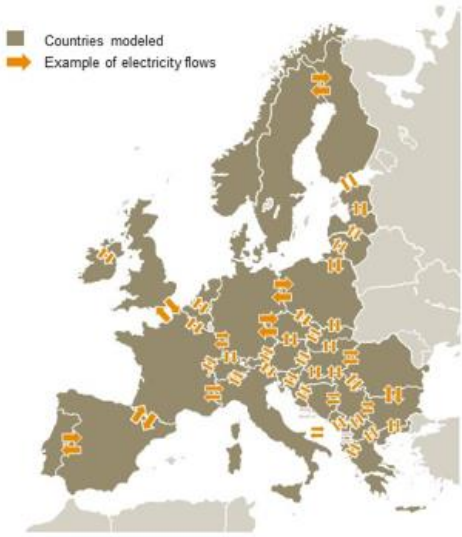


5.1.3 Electricity simulation - Power2Sim

The Power2Sim ("P2S") is a commercially available software created by Energy Brainpool®, which is commonly used by companies and institutions to simulate the electricity markets in Europe. In the preparation of the Strategy, the P2S model is used to deep-dive and confirm the results of the more comprehensive energy market model MARKAL.

The key feature of the electricity model used is its ability to assess the market dynamics within an integrated European perspective, at a very high level of detail. In fact, the P2S is able to provide a simultaneous indication of each power plant in Europe, and the related imports and exports of each country, based on the margin cost merit order modelling on an hourly basis (Figure 5.19).

Figure 5.19 Power2Sim electricity model overview



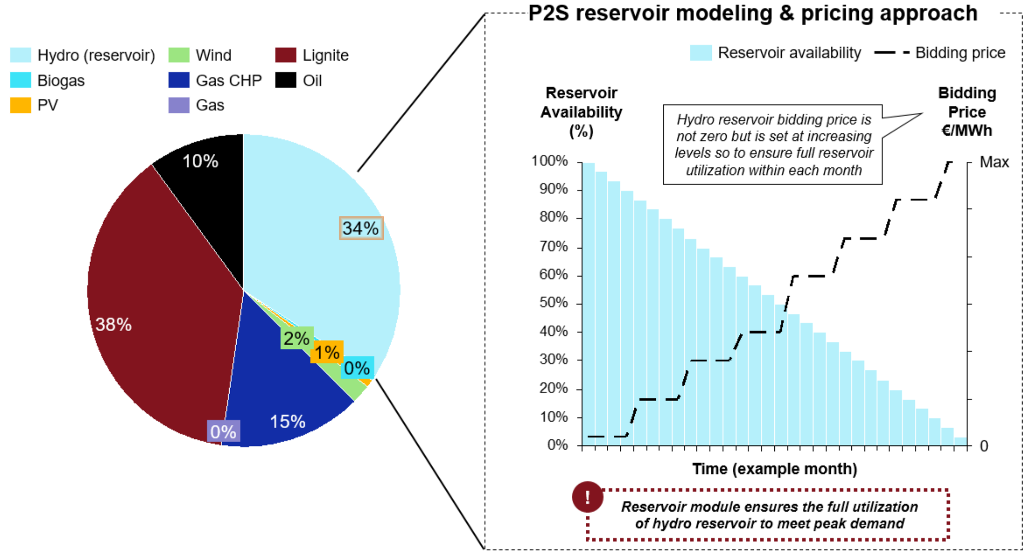
Model features used in the Macedonia power market modeling

European import / export based on perfect market coupling	Simultaneous simulation of electricity production, import and exports of all European countries based on the perfect market coupling principle
Marginal cost merit order modeling	Simulation of wholesale electricity prices and generation based on the marginal cost principle
Hourly and plant by plant simulation until 2040	Electricity modeling defined on an hourly basis for each European plant until 2040
Hydro reservoir modeling	Hydro reservoir utilization defined on the monthly reservoir availability to respond to peak demand, with pricing set on a supply / demand basis
Historical meteo-pattern modeling for RES	Electricity production from renewable sources defined on the historical weather patterns

Source: Energy Brainpool, Project team analysis

The model has also the advantage to perfectly fit the heavily hydro-based Macedonian electricity market, thanks to its innovative hydro reservoir modelling & pricing methodology which adjusts the hydro reservoir bidding to ensure full utilization of the countries' monthly reserves to meet peak demand (Figure 5.20).

Figure 5.20 North Macedonia installed capacity



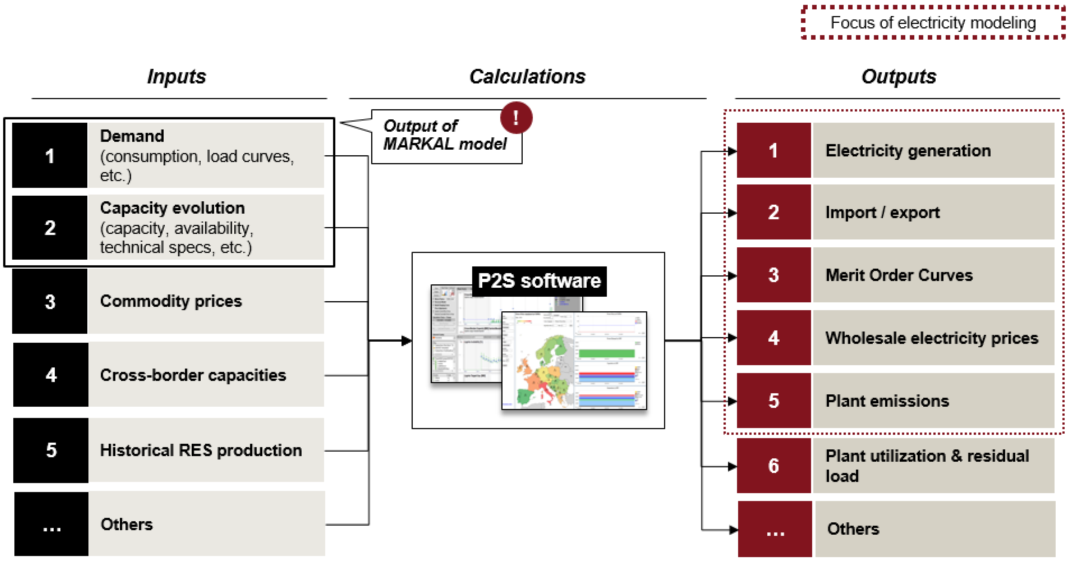
Note: 1) Based on the sensitivity parameter, price swing can be higher / lower in order to have a better/worse matching of demand and supply
Source: Energy Brainpool, Project team analysis

For the preparation of the Strategy, the P2S has been fully integrated with the energy market model: in fact, the demand and installed capacity evolution used by the P2S represent the outputs of the MARKAL model.

Furthermore, to confirm the validity of the energy market model analyses, the P2S focuses on five key outputs (Figure 5.21):

1. Electricity generation;
2. Import / export (and related integration of North Macedonia within the European electricity system);
3. merit order curve assessment (with related theoretical and average reserve margins and related electricity balances);
4. Wholesale electricity prices evolution;
5. Electricity system emissions.

Figure 5.21 Electricity model structure



Source: Project team analysis

5.2 Integrated energy results

The modeling of the Macedonian energy sector development is driven by the demand of useful energy. The key parameters used for estimation of the useful energy are the projections for the GDP and population growth, which combined with specific factors, such as production index growth in industry, heating and cooling degree days, person per households, elasticity factors and others, determine the demand projections by sectors.

The useful energy demand (excluding transport) is projected to grow to 2 mtoe in 2040, which is ~1 mtoe higher compared to 2017 (97% growth). Household and industry sectors are the main drivers of the useful energy demand growth, representing over 2/3 of the total useful energy demand (Figure 5.22). Specifically, for the household sector, half of the useful energy covers space heating needs, while the other half the energy needs for lighting, cooking, hot-water, cooling and other appliances (Figure 5.23).

Figure 5.22 Evolution of the total useful energy demand evolution

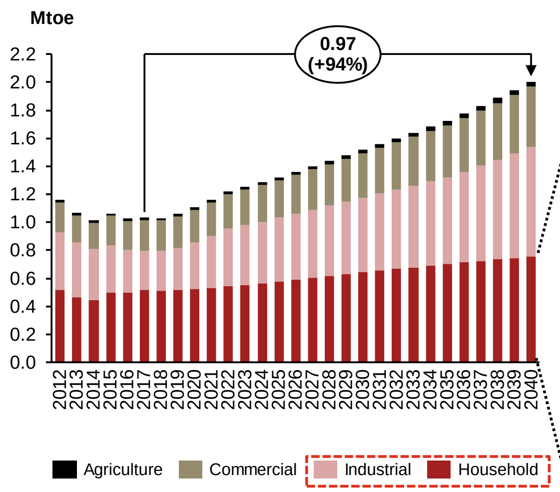
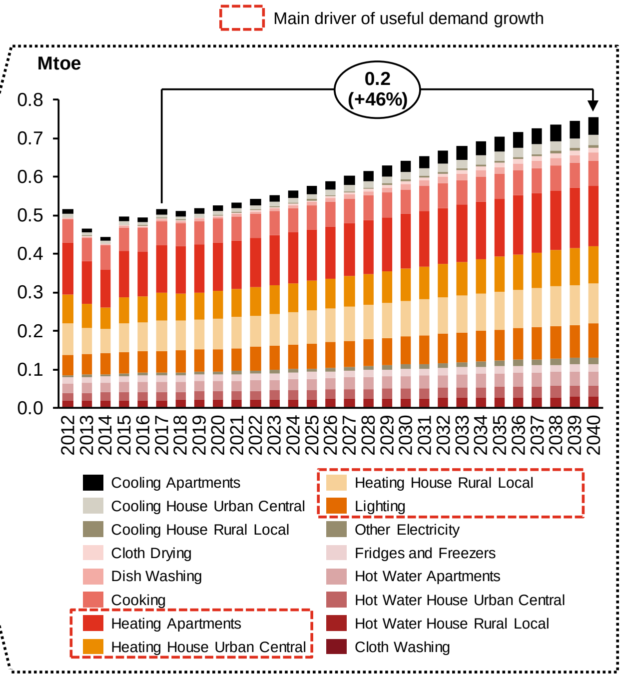


Figure 5.23 Evolution of the useful energy demand in household sector



Source: Project team analysis

The useful energy demand in transport is also projected to grow. Freight useful demand is expected to double over the period, while passenger kilometers will increase by 79% (Figure 5.24 and Figure 5.25). The passenger transport is primarily driven by light duty vehicles, particularly for long-distance. For the usage of rail transport, the document is in line with the Transport Strategy for 2030.

Figure 5.24 Transport (passenger + freight) evolution

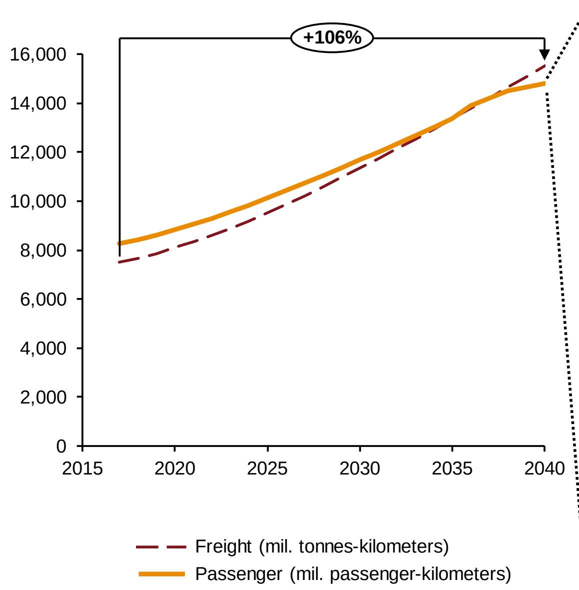
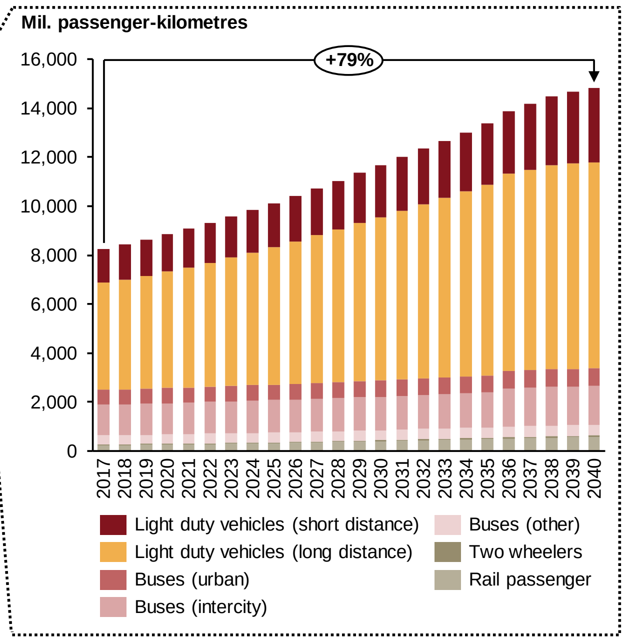


Figure 5.25 Passenger transport evolution

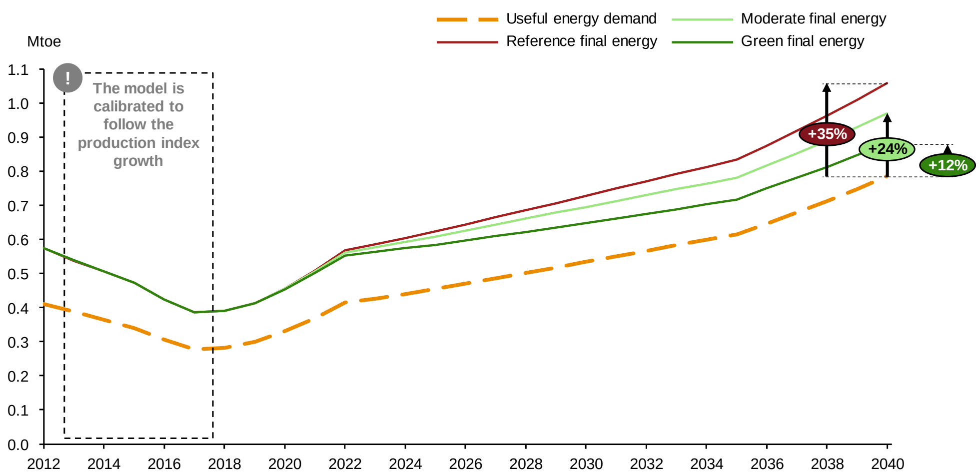


Source: MARKAL model (inputs for transportation based on IEA / SMP)

5.2.1 Energy efficiency

Final energy consumption in the industry sector is 12% to 35% higher compared to the useful energy demand. Although, the difference between the useful and final energy consumption is reducing, still the overall efficiency of the industry sector is ~90% (~15pp more that in the Reference scenario). The process of decoupling starts in 2021 for all scenarios (Figure 5.26). For the period 2012 – 2017 the model is calibrated to reflect the production index growth in the industry.

