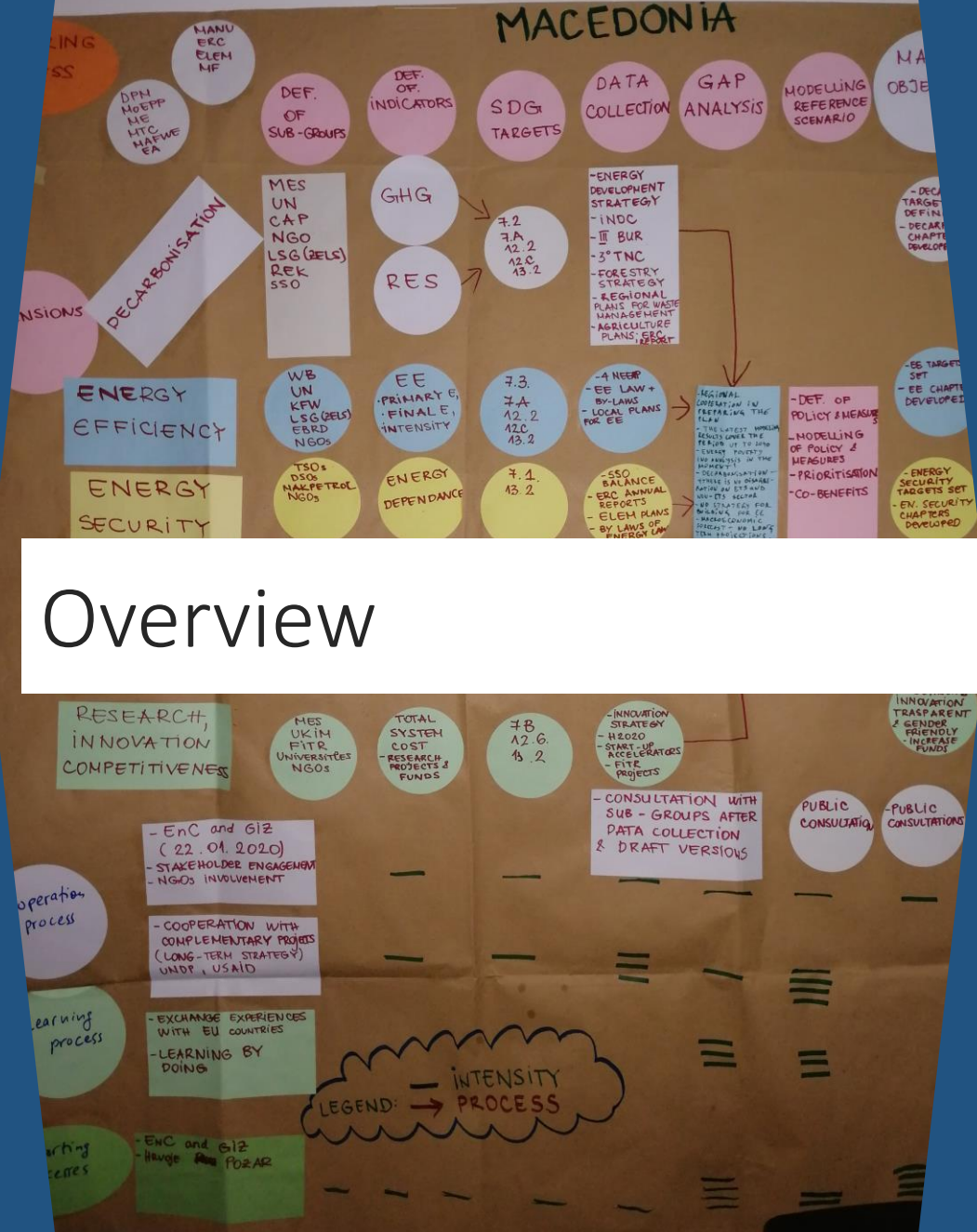


3rd Regional Exchange of Modelling Experts involved in the Development of Integrated National Energy and Climate Plans (NECPs) in South-Eastern European Countries

Sensitivity analyses

Presenter Name: Aleksandar Dedinec PhD. (Macedonian Academy of Sciences and Arts)

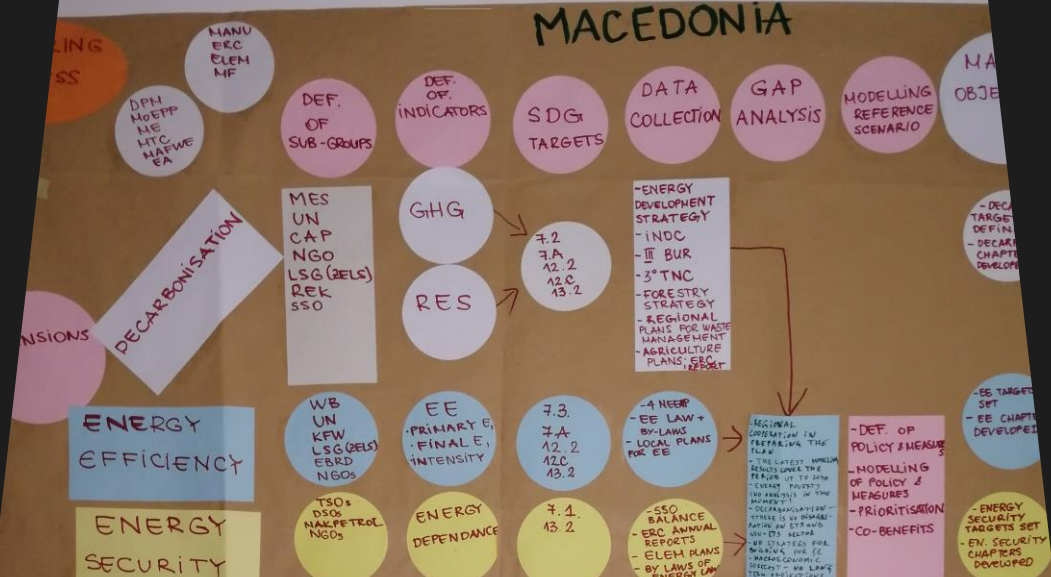
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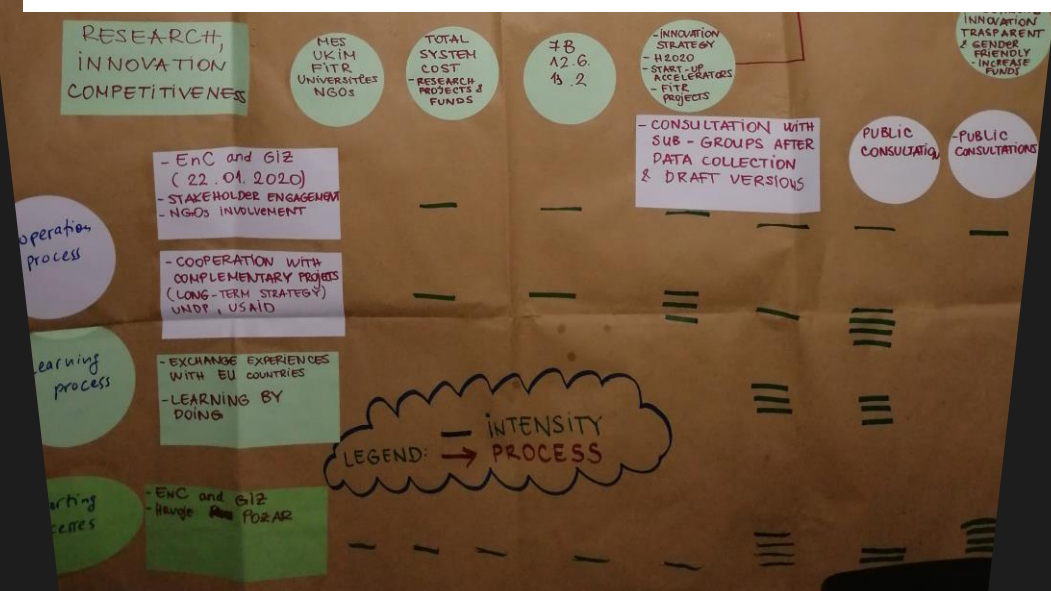
Overview

