

*15th Regional Exchange of
Modelling Experts involved in the
Development of Integrated
National Energy and Climate Plans
(NECP) in the WB6*



**Building up
modelling capacity
for integrated
NECP**

Coal phase-out in North Macedonia: The model behind the decision

Aleksandar Dedinec PhD scientific collaborator, Macedonian Academy of Sciences and Arts

Our team

Akad. Gligor Kanevce,
Team leader



Gligor is Head of the Research Centre for Energy and Sustainable Development at the Macedonian Academy of Sciences and Arts (ICEOR-MANU) since 2012. He is member of the Macedonian Academy of Sciences and Arts. He has been with the Laboratory for Thermal Engineering and Energy, Institute of Nuclear Sciences – Vinca, Belgrade from 1970 to 1983. Gligor is author or co-author of about 200 papers in the fields of energy, air pollution modelling, drying, and heat transfer. Since 2012, he is member of the National Council for Sustainable Development process. He has wide experience in climate change and energy development projects at national level both in domain of energy sector modelling, long term energy system strategy development, sub-sector policies and regulations, etc.

Prof. Dr. Natasa Markovska
Senior Expert



Natasa is Scientific Advisor and Professor at the Research Center for Energy and Sustainable Development of MANU. Since 2006 she has been lecturing the postgraduate course “Energy and the Environment” at South-eastern European University, Tetovo and Integrated Business Faculty, Skopje, and from 2013 the postgraduate course “Energy and Climate Change” at Faculty of Electrical Engineering and Information Technologies, UKIM, Skopje. Since 2017, she is accredited mentor of PhD studies Faculty of Electrical Engineering and Information Technologies, UKIM, Skopje. She has contributed to a multiple RES, sustainable energy and GHG, environment and climate change strategy and planning projects including 2040 national energy and climate development strategy. She contributed to First Biennial update report (GHG inventory, climate change, mitigation and adaptation) for several SEE countries

Natasa will be part of the team responsible for projection system/model development, model functionality description and implementation support (training and workshops).

Sci. Coll. Dr. Verica Taseska Gjorgievska
Senior Expert



Verica works as a Research Assistant at the ICEOR-MANU. She is one of the lead persons of the modelling and energy planning team (using tools like MARKAL/TIMES modelling framework, LEAP, GACMO, RETScreen, EnergyPLAN, etc.). As part of ICEOR-MANU team, she participated in many international and national research and strategic planning projects in the field of energy, renewable energy and environment (with emphasis on the impact of climate change). She is currently contributing as a modeller in the preparation of 3rd Biennial update report on climate change. She is author/co-author of 3 book chapters and 15 scientific papers in the field of energy planning and renewable energy sources published in several international journals.

Sci. Coll. Dr. Aleksandar Dedinec
Senior Expert



Aleksandar works as a Scientific Contributor at the ICEOR-MANU. He is an expert in the energy, energy efficiency, renewable energy and climate change sectors. He is one of the lead persons on the MARKAL/TIMES energy strategy modeling in Macedonia. He has been participating in the implementation of 74 projects related to energy strategies, laws and bylaws, energy efficiency, renewable energy sources, as well as climate change. He has been engaged by renowned world institutions (USAID, UNDP, PWC, Energy Community, Hrvoje Pozar and others), as an independent consultant, in the realization of 31 projects in these areas.

He is the author or co-author of 43 papers in the field of sustainable energy development, 13 of which have been published in top world journals with an impact factor, 24 papers in proceedings and 6 in abstracts. In addition, he has participated in more than 100 workshops both in Macedonia and abroad.

Ass. Prof. Dr. Aleksandra Dedinec



Aleksandra works as an Assistant Professor (from 02/2018 - ongoing) at the Faculty of Computer Science and Engineering, Ss. Cyril and Methodius University in Skopje.

Her research is in the field of energy systems modelling, climate change, smart grids and machine learning. She is participating in several projects related to energy strategies, smart grids modelling, energy efficiency, renewable energy sources and climate change.

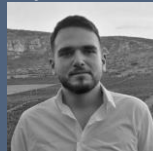
She is author/co-author of 5 scientific papers in the field of energy systems modelling, machine learning, renewable energy sources and climate change published in several international journals with impact factor, as well as of 17 scientific papers published in proceedings and international journals.

MSc Emilija Mihajloska
Junior Expert



Emilija Mihajloska as a researcher is participating in two Horizon 2020 projects, REPLACE- dealing with inefficient heating systems and BE-Rural - developing rural bio-economies. She is developing heat demand maps on local and country level. She is also part of the national GHG inventory team and has knowledge of GHG emissions and sinks.

Dejan Dimitriev



Dejan Dimitriev is a student at the Faculty for electrical engineering and information technology and it is involved in the realization of two projects within the Macedonia Academy of sciences and arts. He is co-author of three conference paper.