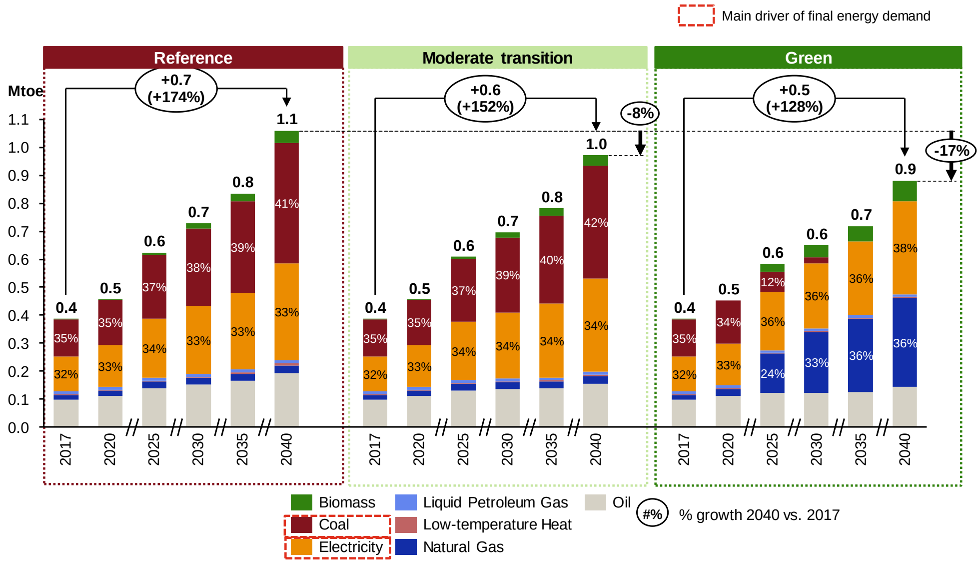
Figure 5.26 Useful vs. final energy consumption in industry sector, by scenario



Source: MARKAL model

The total final energy consumption in the industry is reduced by 8.3% and 16.9% in 2040 in the Moderate transition and Green scenario, respectively, compared to the Reference scenario (Figure 5.27**).** In the Moderate transition scenario, the coal has the highest share (similar to the Reference scenario) reaching 42% in 2040. This is completely opposite to the Green scenario where in 2040 there is no coal, which is mainly replaced by the natural gas (with a share of 36 %). This replacement is result of the higher CO_2 in the Green scenario compare to the Moderate transition scenario. Electricity is one of the main drivers in all three scenarios with a share of 33%, 34% and 36% in the reference, the moderate transition and in the green scenario, respectively.

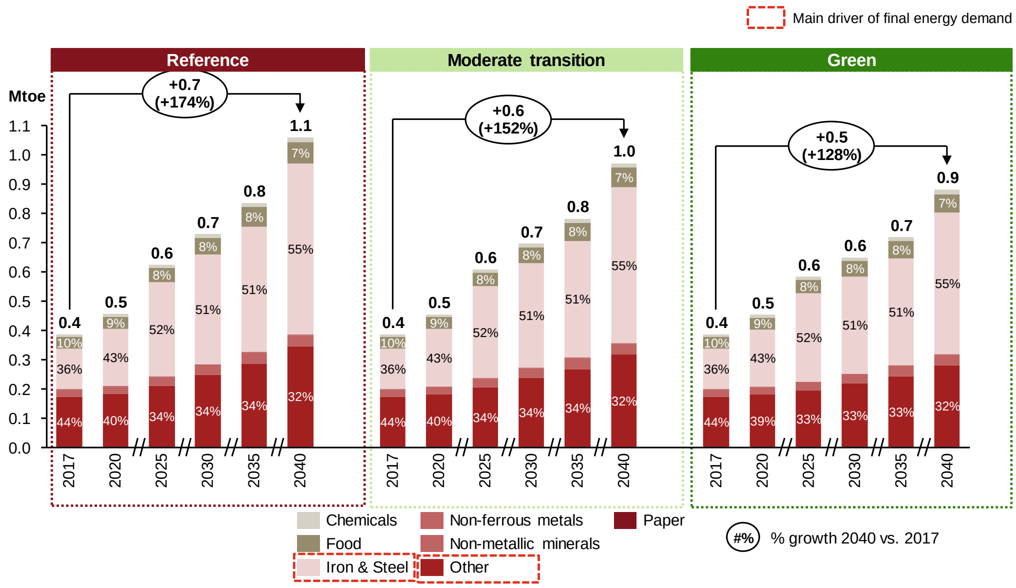
Figure 5.27 Final energy consumption by fuels – industry



Source: MARKAL model

All industrial subsectors are subjected to energy efficiency measures. Even though the final energy consumption is different in all three scenarios, the share of the subsectors in the final energy consumption is identical (Figure 5.28). The subsector with the highest share in the final energy consumption is the Iron & Steel subsector, with around 55% share in 2040.

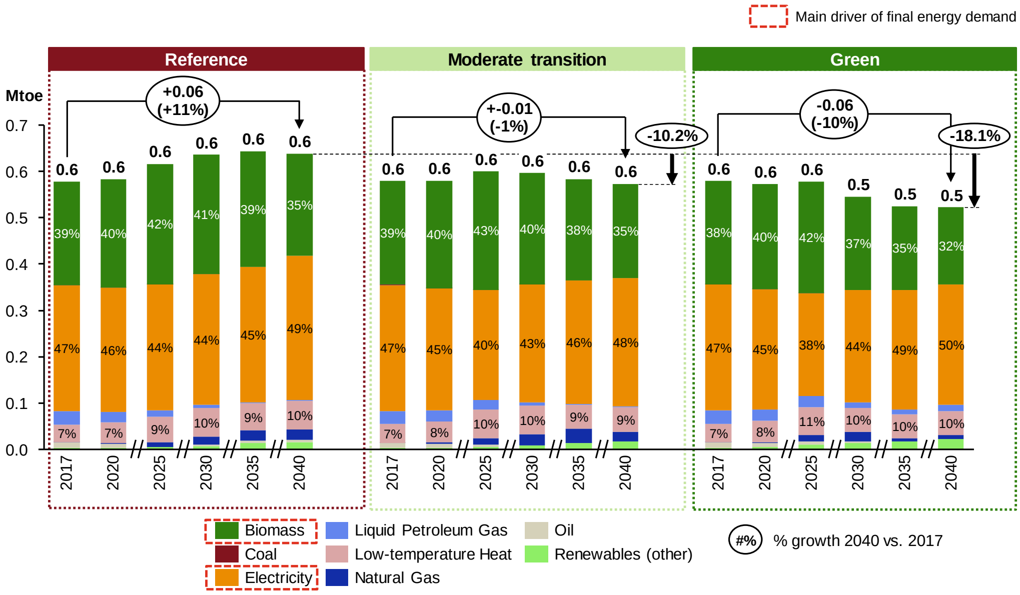
Figure 5.28 Final energy consumption by subsectors – industry



Source: MARKAL model

The total final energy consumption in the households is reduced by 9.5% and 17.5% in 2040 in the Moderate transition and Green scenario, correspondingly, compared to the reference scenario (Figure 5.27**Figure** 5.29**).** Electricity has the highest share of 49%, 48% and 50%, followed by the biomass with 34%, 35% and 32% share in 2040 in each of the three scenarios: Reference, Moderate transition and Green, respectively. Compare to 2017, in 2040 the final energy consumption in the Green scenario is ~10% lower.

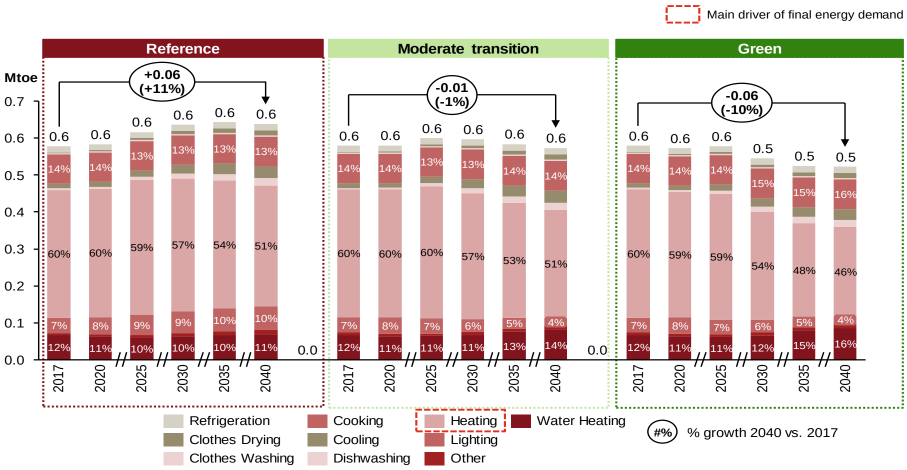
Figure 5.29 Final energy consumption by fuels – households



Source: MARKAL model

Clothes drying, dishwashing and cooling are the fastest growing household subsectors. Although, more efficient technologies are introduced they cannot respond to the growing needs in these subsectors. More than half of the final energy in the households is consumed for heating, as shown in Figure 5.30 (51%, 51% and 46% in 2040 in the Reference, Moderate transition and Green scenario, correspondingly).

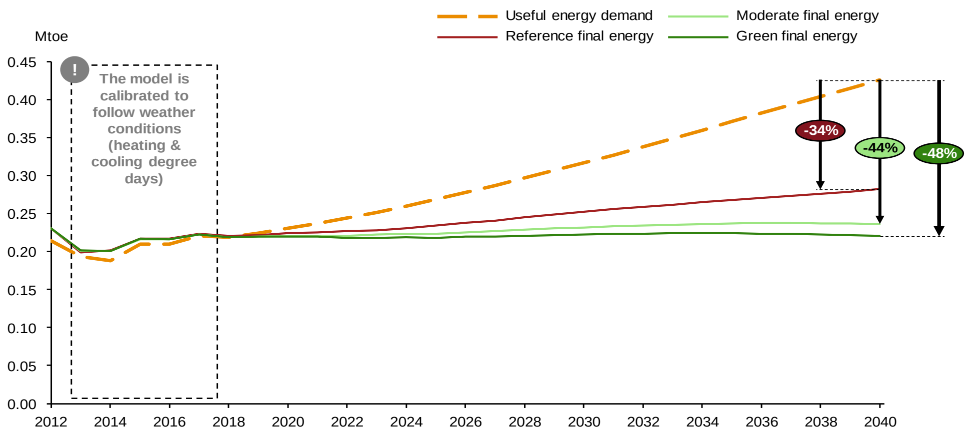
Figure 5.30 Final energy consumption by subsector – households



Source: MARKAL model

Final energy consumption in the commercial sector is 34% to 48% lower compare to the useful energy demand. The analyses done for this sector show that the situation is almost identical as for the household. The implemented energy efficiency measures result in lower energy consumption, while at the same time the useful energy demand is projected to grow (Figure 5.31). The decoupling starts in 2019. For the period 2012 – 2017 the model is calibrated to reflect the weather conditions.

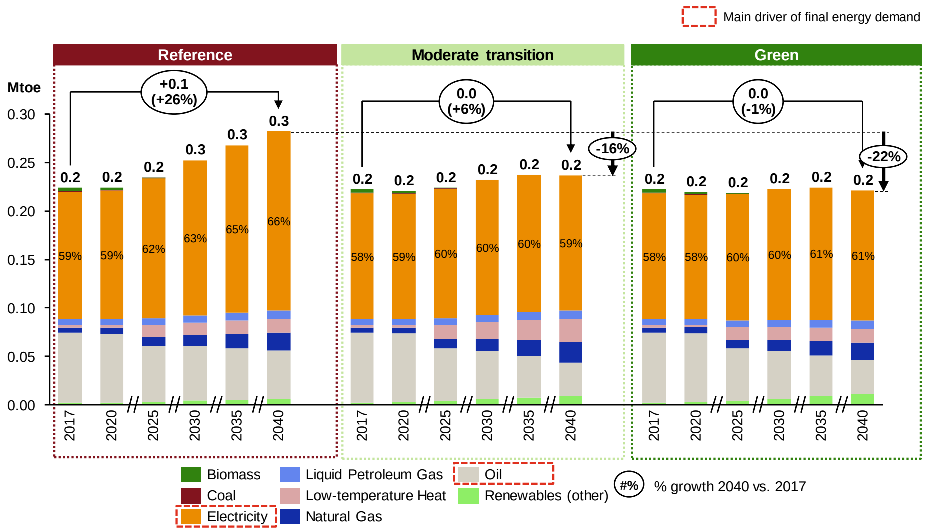
Figure 5.31 Useful vs. final energy consumption in commercial sector, by scenario



Source: MARKAL model

Total final energy consumption in the commercial sector is reduced by 16% and 22% in 2040 in Moderate transition and Green scenario compared to Reference. Electricity has the highest share in all scenarios (Figure 5.32).