- Energy planning
- Sensitivity analysis

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Energy planning



1. Factors influencing the development of energy

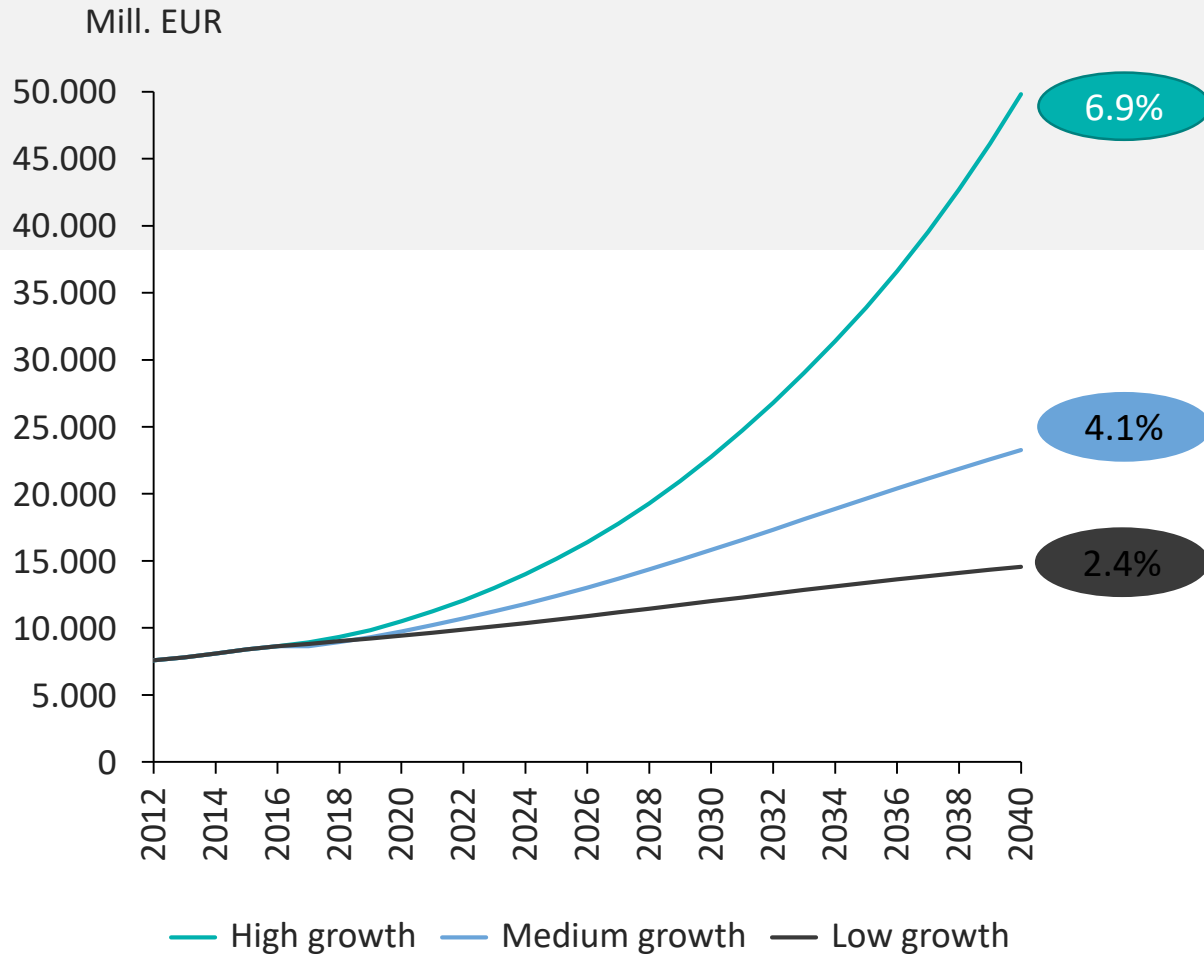
- economic development (GDP growth) – Covid 19 impact,
- population growth,
- available energy sources and movement of their prices,
- available technologies for the production, transmission and consumption of energy, their energy efficiency and their cost,
- implementation of certain policies (increase in energy independence, reducing emissions of CO₂, SO₂, PM and NO_x, stimulants for improving of energy efficiency, incentives for utilization of renewable energy, subsidizing the poor),
- the geopolitical events.

2. Factors influencing the accuracy of forecasting of the future development of energy

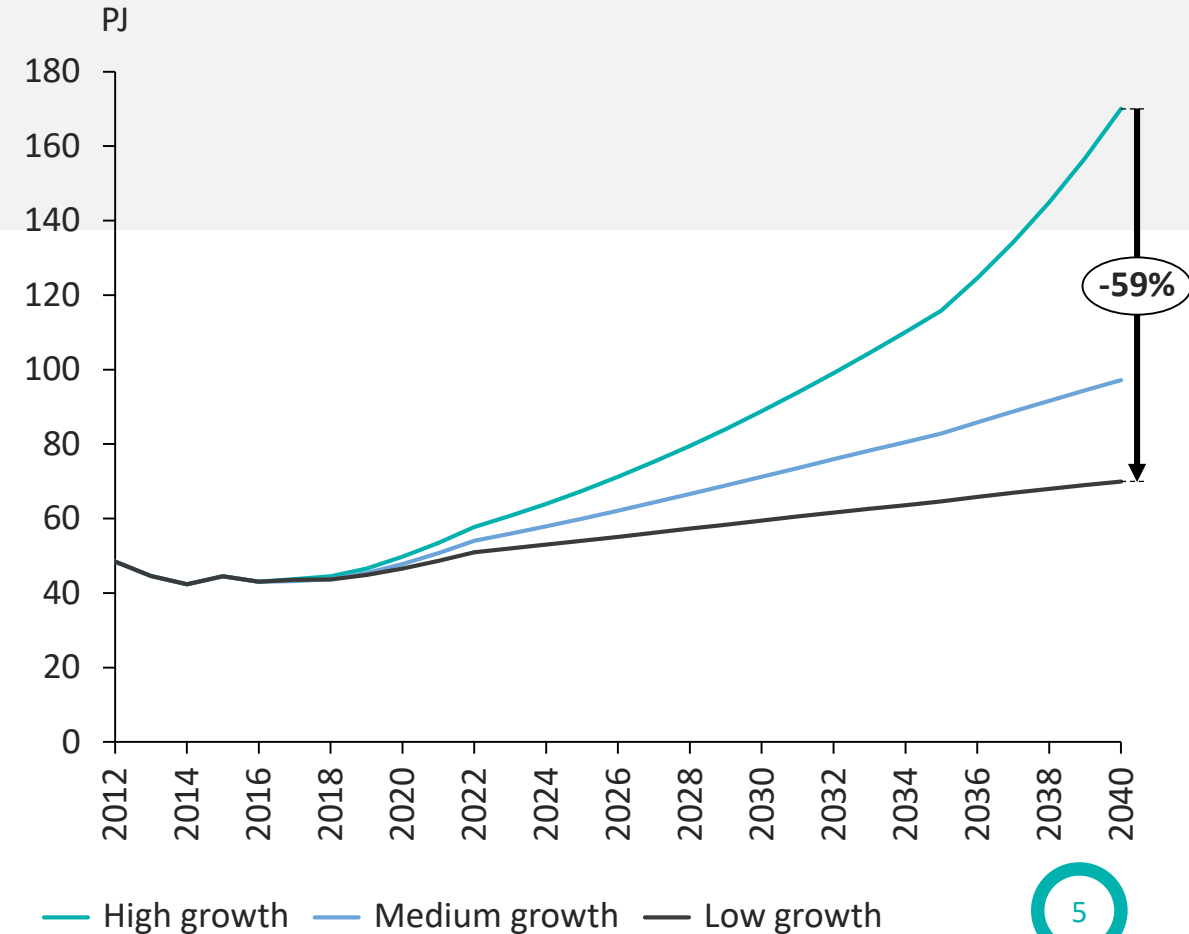
- the accuracy of the planning of all the factors listed in 1,
- software used for planning energy development and its ability to encompass the factors that influence the development of energy,
- the accuracy of input data,
- the set of assumptions and limitations.