Content

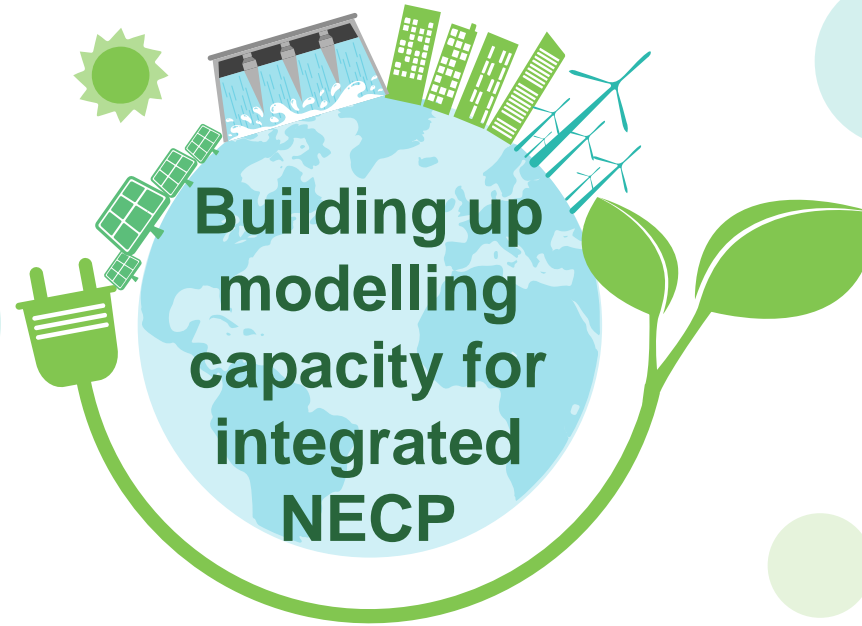
01 Introduction

02 Input data

03 Methodology

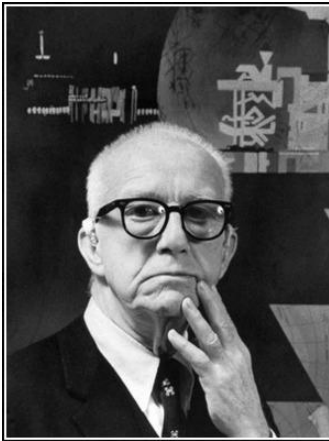
04 Results

05 Recommendations



Introduction

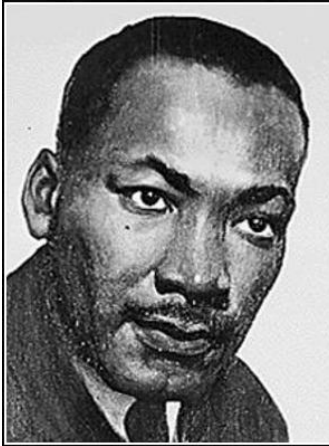
Coal phase-out in North Macedonia:
The model behind the decision



There is no energy crisis, only a crisis of ignorance.

— R. Buckminster Fuller —

AZ QUOTES



Every crisis has both its dangers and its opportunities. Each can spell either salvation or doom.