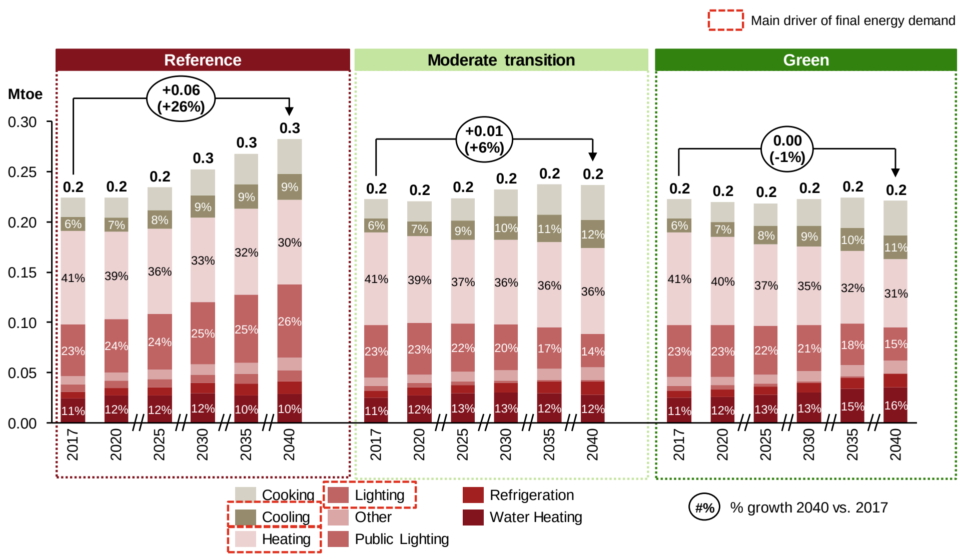
Figure 5.32 Final energy consumption by fuels – commercial



Source: MARKAL model

Highest reduction in the final energy consumption in the commercial sector are in heating and lighting subsectors (Figure 5.33).

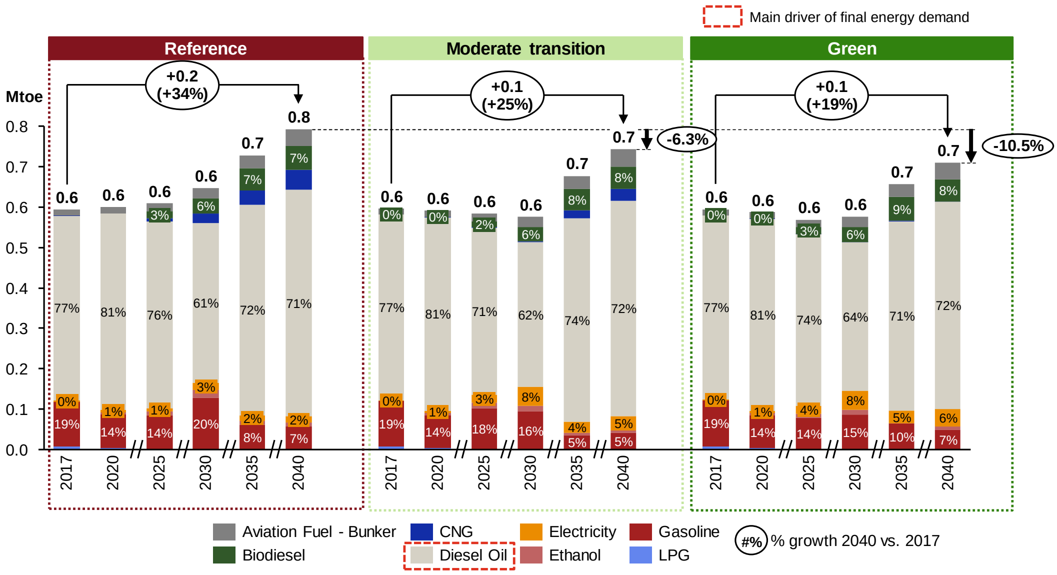
Figure 5.33 Final energy consumption by subsector - commercial



Source: MARKAL model

The total final energy consumption in the transport is reduced by 6.3% and 10.5% in 2040 in the moderate transition and the green scenario, correspondingly, compared to the Reference scenario. The highest share of around 70% in 2040 has the diesel in each of the three scenarios, offset by domestic vehicles and vehicles in transit. The share of biodiesel form 0% in 2017 reaches 7.6% in 2040 in both the moderate transition and green scenario. There is also high increase in the use of electricity, from 0.5% in 2017 to 4.8% and 6% in 2040 in the moderate transition and green scenario, correspondingly (Figure 5.34). The diesel and CNG consumption in the Green scenario is decreasing relative to the Reference scenario, while the gasoline consumption remains at the same level. The projection of final energy consumption in transport will largely depend on transit of vehicles through North Macedonia and on the fuel prices in North Macedonia and neighbouring countries.

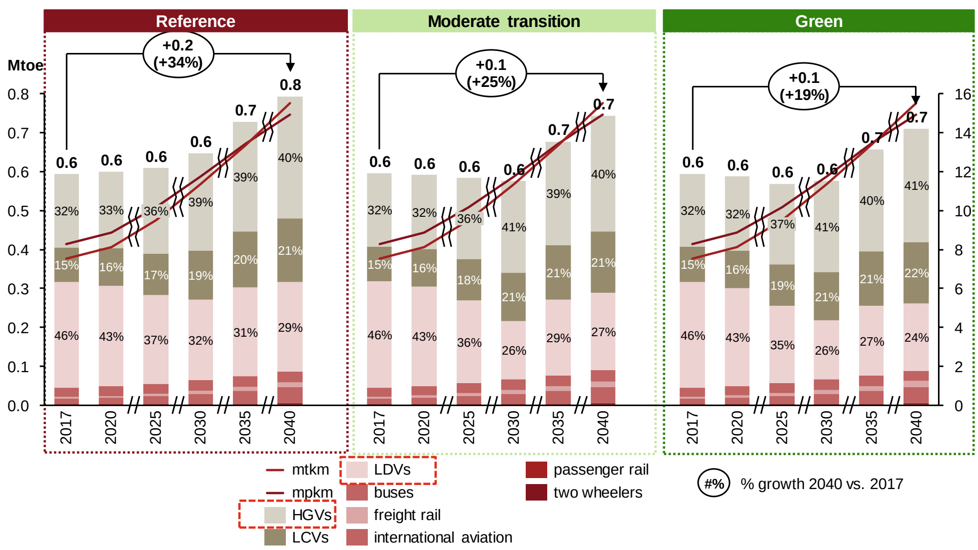
Figure 5.34 Final energy consumption by fuels – transport



Source: MARKAL model

The highest reduction of the final energy consumption in transport is achieved by Light Duty Vehicles (LDVs) as a result of introduced advance technologies such as electric cars, PHEV (plug-in hybrid electric vehicles) as well HEV (Hybrid electric vehicles). These technologies will increase the overall efficiency of the transport sector (Figure 5.35). The largest share of around 40% in 2040 of the final energy in the transport is consumed by the heavy goods vehicles (HGVs) in each of the scenarios.

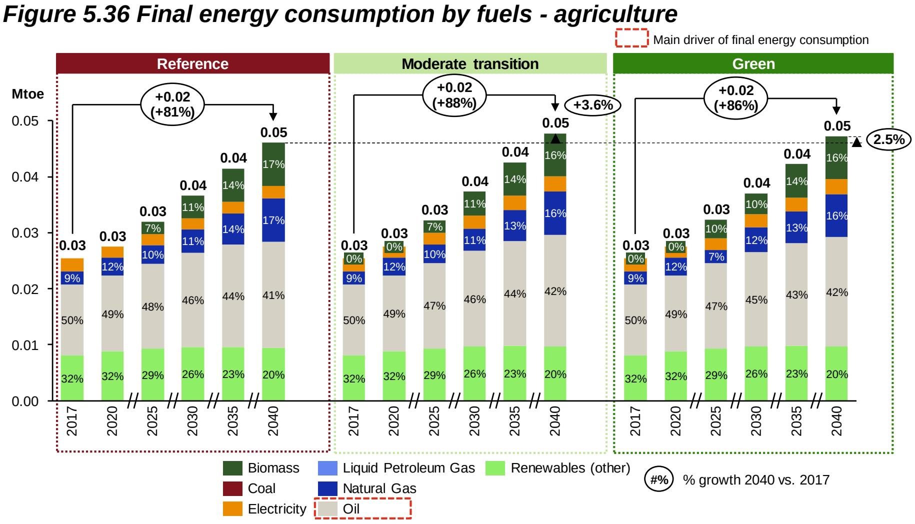
Figure 5.35 Final energy consumption subsector – transport



Source: MARKAL model

The final energy consumption in agriculture is nearly the same in each scenario. The most widely used fuel in the agriculture is the oil whose share of around 50% in 2017 is reduced to around 40% in 2040 in each of the three analyzed scenarios. On the other hand, the share of biomass is increased from 0% in 2017 to around 16% in 2040 in each of the scenarios (Figure 5.36).

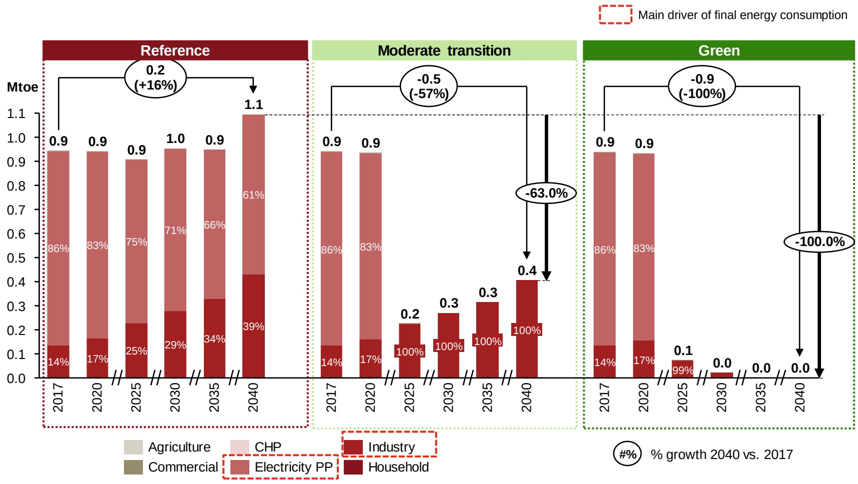
Figure 5.36 Final energy consumption by fuels - agriculture



Source: MARKAL model

In 2040, the total coal consumption is reduced by 63% and 100% in the moderate transition and the green scenario, correspondingly, compared to the reference scenario. In the reference scenario, in 2017 85.6% of the coal is used by the electricity PPs and 14.2% in the industry sector, while in 2040 the coal used for electricity PP is reduced to 60.7% and the coal used in the industry sector is increased to 39.3%. On the other hand, in the moderate scenario in 2040 coal is only used in the industrial sector and in the green scenario coal is not used at all in 2040 (Figure 5.37).

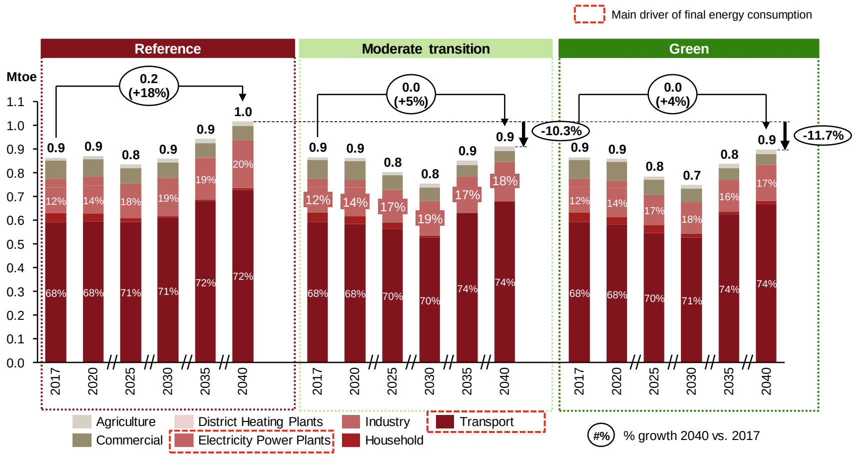
Figure 5.37 Coal consumption by sectors



Source: MARKAL model

In 2040, the total oil consumption is reduced by 10.3% and 11.7% in the moderate transition and the green scenario, correspondingly, compared to the reference scenario. The oil is mainly used in the transport sector, with a share of 71.6%, 74.5% and 74.2% in 2040 in the reference, moderate transition and the green scenario. The transport sector is followed by the industry sector with a share of 20.1%, 18.2% and 17.1% in each of the scenarios (Figure 5.38).

Figure 5.38 Oil and oil products consumption by sectors

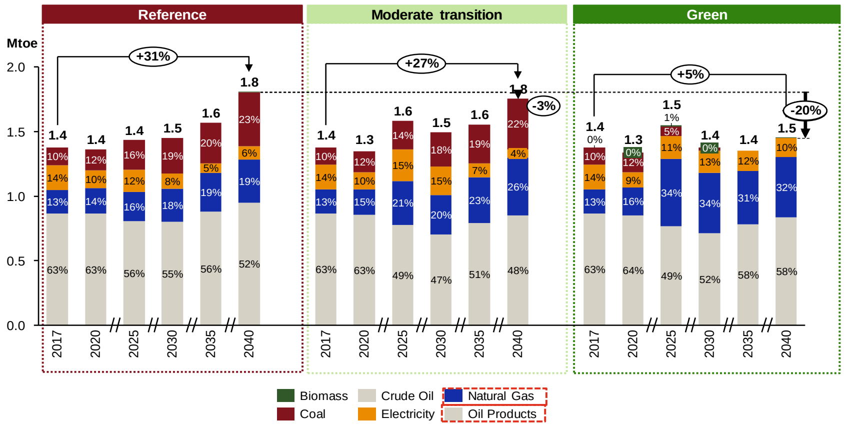


Source: MARKAL model

5.2.2 Integration and security of energy markets

Oil products with 47% to 58% share are the main driver of the imported fuels. The implementation of the EE and RES measures contributes to the reduction of the net import. In the Green scenario it is decreased by 20% compare to the Reference scenario (Figure 5.39).

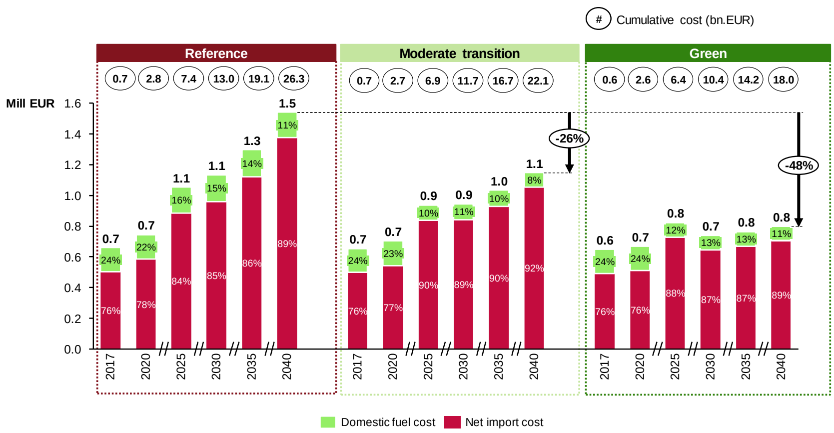
Figure 5.39 Net import by fuels



Source: MARKAL model

Import fuel expenditure participate from ~75 to ~90% in the primary energy expenditure. Even though the amount of the net-import in the Moderate scenario is almost the same as in the Reference, primary energy expenditures are 26% lower (Figure 5.40). This is mainly result of the fuel switch and on the other hand in the Moderate scenario the fuel prices are lower compare to the Reference (WEO 2017). Additionally, in the Green scenario import expenditures are 48% lower to Reference.