Economic development (GDP growth)

GDP growth (Covid-19 influence)

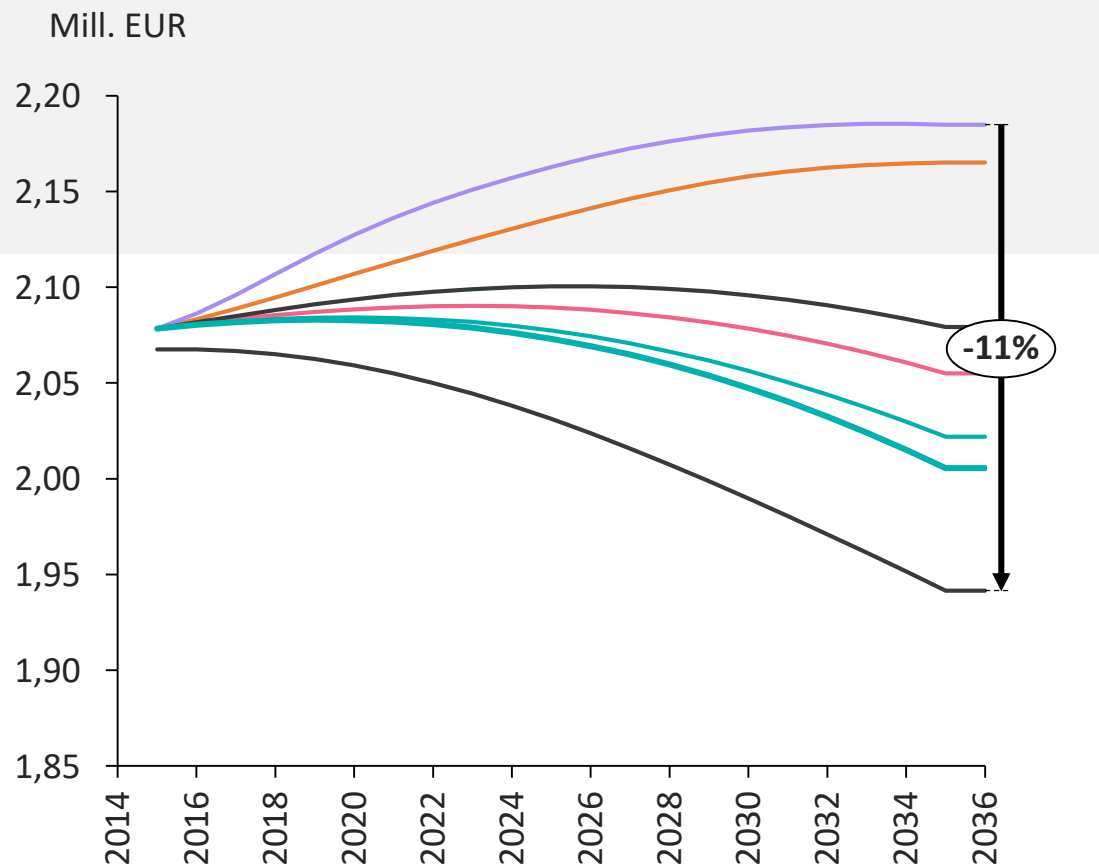


Useful energy demand



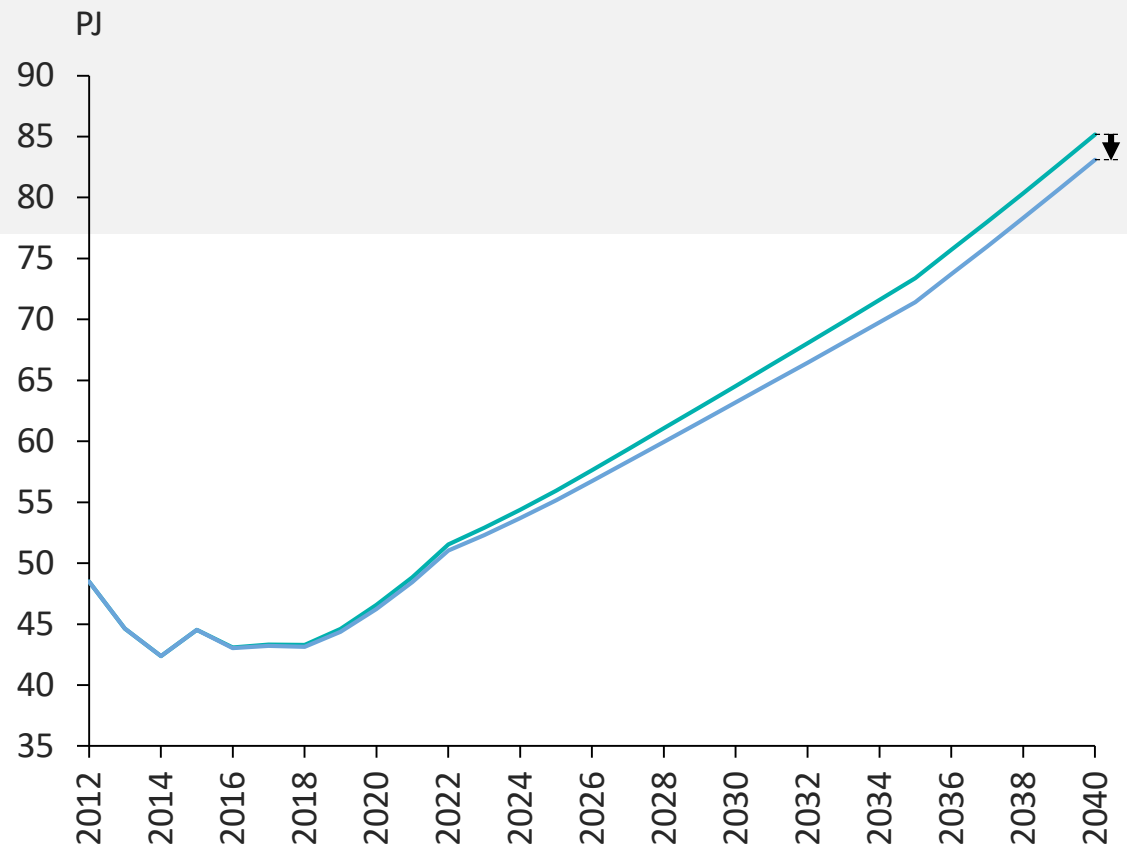
Economic development (GDP growth)