Figure 5.40 Primary energy expenditure

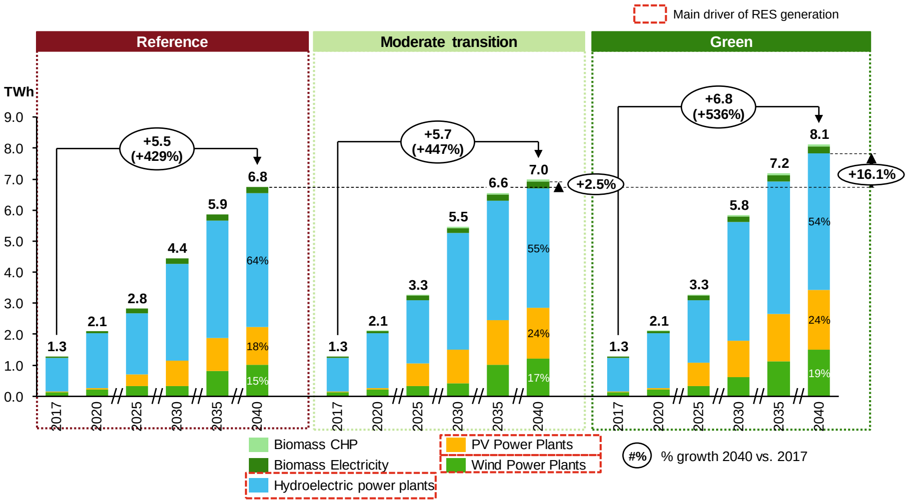


Source: MARKAL model

5.2.3 Decarbonisation

The overall electricity production from RES is increase by 2.5% and 16.1% in the Moderate and Green scenario compare to Reference. The investment in the wind and solar will reduce the share of electricity produced from the hydro PP from 64% (Reference) to 54% (Green).

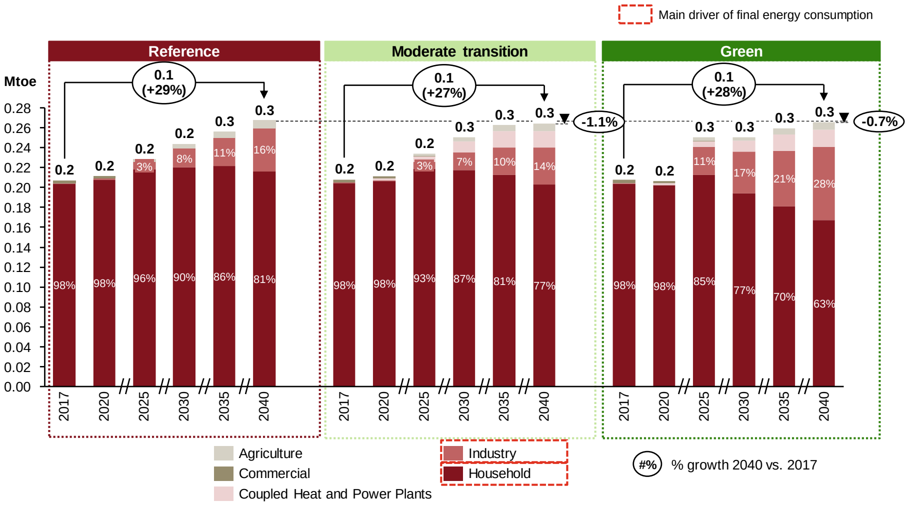
Figure 5.41 Hydro + other RES



Source: MARKAL model

The total biomass consumption remains the same in 2040 in all three scenarios, but the distribution by sectors is different. The biomass consumed in the household sector from 98% share in 2017 is reduced to 81%, 77% and 63% in 2040, in the Reference, Moderate transition and Green scenario, correspondingly. On the other hand, the share in the industry sector from 0.1% in 2017 is increased to 16%, 14% and 28% in each of the scenarios (Figure 5.42).

Figure 5.42 Biomass consumption



Source: MARKAL model

5.3 Detailed electricity results

5.3.1 Summary of results until 2040

In 2040, for all scenarios, North Macedonia will complete its transition to a mostly RES-oriented country, although in different pathways (Figure 5.43).

Figure 5.43 North Macedonia electricity market evolution in a nutshell

Focus	Today (2017)	2040: Reference	2040: Moderate Transition	2040: Green
Demand	**Demand 1.5 GW** **Consumption 7.2 TWh**	**Demand 2.3 GW (+ 51%)** **Consumption 10.9 TWh**	**Demand 2.0 GW (+ 35%)** **Consumption 9.8 TWh**	**Demand 2.1 GW (+ 41%)** **Consumption 10.2 TWh**
Supply	**RES production @ 25%** (mostly hydro reservoir)	**RES production @ 71%** (45% Hydro)	**RES production @ 78%** (44% Hydro)	**RES production @ 90%** (49% Hydro)
Supply & Demand balance	**Negative net import balance @ 27%** and theoretical reserve margin @ +7%	**Negative net import balance @ 14%** and negative theoretical reserve margin @ -8%	**Negative net import balance @ 8%** and negative theoretical reserve margin @ -4%	**Negative net import balance @ 12%** and negative theoretical reserve margin @ -23%
Wholesale electricity prices	**48 €/MWh**	**66 €/MWh** (+38% vs. +91% avg. commodity prices[1])	**63 €/MWh** (+31% vs. +109% avg. commodity prices[1])	**72 €/MWh** (+50% vs. +370% avg. commodity prices[1])
Emissions	**4.4 Mt CO2** **54 k tons of local pollutants**	**2.5 Mt CO2** (-42% vs. '17) and **9 k tons local pollutants** (-83% vs. '17)	**0.7 Mt CO2** (-84% vs. '17) and **0.7 k tons local pollutants** (-99% vs. '17)	**0.3 Mt CO2** (-93% vs. '17) and **0.4 k tons local pollutants** (-99% vs. '17)

Note:1) Arithmetic average of gas and CO_2 prices delta 2040 vs 2018;
Source: Project team analysis

5.3.2 Demand evolution (MARKAL model)

The highest consumption and demand will take place in the Reference scenario, followed by the Green and Moderate transition scenario (Figure 5.44 and Figure 5.45).

Figure 5.44 Electricity conusmption[1] evolution

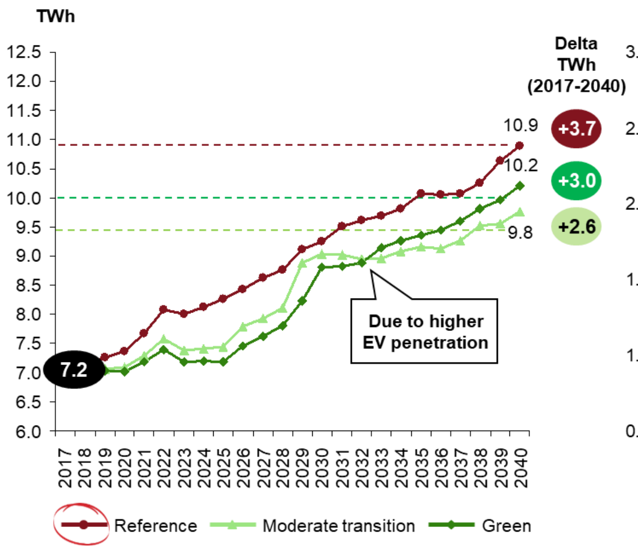
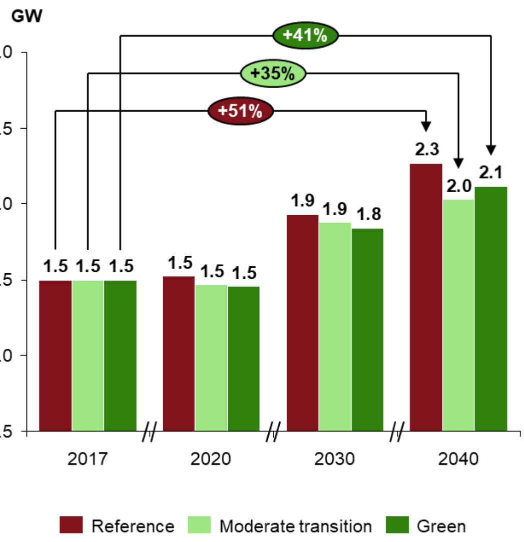


Figure 5.45 Electricity peak demand

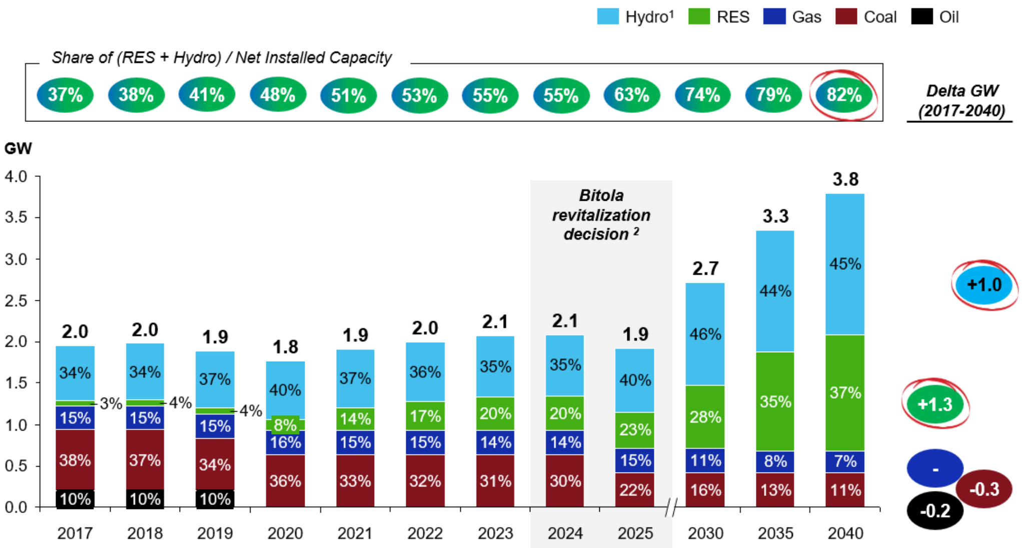


Note: 1) Electricity demand at generation level (net of own consumptions from PPs)
Source: MARKAL model, Project team analysis

5.3.3 *Electricity supply*

In the Reference scenario, installed capacity will almost double by 2040 reaching 3.8GW (+1.8GW vs. today), with RES increasing to 82% over the total portfolio and the Bitola plant being revitalized (Figure 5.46).

Figure 5.46 Evolution of net installed capacity – Reference scenario, 2017-2040



Note: 1) "Hydro" includes both large (mainly reservoir) and small (mainly run of the river) hydro power plants. Tenovo-Kozjak project assumed as an increase in installed capacity; 2) Coal revitalization decision based on least-cost optimization rationale, performed in the energy modelling exercise (MARKAL); Source: MARKAL model, Project team analysis

In the Reference scenario, Bitola is revitalized as it represents the least expensive option on the basis of the assumptions taken. Additionally, country will phase-out only a small portion of its conventional portfolio but will focus all of its new investments in hydro and renewables (Figure 5.47 and Figure 5.48).

Figure 5.47 Planned generation capacity phase-outs – Reference scenario

Plant	Tech-nology	Capacity (Net, MW)	Phase-out (Year)
Oslomej	Lignite	100	2019
Negotino	Oil	198	2020
Total phased-out capacity (GW)		0.3	2019-2020

Figure 5.48 Planned key generation capacity investments – Reference scenario

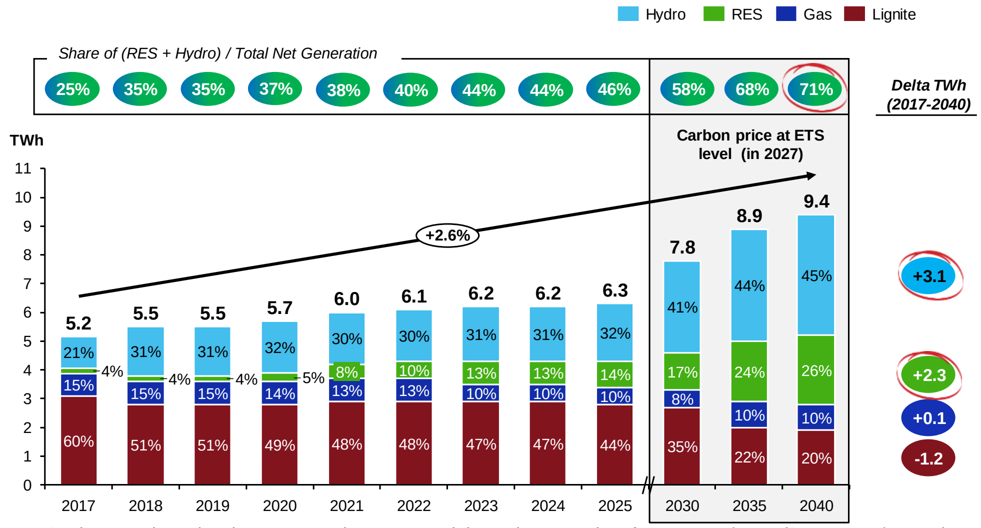
Plant	Tech-nology	Capacity (Net, MW)	% on tot.	Entrance (Year)
New Wind promoted	Wind	113	5%	2018-2023
New Wind non-prom.	Wind	350	15%	2031-2040
New PV promoted	Solar	457	20%	2020-2040
New PV non-prom.	Solar	400	17%	2028-2036
New Biogas	Biogas	23	1%	2020-2040
Cebren	Hydro	123 – 458	20%	2029-2037
Gradec	Hydro	75	3%	2030
Veles	Hydro	96	4%	2030
Globocica II	Hydro	20	1%	2037
Kanal Vardar – Kozjak	Hydro	126	5%	2030
New Small Hydro	Hydro	223	10%	2019-2040
Total new capacity (GW)		2.3	100%	2018-2040

! Tables do not include plants revitalizations such as Bitola or Gas CHP plants (life extension of 260 MW from 2033)

Note: When a range is indicated for the "Entrance (year)", the capacity is gradually increased over a multiannual timeframe. Differences may arise due to rounding; category New Small Hydro includes also 15 small power plants on Vardar valley (137 MW, without feed-in tariff) and 34 MW that are in construction phase.
Source: ESM, MEPSO, MANU, MARKAL model, Project team analysis

Electricity generation in the Reference scenario will increase to 9.4 TWh by 2040, mostly driven by RES which will account for 71% of total electricity produced (Figure 5.49).