Population growth



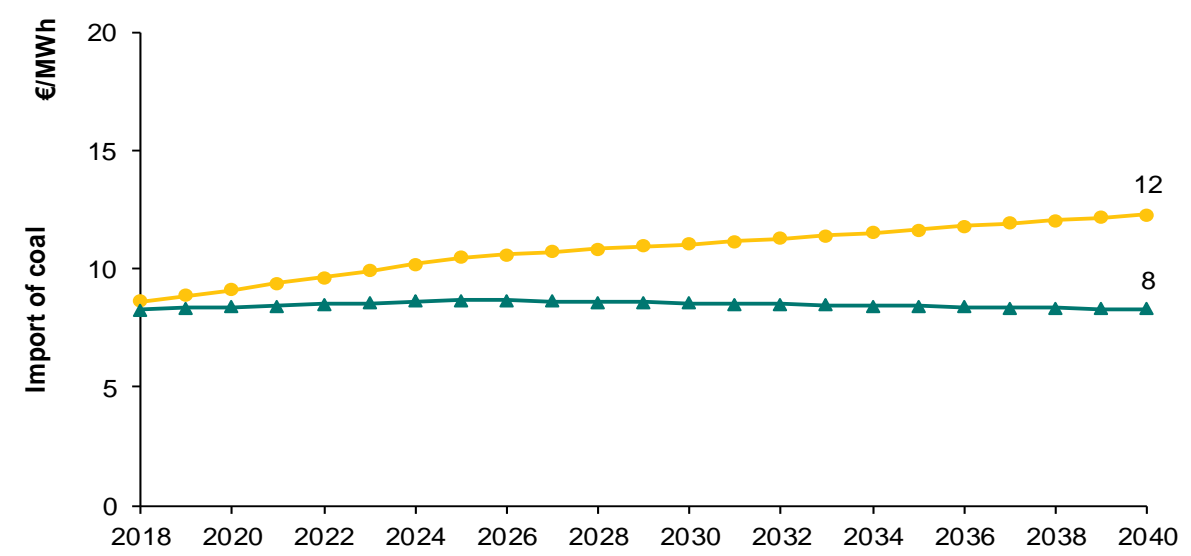
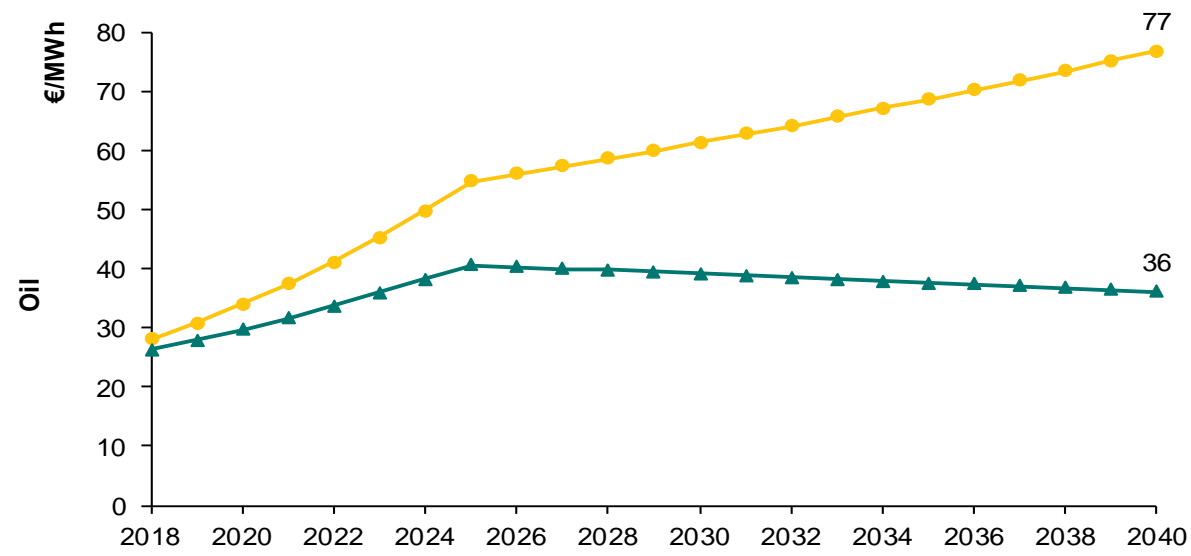
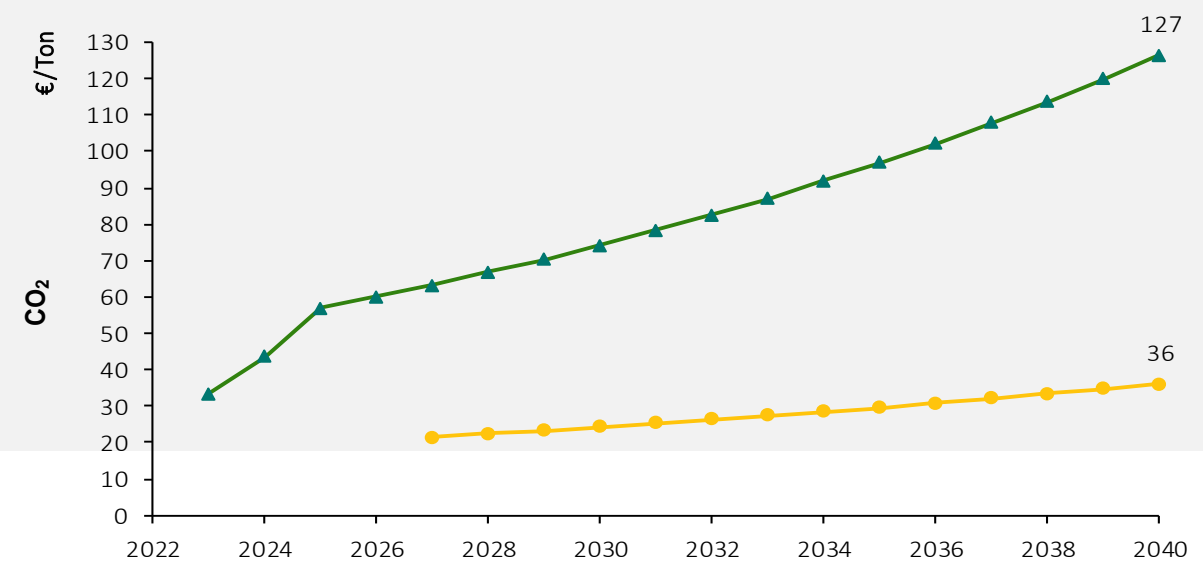
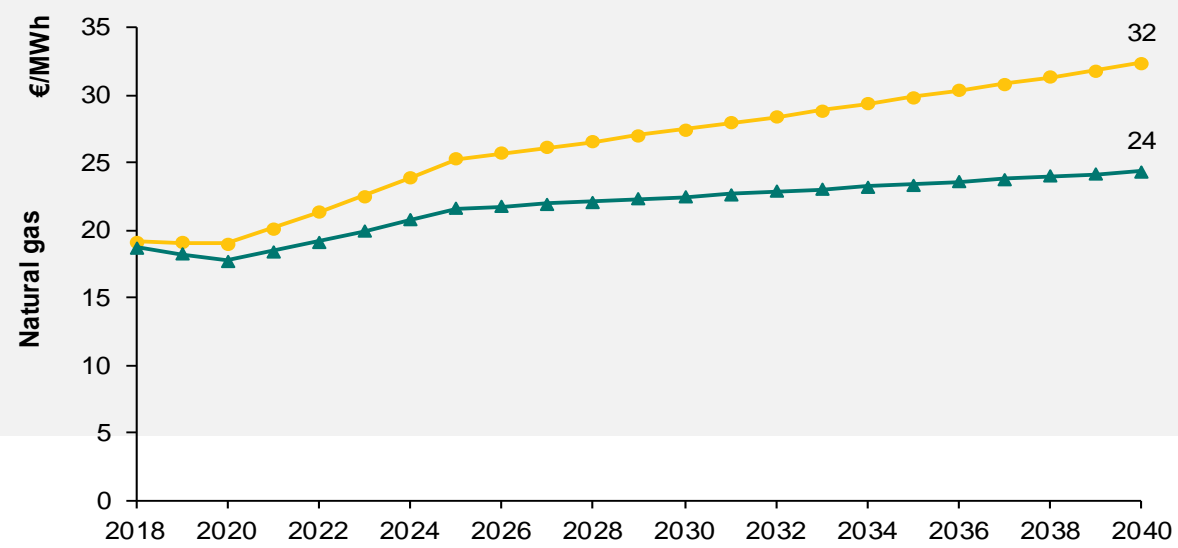
- Constant-fertility
- High variant
- Constant-mortality
- Low variant
- Instant-replacement
- Medium variant
- Zero-migration

Useful energy demand



- Constant
- Low

Fuel prices

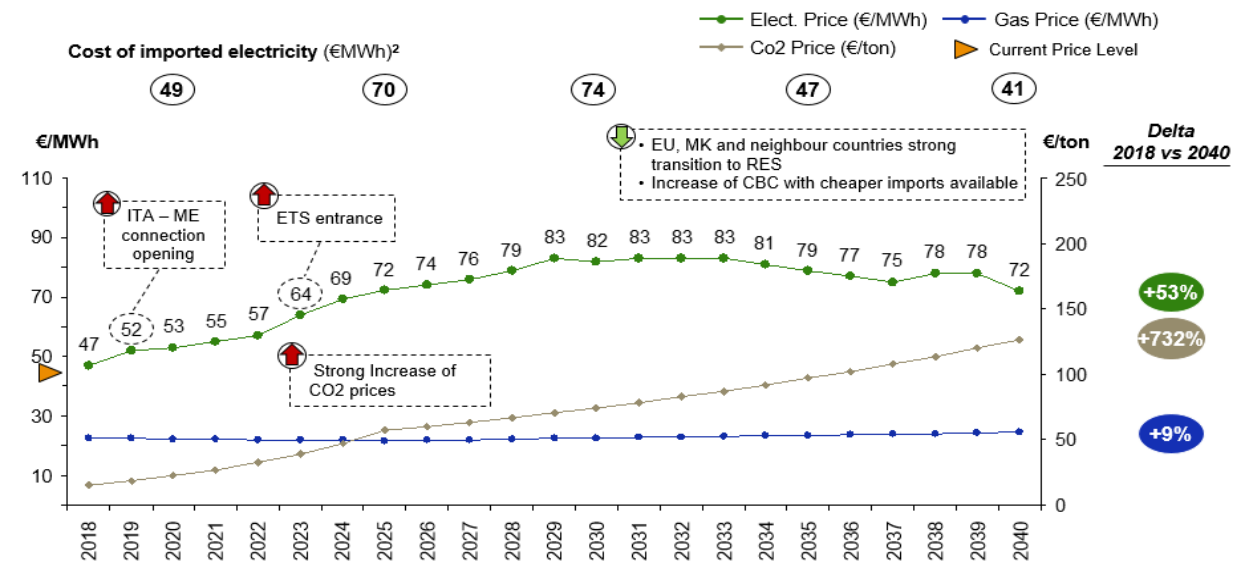
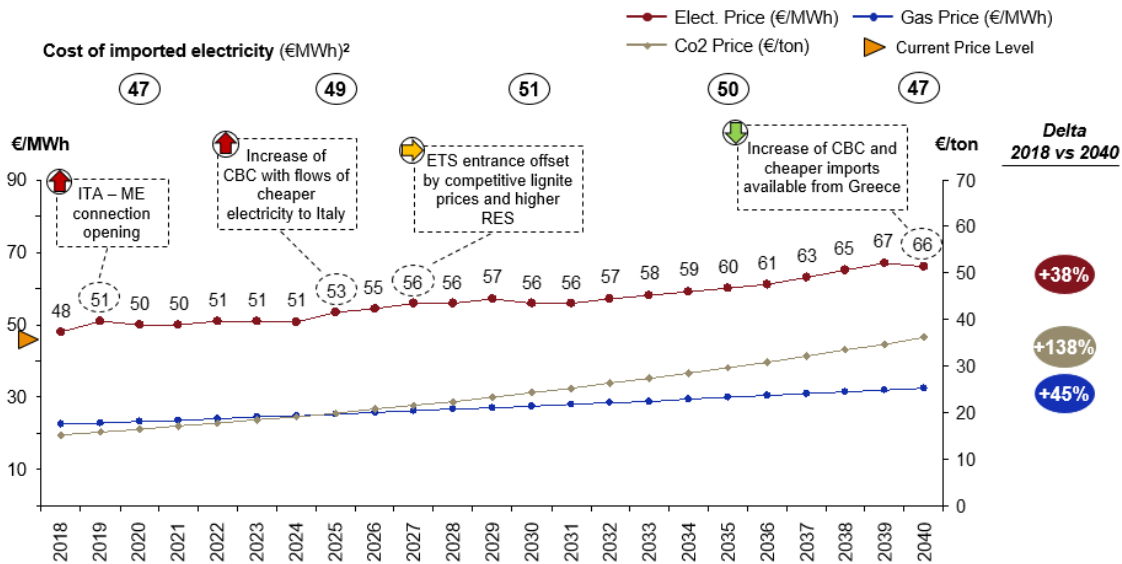


● Reference ▲ Green

Import price of electricity

Case 1: Low CO2 tax

Case 2: Intensive CO2 tax



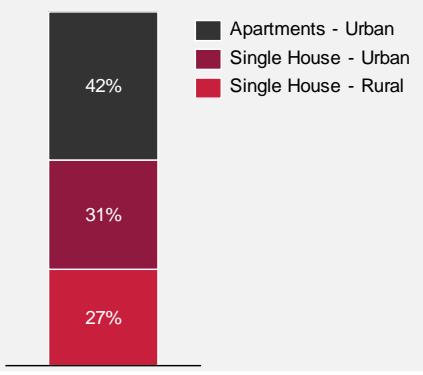
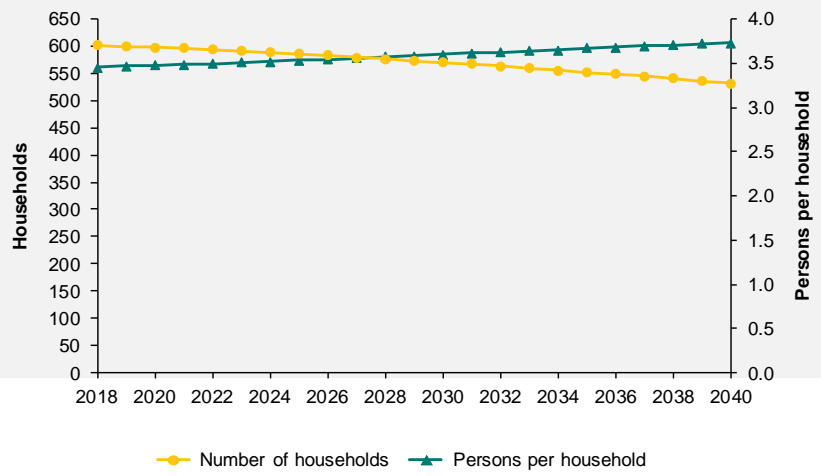
3. The uncertainties that make the differences in modeling on a global scale

- penetration of energy efficiency measures,
- penetration of renewable energy sources (RES),
- policies related to CO₂ price and subsidies for RES
- changes in prices of technologies for the utilization of RES
- changes in prices of energy sources,
- prices for the accumulation of energy (reversible hydropower plants, batteries, ...),
- prices for balancing the changing power sources (accumulators of energy, capacity of power plants for balancing and their prices, interconnection capacities, legislation for balancing larger regions, etc.),

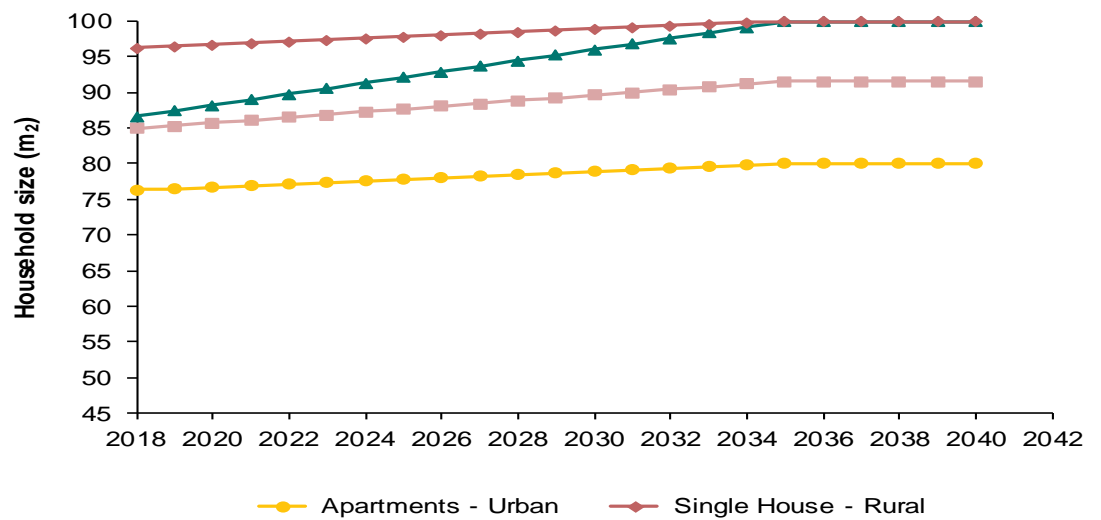
4. The uncertainties that make the differences in modeling of the energy development of Macedonia