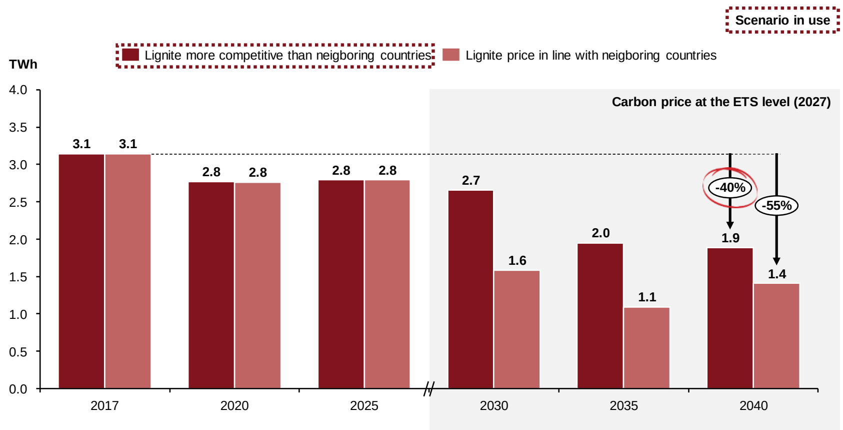
Figure 5.49 Evolution of total net generation mix – Reference scenario, 2017 - 2040



Note: Coal generation takes into account the raw material supply constraint of ~5 M tons / year (3.5 M tons / year since 2035)
Source: MARKAL model, Power2Sim model, Project team analysis

Within the highly RES-based context of the Reference scenario, Bitola is expected to remain an important source of baseload generation for North Macedonia, provided that lignite remains competitive compared to the neighbouring countries (Figure 5.50). In fact, Bitola competitiveness and related utilization will be put at risk once the carbon price reaches the ETS level, since it does not rank within the highest efficiency range in the region.

Figure 5.50 Evolution of North Macedonia lignite generation, 2017-2040



Note: In the simulation with "competitive lignite" a more competitive price of 5 €/MWh was considered
Source: MARKAL model, Power2Sim model, Project team analysis

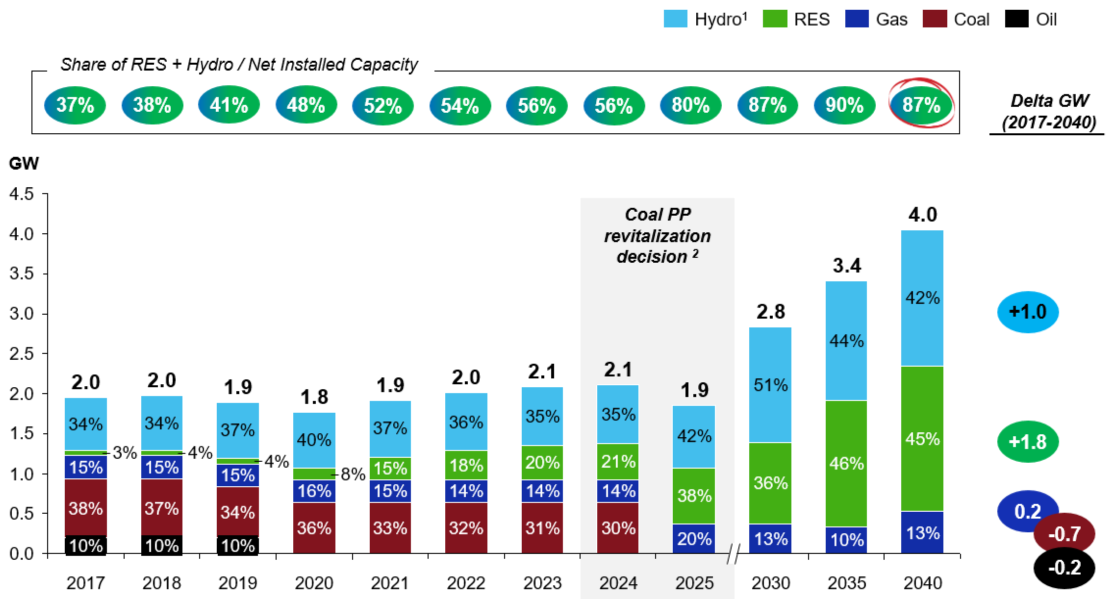
Figure 5.51 Countries adopting ETS today and average portfolio specs in the region, 2017

Country	Installed gross capacity (MW)	Net efficiency range (%)
Macedonia	**736**	**30%** *(32% after revitalization)*
Germany	22,046	28-45%
Poland	8,756	22-42%
Slovenia	1,095	22-41%
Bosnia & Herzeg,	1,815	26-39%
Serbia	5,365	25-38%
Bulgaria	3,427	23-36%
Greece	3,646	25-38%
Czech Republic	6,387	25-43%

Note: 1) Includes Kosovo plants
Source: Brainpool Energy Plants Database; Project team analysis

In the Moderate transition scenario, the generation capacity will grow to 4.0 GW by 2040 (+2 GW vs. 2017), with RES reaching 87% of the total installed portfolio. In this scenario coal is phased-out in 2025, since it represents the most expensive option with the assumptions taken (Figure 5.52).

Figure 5.52 Evolution of net installed capacity – Moderate transition scenario, 2017-2040



Note: 1) "Hydro" includes both large (mainly reservoir) and small (mainly run of the river) hydro power plants. Tenovo-Kozjak project assumed as an increase in installed capacity 2) Coal revitalization decision based on least-cost optimization rationale, performed in the energy modelling exercise (MARKAL)
Source: MARKAL model, Project team analysis

In the Moderate transition scenario, North Macedonia will phase-out ~ 0.9 GW of the existing conventional capacity while add ~ 3.1 GW of RES and Gas PPs (Figure 5.53 and Figure 5.54).

Figure 5.53 Planned generation capacity phase-outs – Moderate transition scenario

Plant	Tech-nology	Capacity (Net, MW)	Phase-out (Year)
Oslomej	Lignite	100	2019
Bitola	Lignite	636	2025
Negotino	Oil	198	2020
Total phased-out capacity (GW)		0.9	2019-2025

Figure 5.54 Planned key generation capacity investments – Moderate transition scenario

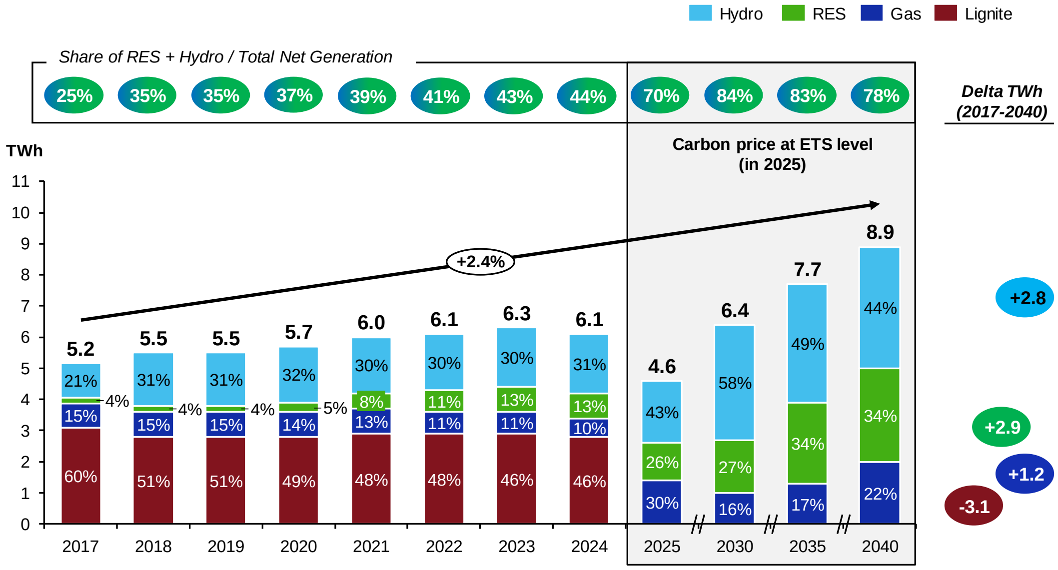
Plant	Tech-nology	Capacity (Net, MW)	% on tot.	Entrance (Year)
New Wind promoted	Wind	113	4%	2018-2023
New Wind non-prom.	Wind	450	15%	2029-2040
New PV promoted	Solar	547	18%	2025-2036
New PV non-prom.	Solar	610	20%	2018-2040
New Biogas	Biogas	23	1%	2020-2036
New Biomass	Biomass	15	0%	2020-2035
New Large Hydro *(Cebren, Gradec, Veles, KV Kozjak, Globocica)*	Hydro	775	26%	2029-2037
New Small Hydro	Hydro	223	7%	2019-2040
New Gas TPP	Gas	85	3%	2025
New Gas CHP 1	Gas	119	4%	2039
New Gas CHP 2	Gas	61	2%	2040
Total new capacity (GW)		3.0	100%	2018-2040

! N.B. Tables do not include Gas CHP plants revitalization (life extension of 260 MW from 2033)

Note: When a range is indicated for the "Entrance (year)", the capacity is gradually increased over a multiannual timeframe. Sum differences may arise due to rounding; category New Small Hydro includes also 15 small power plants on Vardar valley (137 MW, without feed-in tariff) and 34 MW that are in construction phase.
Source: ESM, MEPSO, MANU, MARKAL model, Project team analysis

Generation will reach 8.9 TWh in 2040 (with RES @ 78%), with a drop in the 2025-2030 period following coal phase-out (Figure 5.55).

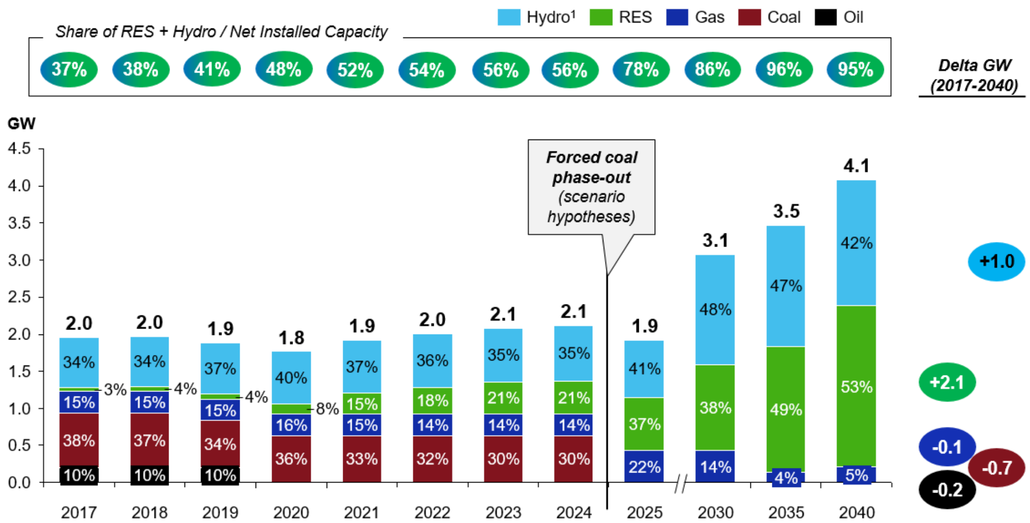
Figure 5.55 Evolution of total net generation mix – Moderate transition scenario, 2017-2040



Note: Coal generation takes into account the raw material supply constraint of ~5 M tons / year (3.5 M tons / year since 2035). Difference may arise due to rounding
Source: MARKAL model, Project team analysis

In the Green scenario installed capacity will grow to 4.1 GW (+2.1GW vs. 2017), with the country's portfolio based almost entirely on renewable with ~95% of portfolio in 2040 (Figure 5.56).

Figure 5.56 Evolution of net installed capacity – Green scenario, 2017 - 2040



Note: 1) "Hydro" includes both large (mainly reservoir) and small (mainly run of the river) hydro power plants.
Note: Differences may arise due to rounding
Source: MARKAL model, Project team analysis

In the Green scenario, North Macedonia will phase-out ~1.2GW of the existing conventional capacity while add ~ 3.4 GW of RES and gas power plants (Figure 5.57 and Figure 5.58).

Figure 5.57 Planned generation capacity phase-outs – Green scenario

Plant	Tech-nology	Capacity (Net, MW)	Phase-out (Year)
Oslomej	Lignite	100	2019
Bitola	Lignite	636	2025
Negotino	Oil	198	2020
TE-TO (CHP)	Gas	230	2033
Total phased-out capacity (GW)		1.2	2019-2033

Figure 5.58 Planned key generation capacity investments – Green scenario

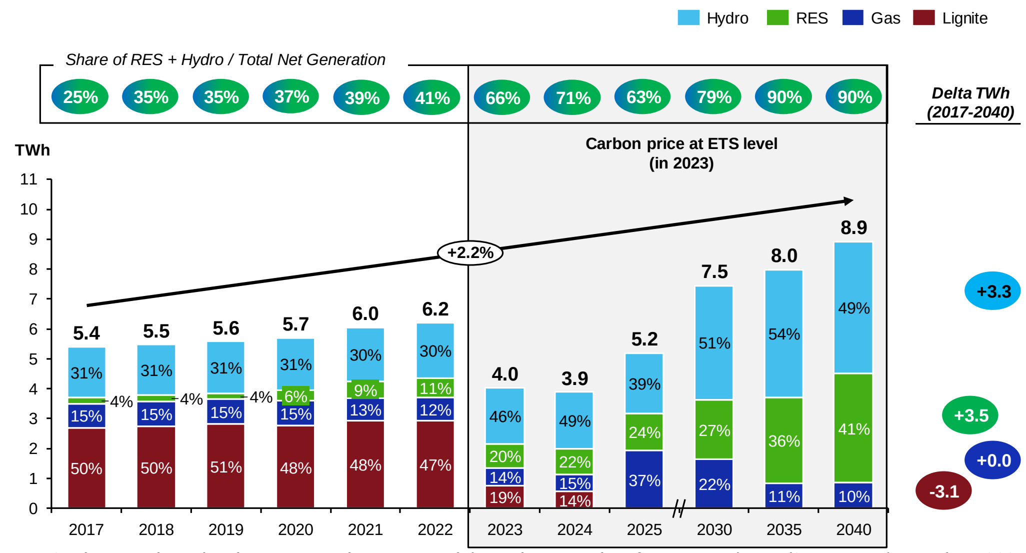
Plant	Tech-nology	Capacity (Net, MW)	% on tot.	Entrance (Year)
New Wind promoted	Wind	113	3.5%	2018-2023
New Wind non-prom.	Wind	600	18.5%	2029-2040
New PV promoted	Solar	597	18.4%	2025-2039
New PV non-prom.	Solar	760	23.4%	2018-2040
New Biogas	Biogas	23	0.7%	2020-2036
New Biomass	Biomass	15	0.5%	2020-2035
New Large Hydro *(Cebren, Gradec, Veles, KV Kozjak, Globocica)*	Hydro	775	23.9%	2029-2037
New Small Hydro	Hydro	223	6.9%	2019-2040
New Gas TPP	Gas	141	4.3%	2025
Total new capacity (GW)		3.2	100%	2018-2040

! N.B. Tables do not include Gas CHP plants revitalization (life extension of 70 MW from 2033)

Note: When a range is indicated for the "Entrance (year)", the capacity is gradually increased over a multiannual timeframe. Sum differences may arise due to rounding; category New Small Hydro includes also 15 small power plants on Vardar valley (137 MW, without feed-in tariff) and 34 MW that are in construction phase.
Source: ESM, MEPSO, MANU, MARKAL model, Project team analysis

Generation in the Green scenario will increase to 9 TWh (90% of which produced with RES resources), but with a huge drop in 2023 when coal becomes not competitive once the carbon price reaches the ETS level and it is phase-out in 2025 (Figure 5.59).

Figure 5.59 Evolution of total net generation mix – Green scenario, 2017-2040

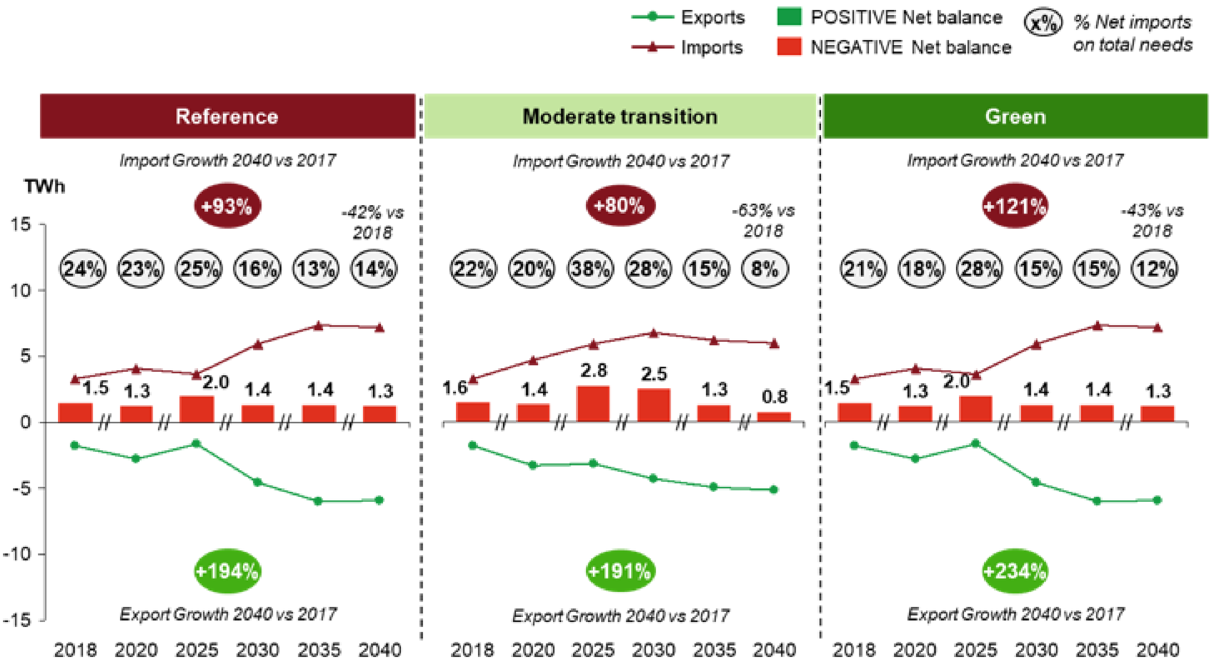


Note: Coal generation takes into account the raw material supply constraint of ~5 M tons / year (3.5 M tons / year since 2035)
Note: Differences may arise due to rounding
Source: MARKAL model, Power2Sim model, Project team analysis

5.3.4 Supply & demand balance

In all three scenarios, North Macedonia will observe a decreasing reliance upon imports and an increasing integration within the European market.

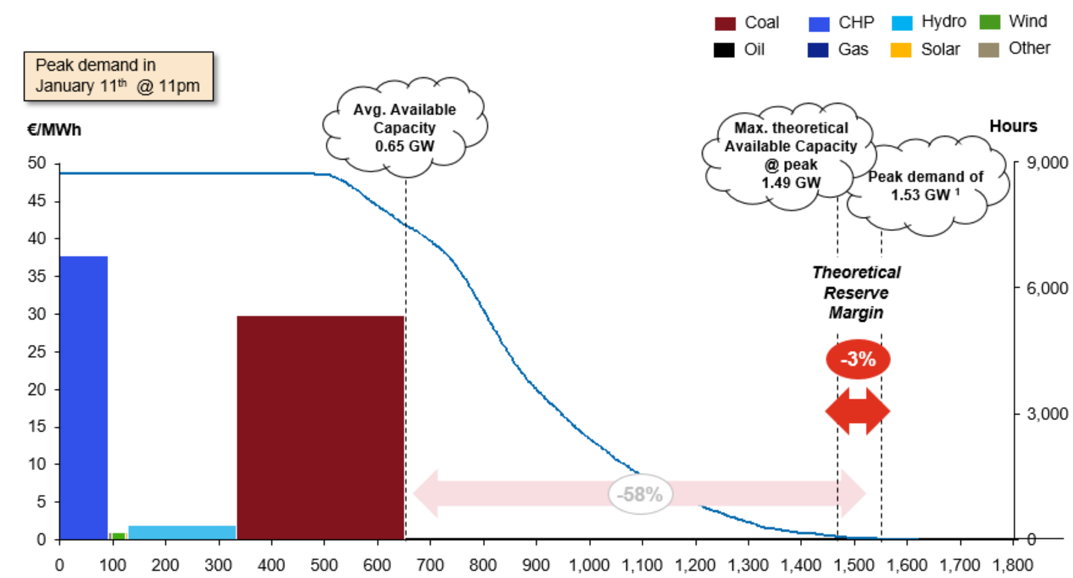
Figure 5.60 Evolution of North Macedonia import/export



Note: 1) Differences might arise due to rounding
Source, MEPSO, ENTSO-E, Power2Sim model, Project team analysis

In the Reference scenario, with the Negotino plant being phase-out (even converted to gas), the country will start to witness a negative theoretical reserve margin already by 2020, which will further worsen in all three scenarios towards 2040 given the high reliance upon RES resources and the peak demand observed during the night period where RES are not available at their full capacity (Figure 5.61).

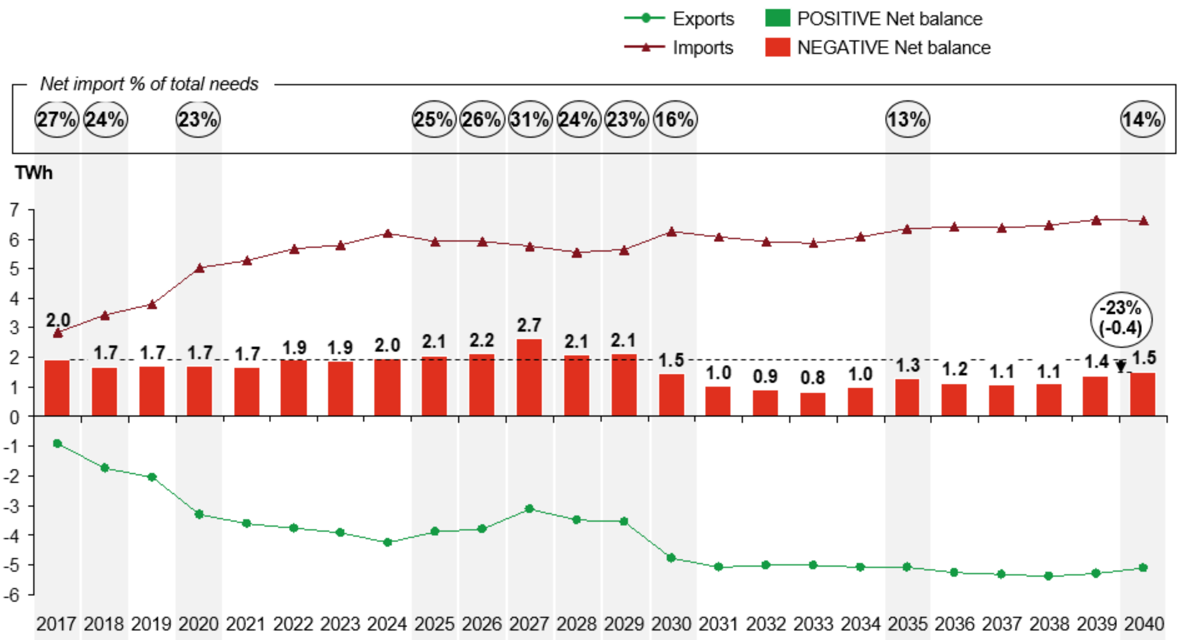
Figure 5.61 North Macedonia merit order curve in 2020 – Reference scenario



Note: the chart shows short run marginal cost of the available generation capacity, excluding O&M variable costs, with RES reported slightly above 0 for graphic purposes only
1) Gas, coal and hydro reservoir are assumed to be available at peak at their full capacity
Source: ENTSO-E, MARKAL model, Power2Sim model, Project team analysis

In the Reference scenario, North Macedonia will decrease its reliance upon import to 14% by 2040 vs. 27% today (Figure 5.62).

Figure 5.62 Evolution of North Macedonia import/exports – Reference scenario



Note: Differences might arise due to rounding
Source: MEPSO, ENTSO-E, MARKAL model, Power2Sim model, Project team analysis

Based on a perfect integrated organized market, having in mind security of supply, in the Reference scenario Serbia and Bulgaria will remain the main import partners for North Macedonia until 2035, replaced by Greece towards 2040 (Figure 5.63 and Figure 5.64).

Figure 5.63 Neighbouring countries installed capacities – Reference scenario, GW

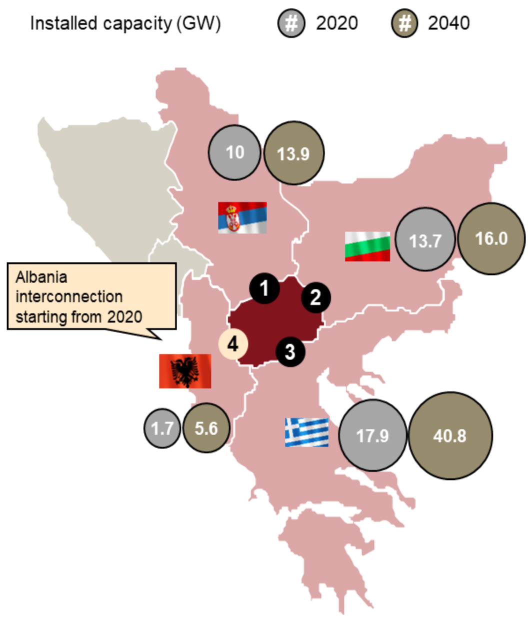
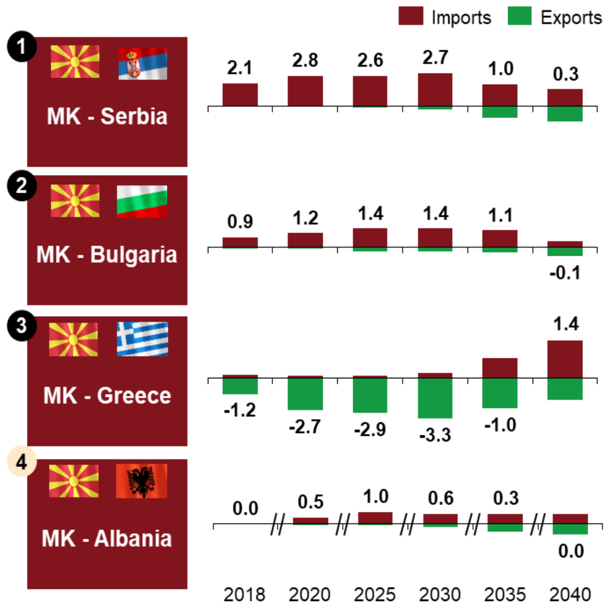