- policies related to penetration of energy efficiency measures,
- policies related to CO₂ price and subsidies for RES,
- prices of technologies for the utilization of RES,
- prices of energy sources, especially of natural gas, and of electricity
- prices for the accumulation of energy (reversible hydropower plants, batteries, ...),
- prices for balancing the changing power sources (accumulators of energy, capacity of power plants for balancing and their prices, interconnection capacities, legislation for balancing larger regions, etc.),
- uncertainties about the construction of main gas pipelines and connection options,
- uncertainty about economically feasible coal reserves for Thermal PP,
- utilization of the Vardar valley (Vardar waterway ?, relocation of the railway ?),
- potential of wind energy,
- uncertainty about the geopolitical events,

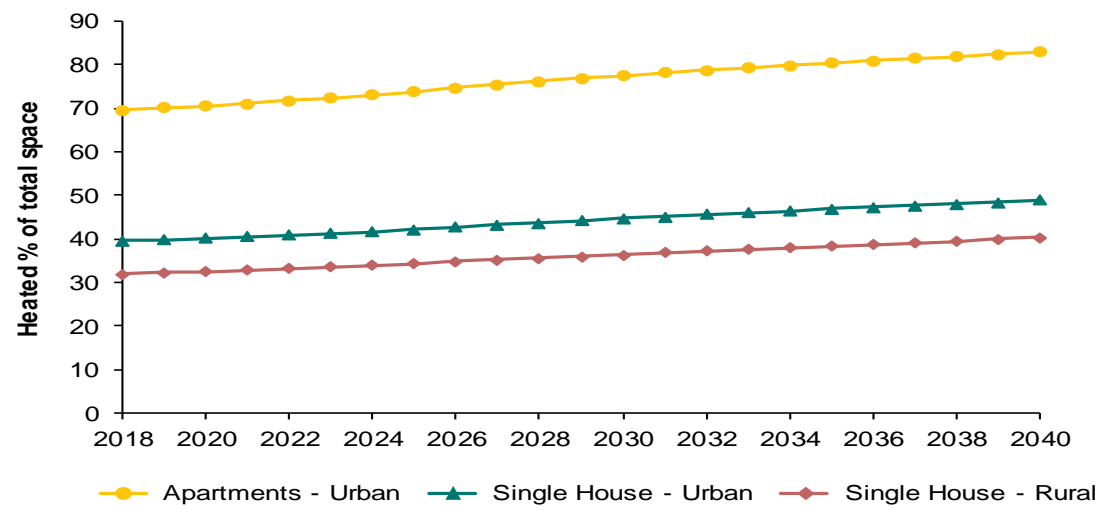
Households projections



Size of dwelling by type



Heated area by type of dwelling



Definition of scenarios

Reference scenario

No new technologies with greater energy efficiency than the technologies that exist in the base year 2012 on the demand side, with a possibility of changing the fuel type of a technology.

On the supply side:

- Domestic lignite TPP and imported high-calorific coal TPP,
- Natural gas TPP, up to the capacity of the existing natural gas pipelines,
- Renewable energy sources with feed-in tariffs (hydro, wind, photovoltaic and biogas) up to the capacity for which the Energy Regulatory Commission of the Republic Macedonia has
- no new large hydropower plants (due to lack of interest of investors and/or resistance of NGOs and the local population).

Scenario with improved energy efficiency on the demand side (EE)

New technologies with greater efficiency than those in the base year 2012 is made, fulfillment of certain standards in terms of the needs for heating and cooling for buildings.

The supply side is defined in the same way as in the reference scenario.

Scenario with electricity deficiency in the region (EE and EI def.)

Macedonia could play a significant role in the region - electricity demand is constantly increasing, not enough generation capacity in the region. Natural gas and hydro PP

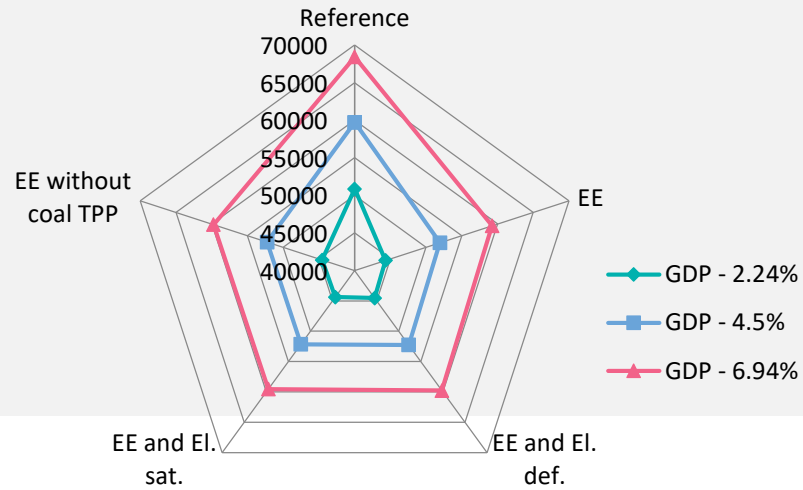
Scenario without new coal fired thermal power plants (EE without coal TPP)

No possibility of building a new coal thermal power plant.

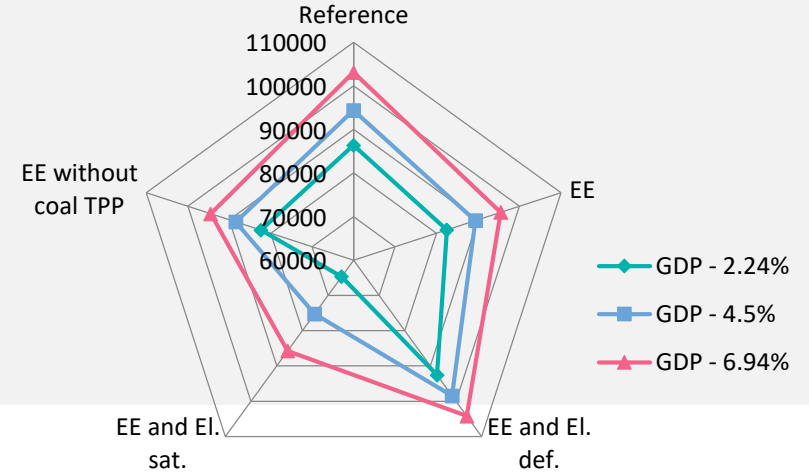
Scenario with electricity saturation in the region (EE and EI Sat)

Electricity demand increase and the closure of the already dilapidated facilities is accompanied by opening of a sufficient number of new facilities abroad, which would mean that there is no room for electricity export is analyzed.

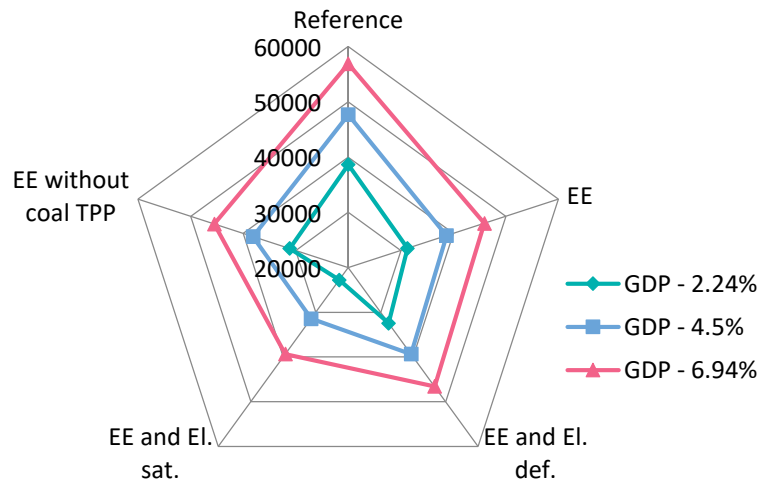
Cumulative final energy consumption [ktoe]



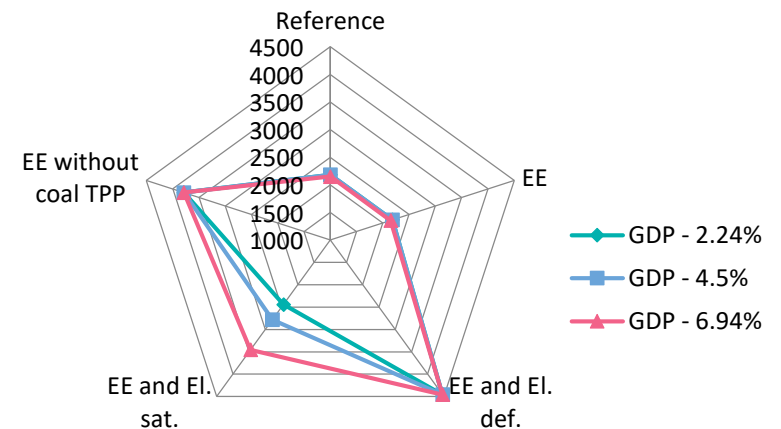
Cumulative primary energy [ktoe]



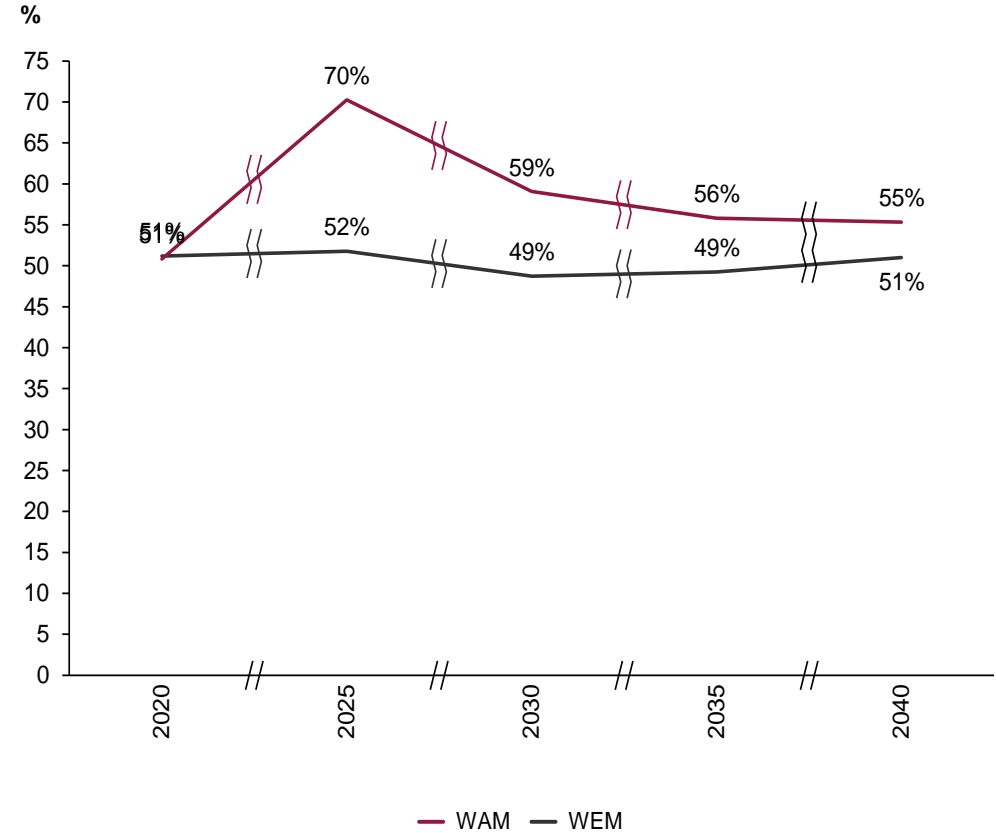
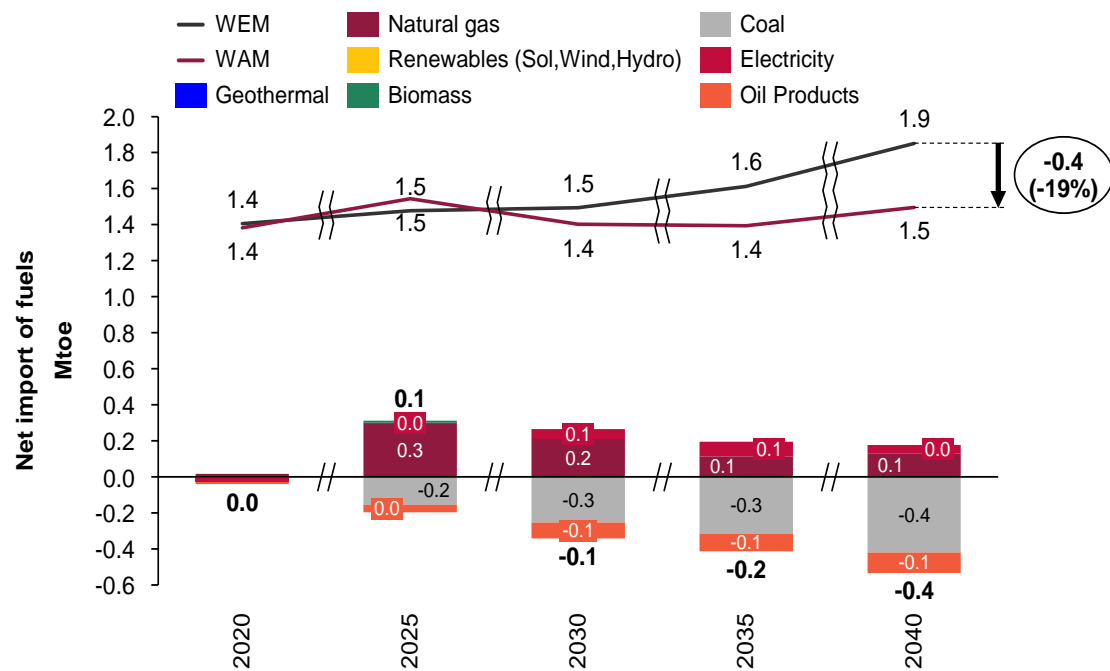
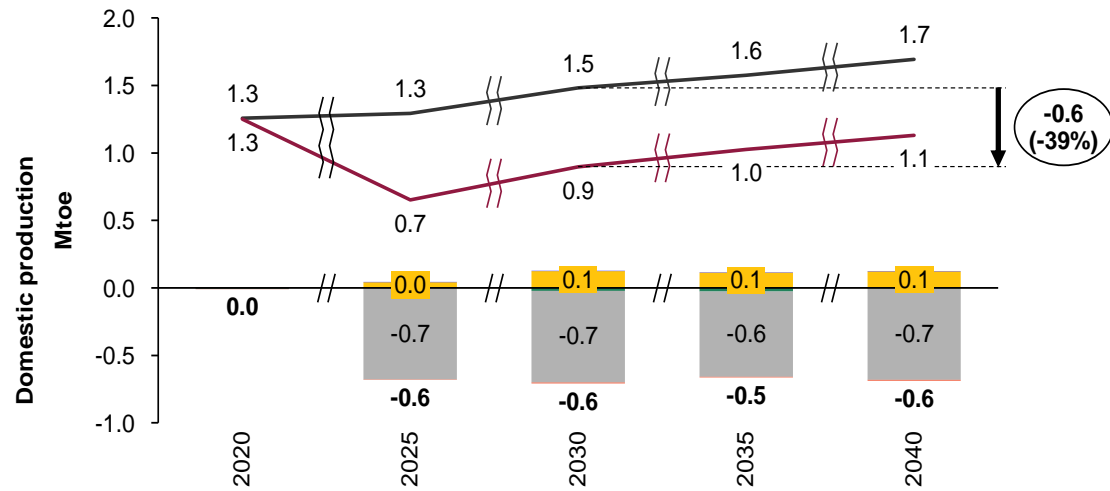
Cumulative net import of energy [ktoe]



Total new capacity for electricity production [MW]