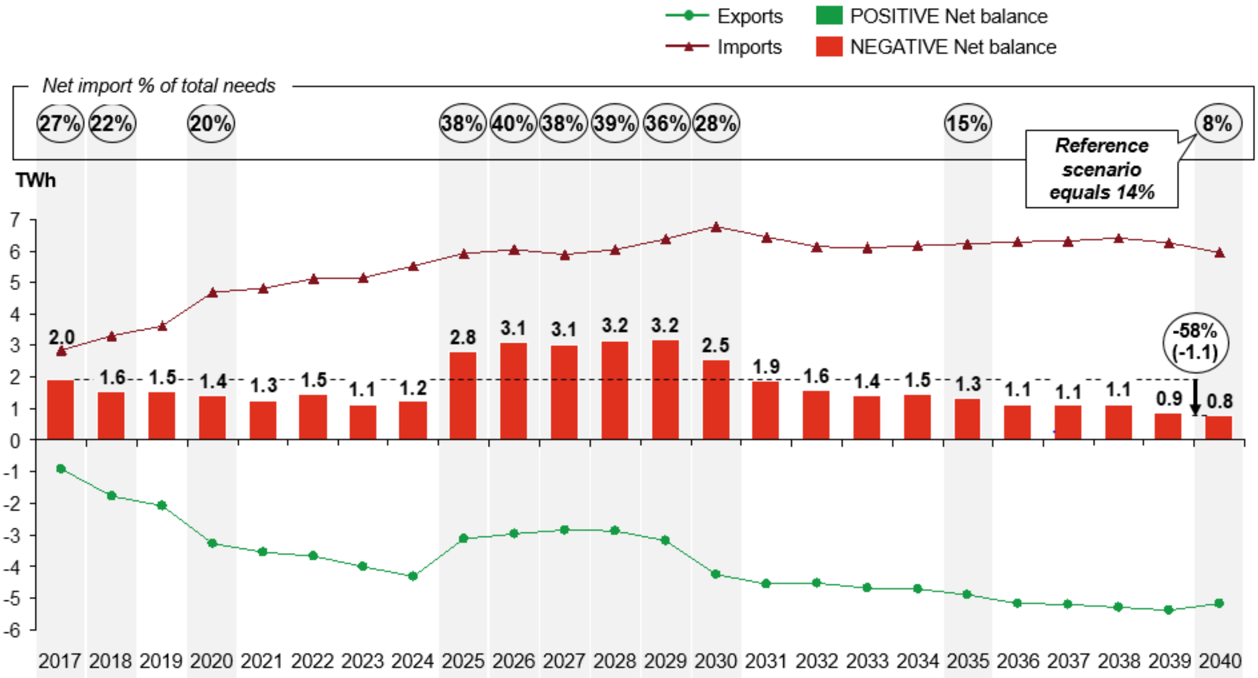
Figure 5.64 Evolution of MK import/export balance – Reference scenario, TWh



Notes: Serbia installed capacity evolution was slightly revised to align ENTSO-E projections with national strategic plans. Increasing importance of Greece as supply partner for North Macedonia is driven by the high RES investments made by the country in the period 2035-2040 (which makes of Greece an important source of cheap electricity)
Source: MEPSO, ENTSO-E, MARKAL model, Powe2Sim model, Project team analysis

In the Moderate scenario, following the substantial import increase when carbon price reaches the ETS level in the period 2025 – 2029, North Macedonia will substantially improve its electricity balance reaching a negative balance of 8% vs. 27% in 2017 (Figure 5.65).

Figure 5.65 Evolution of North Macedonia imports/export – Moderate transition scenario



Note: Differences might arise due to rounding
Source: MEPSO, ENTSO-E, MARKAL model, Power2Sim model, Project team analysis

As in the Reference Scenario, Serbia and Bulgaria will be the main import partners until 2035, replaced by Greece towards 2040 (Figure 5.66 and Figure 5.67).

Figure 5.66 Neighbouring countries installed capacities – Moderate transition scenario, GW

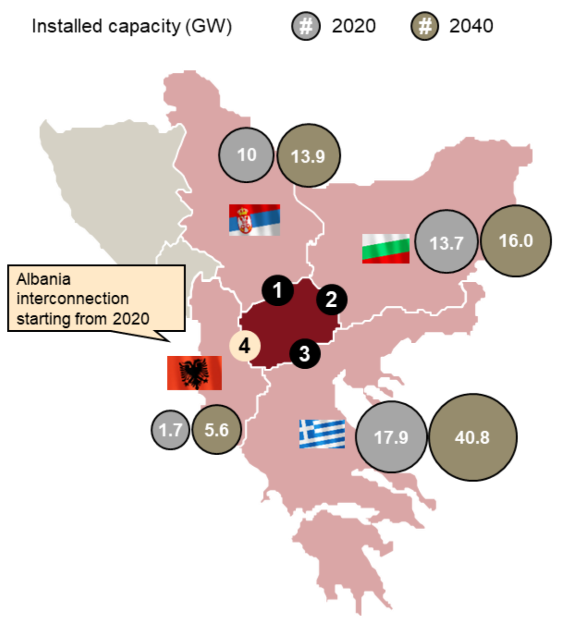
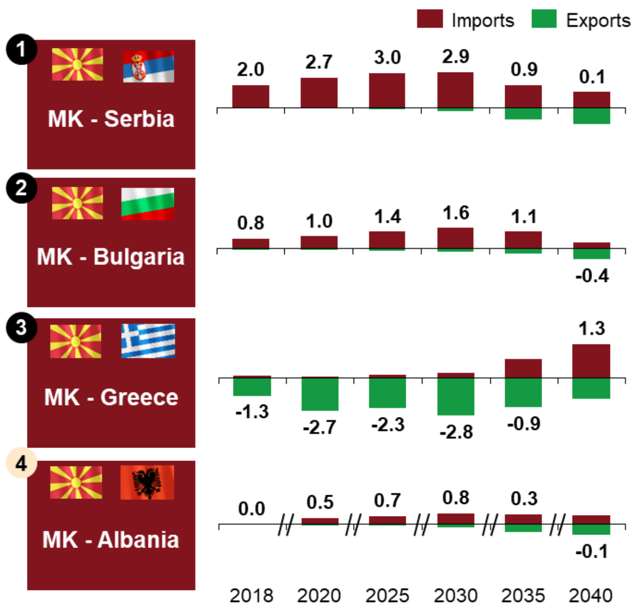


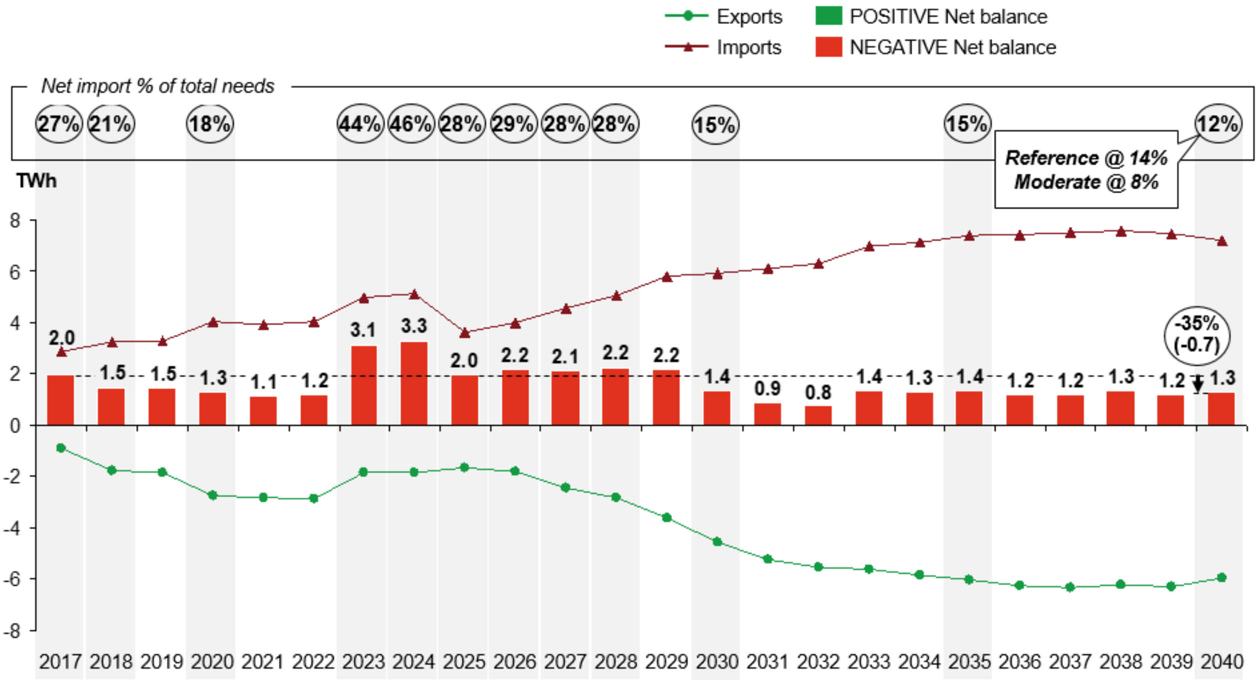
Figure 5.67 Evolution of MK import/export balance – Moderate transition scenario, TWh



Note: Serbia installed capacity evolution was slightly revised to align ENTSO-E projections with national strategic plans
Source: MEPSO, ENTSO-E, RS Energy Sector Development Strategy (2016), Serbia and Kosovo Energy Strategy / Implementation (2016-2017), MARKAL model, Power2Sim model, Project team analysis

In the Green scenario, North Macedonia is expected to substantially rely upon imports starting from 2023 when it has been assumed that the carbon price will reach the ETS level. During this period, the country electricity balance will reach a peak of 46%. However, thanks to the high RES investments assumed, the country is expected to reduce its import balance to a negative 12% (vs. -27% today), improving at the same time its integration within the European system (Figure 5.68).

Figure 5.68 Evolution of North Macedonia import/export - Moderate transition scenario



Note: Differences might arise due to rounding
Source: MEPSO, ENTSO-E, MARKAL model, Power2Sim model, Project team analysis

In the Green scenario, led by the very high CO_2 prices in the region, Serbia and Bulgaria will shift from import to export partners from 2025, with Greece and Albania following the opposite path (Figure 5.69 and Figure 5.70).

Figure 5.69 Neighbouring countries installed capacities – Green scenario, GW

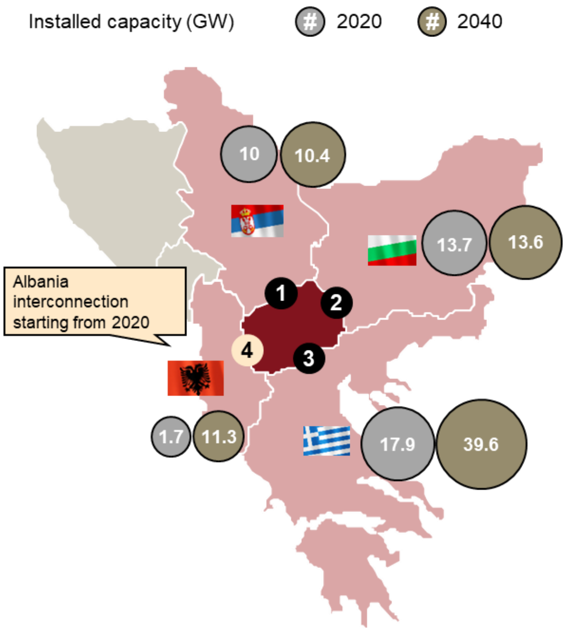
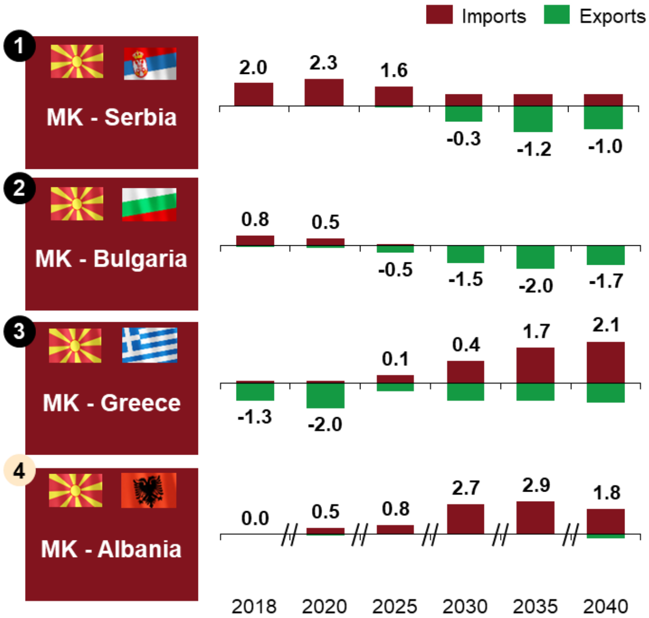


Figure 5.70 Evolution of MK import/export – Green scenario, TWh

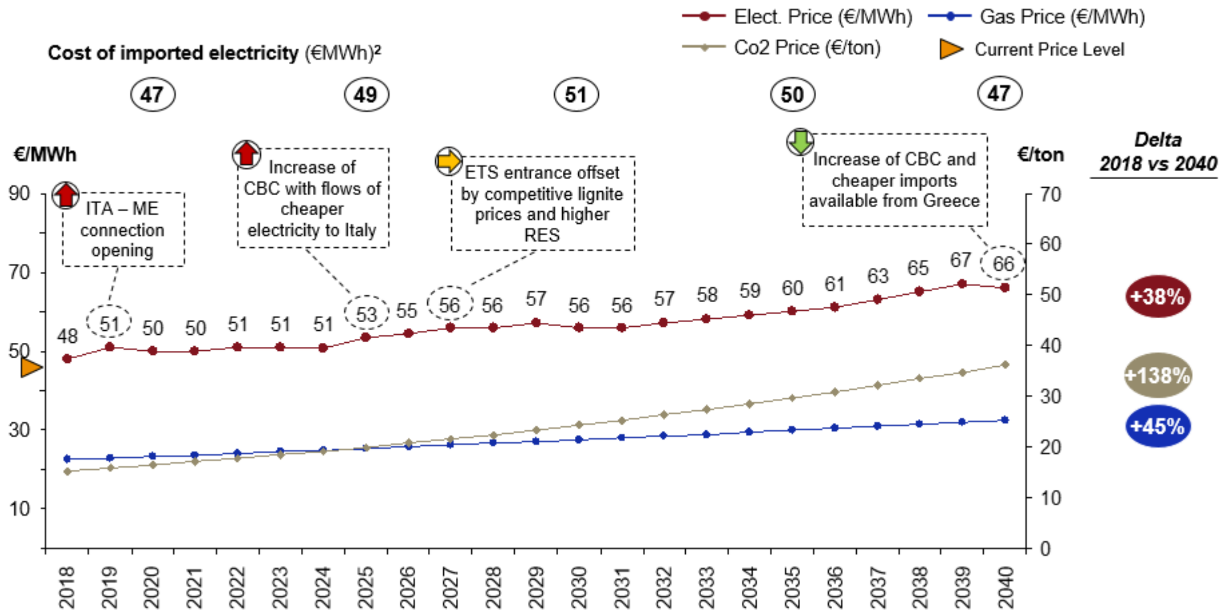


Source: Source: MEPSO, ENTSO-E, MARKAL model, Powe2Sim model, Project team analysis

5.3.5 Wholesale electricity prices

Wholesale prices in the reference scenario will moderately increase, reaching 66 €/MWh by 2040 vs. 48€/MWh today (Figure 5.71).