Without Lignite TPP Bitola

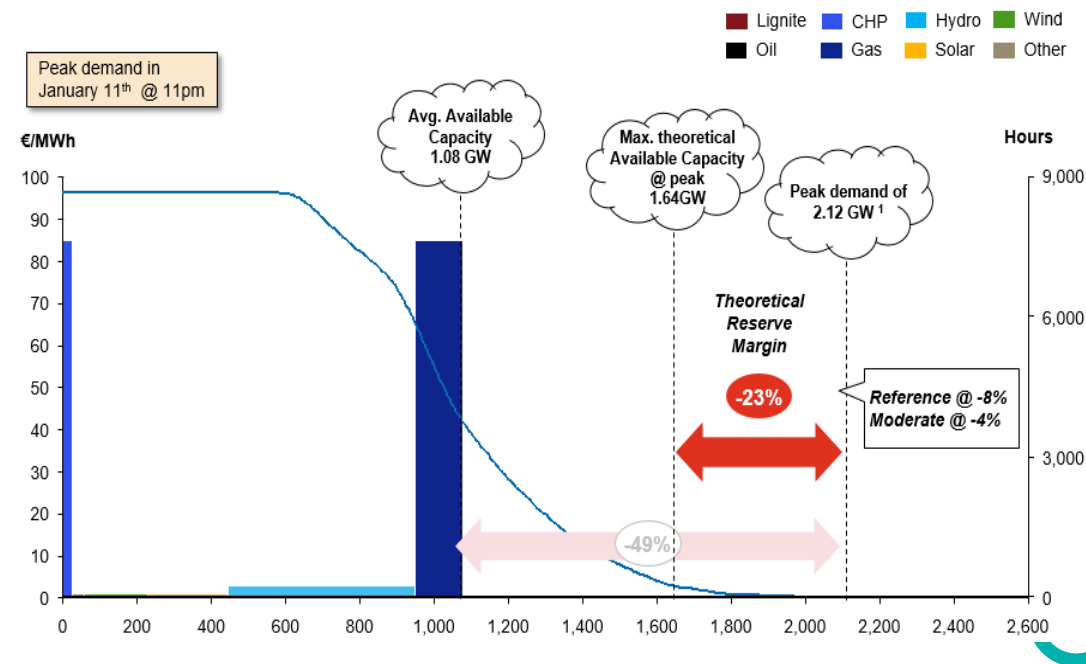
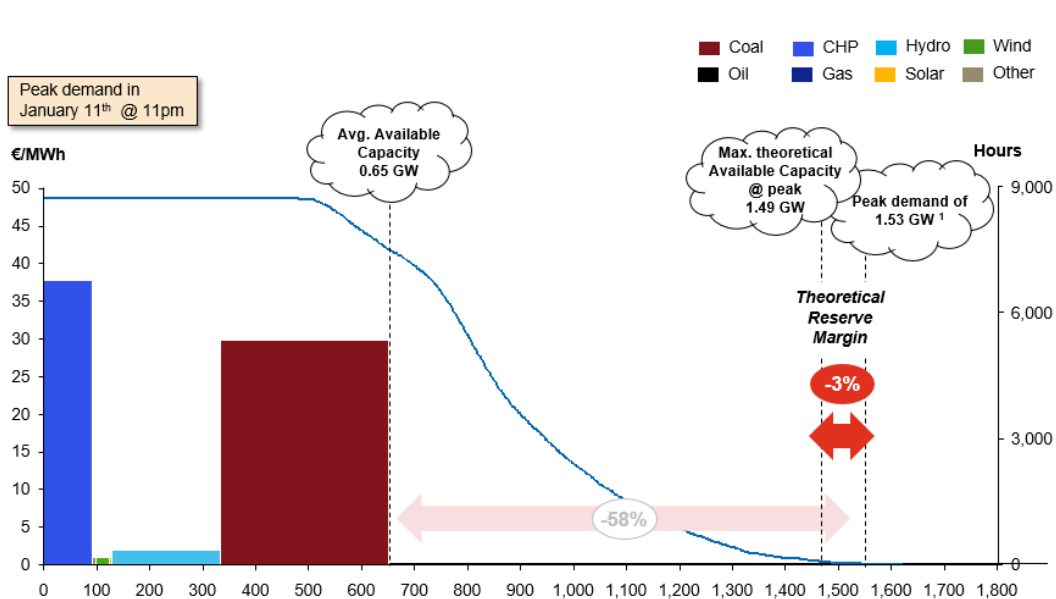


Without Hydro (inc. pump storage Chebren)

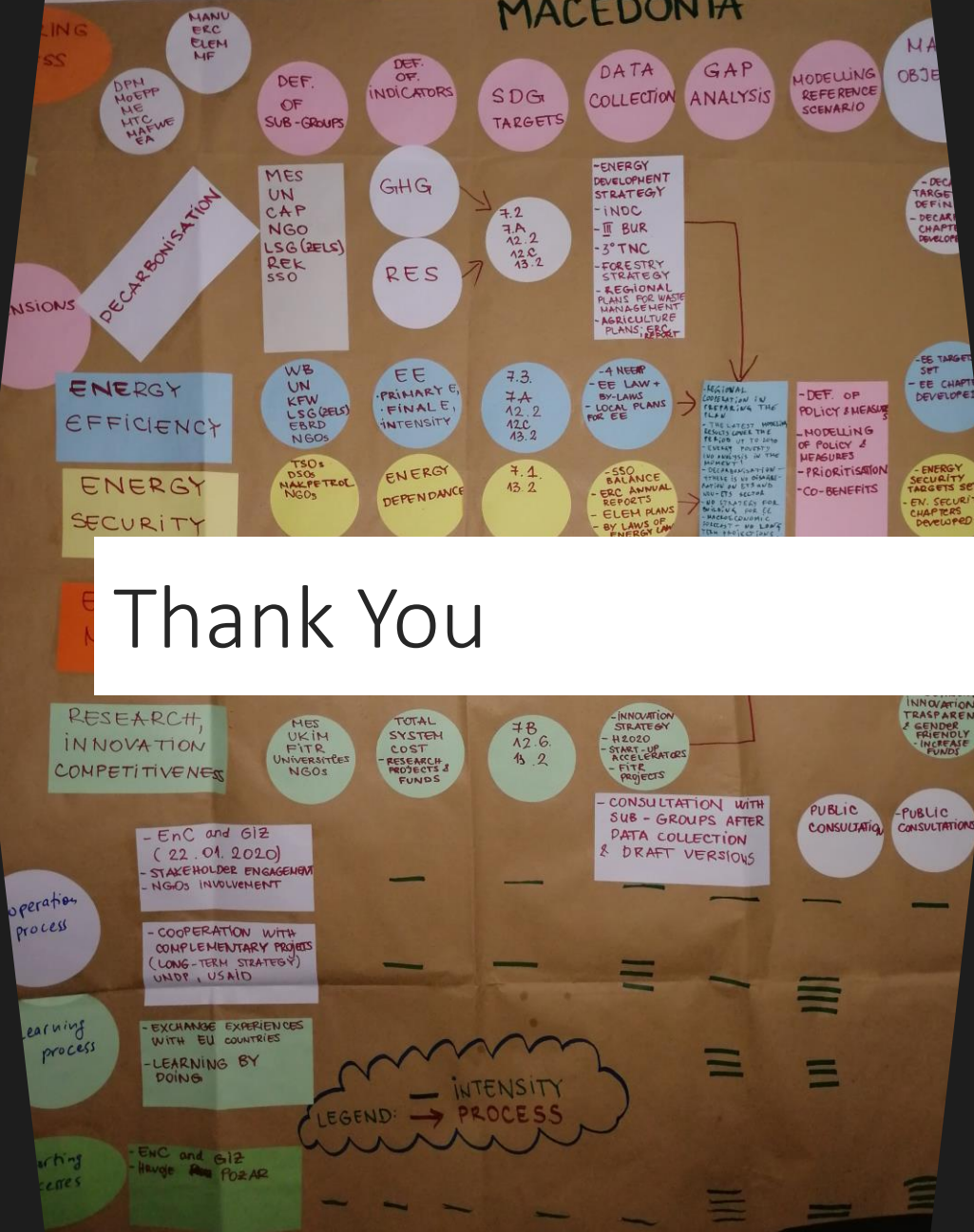
Chebren and the other planned large hydropower plants that significantly improve the flexibility of the system and enable greater inclusion of variable RES in the system. Additionally, in conditions of reduced production or decommission of TPP Bitola, hydro PP are crucial for increasing the security of supply, and also contributes to increasing the RES share

Case 1: coal TPP + less RES

Case 2: high RES and without coal TPP



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Thank You



Email dedinec@manu.edu.mk