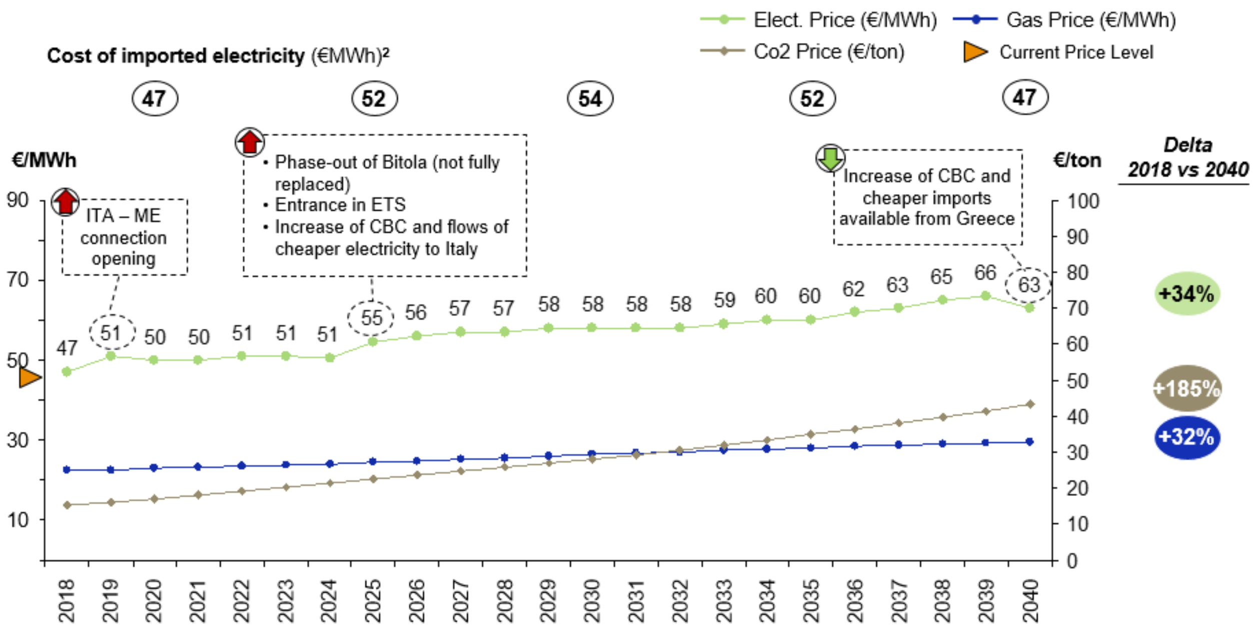
Figure 5.71 Projected wholesale electricity prices[1] – Reference scenario



Note: Price of commodities refer to WEO 2017 projections (Current Policies). For more realistic representation, in 2018, avg. actual YTD values were used in the interpolation. 1) Price forecast based on short run marginal cost, excluding O&M variables. 2) The cost of imported electricity corresponds to the average price paid for imports (differs from the average price of the neighbouring countries).
Source: ENTSO-E, WEO 2017, ERC, Power2Sim model, Project team analysis

In the Moderate transition scenario, despite very high commodity prices (+185% CO_2 and +32% gas), wholesale prices will only increase moderately, reaching 63 €/MWh by 2040 or +34% vs today (Figure 5.72).

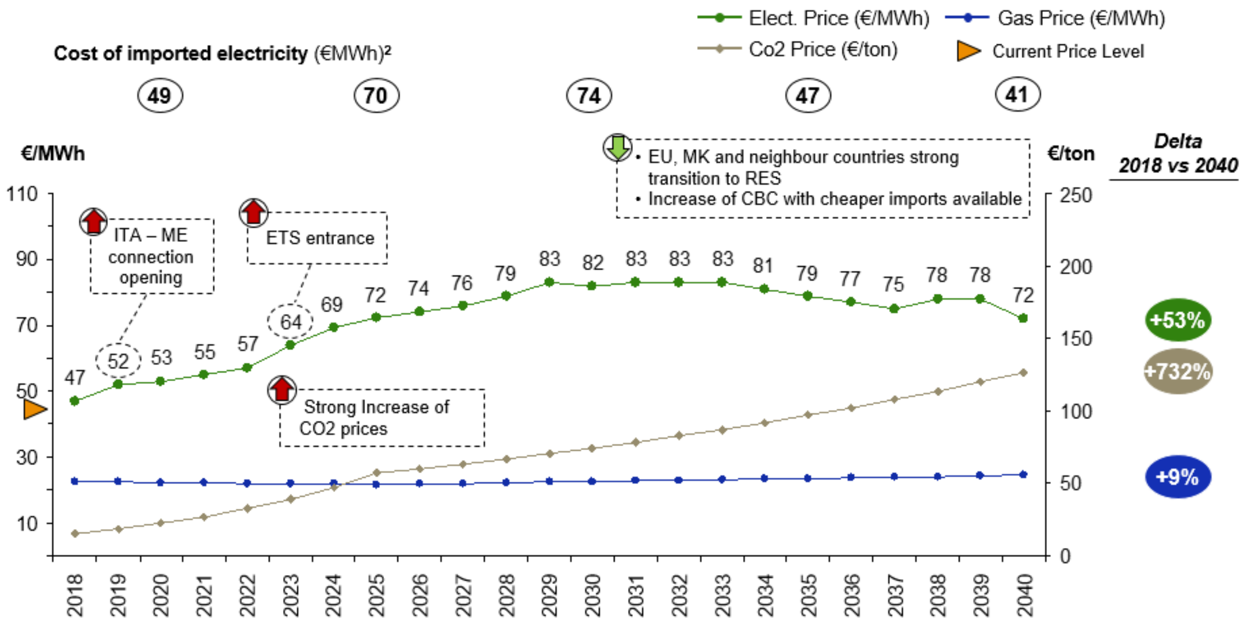
Figure 5.72 Projected wholesale electricity prices[1] – Moderate transition scenario



Note: Price of commodities refer to WEO 2017 projections (New Policies). For more realistic representation, in 2018, avg. actual YTD values were used in the interpolation. 1) Price forecast based on short run marginal cost, excluding O&M variables. 2) The cost of imported electricity corresponds to the average price paid for imports (differs from the average price of the neighbouring countries)
Source: ENTSO-E, WEO 2017, ERC, Power2Sim model, Project team analysis

In the Green scenario, after hitting the peak of 83 €/MWh in 2032, wholesale electricity prices are expected to stabilize to 72 €/MWh by 2040 (Figure 5.73).

Figure 5.73 Projected wholesale electricity prices[1] – Green scenario



Note: Price of commodities refer to WEO 2017 projections (Sustainable Dev.). For more realistic representation, in 2018, avg. actual YTD values were used in the interpolation.
1) Price forecast based on short run marginal cost, excluding O&M variables.
2) The cost of imported electricity corresponds to the average price paid for imports (differs from the average price of the neighbouring countries)
Source: ENTSO-E, WEO 2017, ERC, Power2Sim model, Project team analysis

5.3.6 Emissions

In terms of emissions, all scenarios will show substantial drops in the CO_2 and local pollutants levels of the Macedonian electricity system (Figure 5.74 and Figure 5.75). The higher emissions in the Moderate scenario in 2040 compared to 2030 come from the increased electricity generation from gas power plants (see Figure 5.55).

Figure 5.74 Evolution of CO_2 emissions

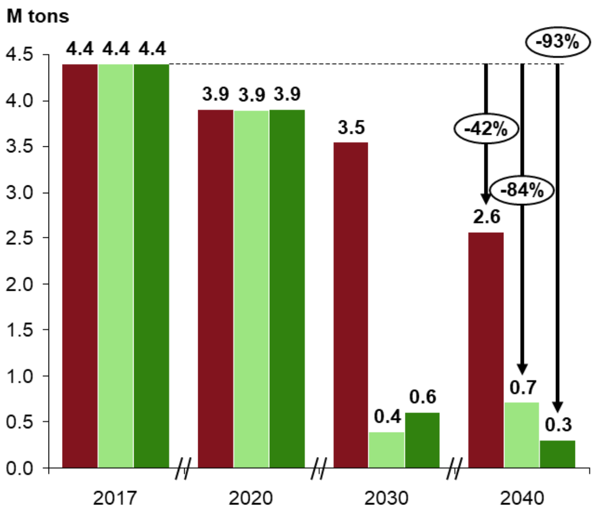
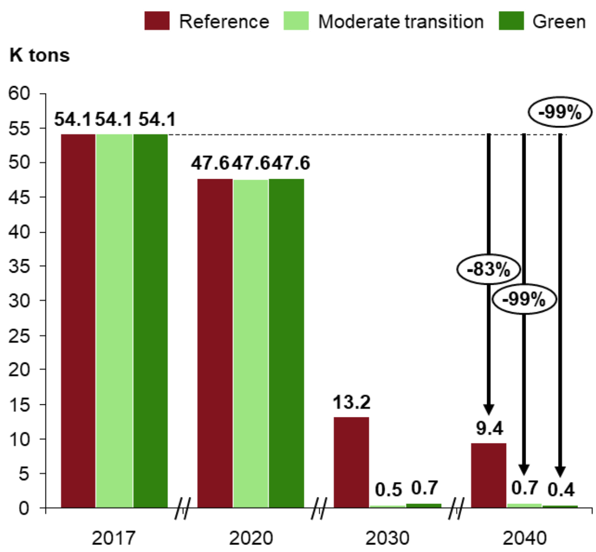


Figure 5.75 Evolution of local pollutants emissions



Source: MARKAL model, Power2Sim model, Project team analysis

APPENDIX II - CONTENT

APPENDIX III - ABBREVIATIONS

Abbreviation	Description
ACER	Agency for the Cooperation of Energy Regulators
AIB	Association of Issuing Bodies
BAU	Business as Usual
BEG	Balkan Energy Group
BEMIP	Baltic Energy Interconnection Plan
BMT	Behind the Meter
BSP	Balancing Service Provider
BUR	Biennial Update Report
CAGR	Compound Annual Growth Rate
CAO	Coordinated Auction Office
CAPEX	Capital Expenditures
CBC	Cross Border Capacities
CCS	Carbon Capture and Storage
CEE	Central Eastern Europe
CEO	Chief Executive Officer
CeProSARD	Center for Promotion of Sustainable Agricultural Practices and Rural Development
CESEC	Central and South East Gas Connectivity
CEZ	Czech Transmission System
CGES	Crnogorski Elektroprenosni Sistem
CHP	Combined heat and power
CNG	Compressed Natural Gas
CROPEX	Croatian Power Exchange
DH	District Heating
DSO	Distribution system operator
EBRD	European Bank for Reconstruction and Development
EE	Energy efficiency
EESC	European Energy Certificate System
EEX	European Energy Exchange
EIB	European Investment Bank
EMS	Eleketromreža Srbije
EnC	Energy Community
ENTSO - E	European Network of Transmission System Operators for Electricity
ENTSO – G	European Network of Transmission System Operators for Gas
EP BiH	Elektroprovreda Bosne I Hercegovine
EPEX	European Power Exchange
ERA	European Research Area
ERC	Energy Regulatory Commission
ESCO	Energy Service Company
ESM	Power Plants of North Macedonia
ETS	Emission Trading System
EU	European Union
EV	Electric Vehicles
FiP	Feed in Premium
FiT	Feed in Tariff
FOLU	Forestry and Other Land Use
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GMRS	Gas Measurement and Regulation Station
H&C	Heating and Cooling
HEP	Hrvatska Elektroprivreda
HFO	Heavy Fuel Oil
HGV	Heavy Goods Vehicle
HPP	Hydro Power Plant
HUPEX	Hungarian Power Exchange
IEA	International Energy Agency
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPEX	Italian Power Exchange
IPPU	Industrial Processes and Product
IRENA	International Renewable Energy Agency
KER	Kerosine
KPI	Key Performance Indicator
LCV	Light Commercial Vehicles
LDV	Light Duty Vehicles
LNG	Liquefied Natural Gas
LP	Local Polutants

LPG	Liquefied Petroleum Gas
MACEF	Macedonian Center for Energy Efficiency
MANU	Macedonian Academy of Sciences and Arts
MEPEX	Montenegrin Power Exchange
MEPSO	Makedonski Elektroprenosen Sistem Operator
MMR	Monitoring Mechanism Regulation
NEEAP	National Energy Efficiency Action Plan
NERP	National Emission Reduction Plan
NGO	Non-governemental Organisation
NREAP	National Renewable Energy Action Plans
NSI	North - South interconnection
NSOG	North Seas Offshore Grid
O&M	Operation and Maintenance
OMEL	Operador del Mercado Ibérico de Energìa
OSC	Oil supply connections
P2S	PowertoSim
PCI	Project of Common Interest
PE	Power Exchange
PECI	Project of Energy Community Interest
PM	Particulate matter emissions
PP	Power Plant
PPS	Purchasing Power Standard
PV	Photovoltaic
R&D	Research and Development
R&I	Research and Innovation
RES	Renewable Energy Source
RES-E	Renewable Energy Sources in Electricity
RES-H&C	Renewable Energy Sources in Heating and Cooling
RES-T	Renewable Energy Sources in Transport
SAIDI	System Average Interruption Duration
SAIFI	System Average Interruption Frequency Index
SBUR	Second Biennial Update Report on Climate Change
SEE	Southern Eastern Europe
SEEPEX	Serbian South East European Power Exchange
SET Plan	Strategy Energy Technology Plan
SGC	Southern Gas Corridor
SME	Small and Medium Enterprises
SMM control block	Serbia, North Macedonia, Montenegro control block
SPF	Seasonal Performance Factor
TAP	Trans Adriatic Pipeline
TEN-E	Trans-European Networks for Energy
TPP	Thermal Power Plant
TS	Transmission System
TSO	Transmission System Operator
UCS	Underground Coal Series
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
WAM	Scenario with Additional Measures
WB	World Bank
WB6	Western Balkans 6 Initiative
WEM	Scenario with Existing Measures
WEO	World Energy Outlook
WOM	Scenario without Measures
WPP	Wind Power Plant
YTD	Year to date
ZEMAK	Macedonian Energy Association

APPENDIX IV - LIST OF FIGURES

APPENDIX V - LIST OF TABLES