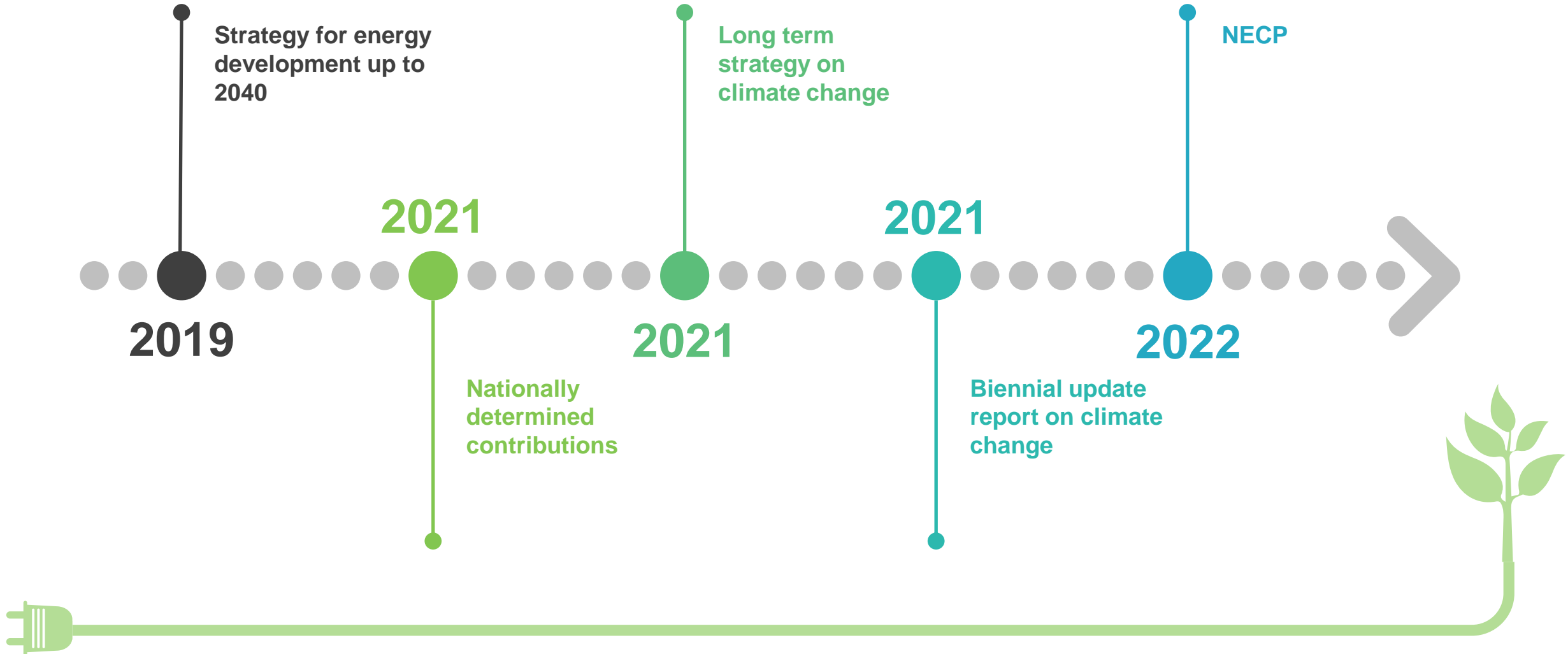
— Martin Luther King —

AZ QUOTES

Quotes



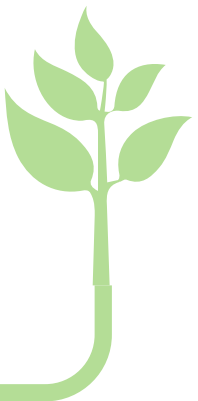
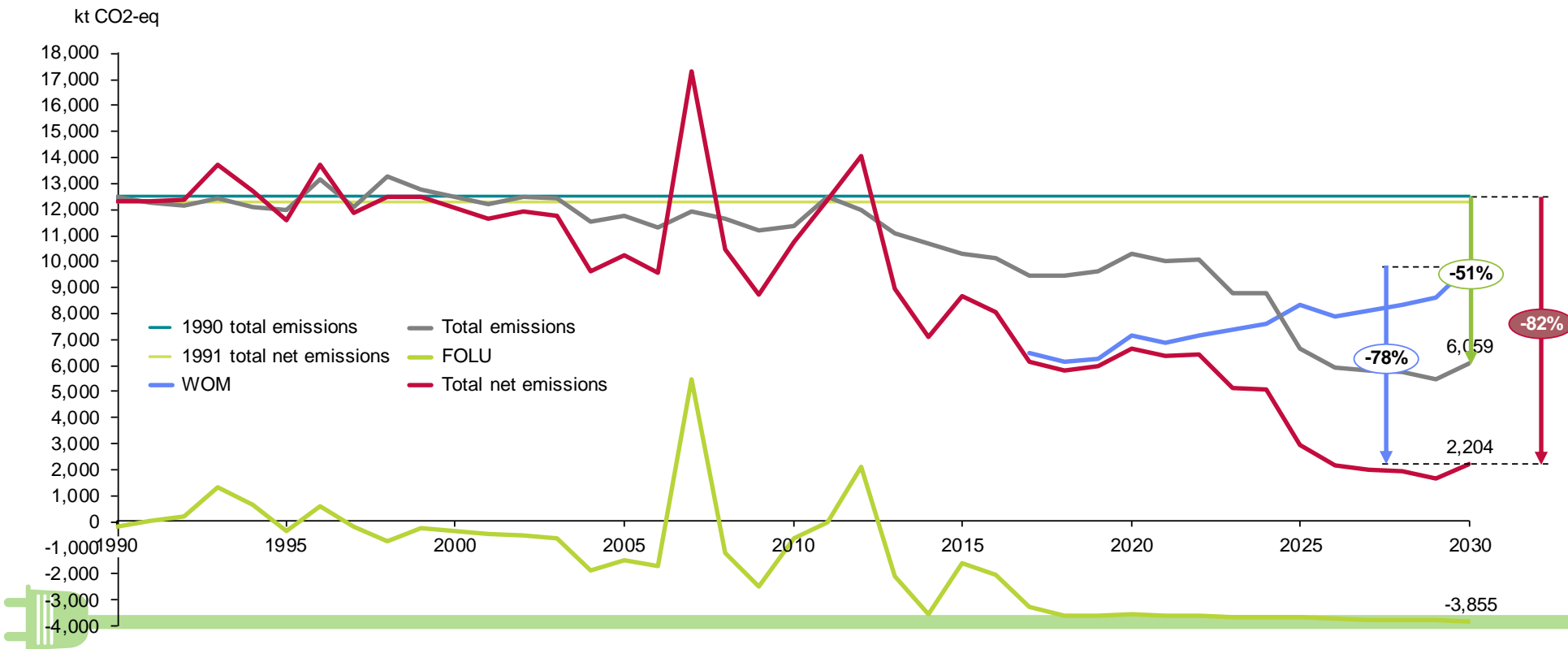
Document adopted



Targets and objectives - Sectoral targets

The **targets** are expressed in relation to 1990, as a base year and are:

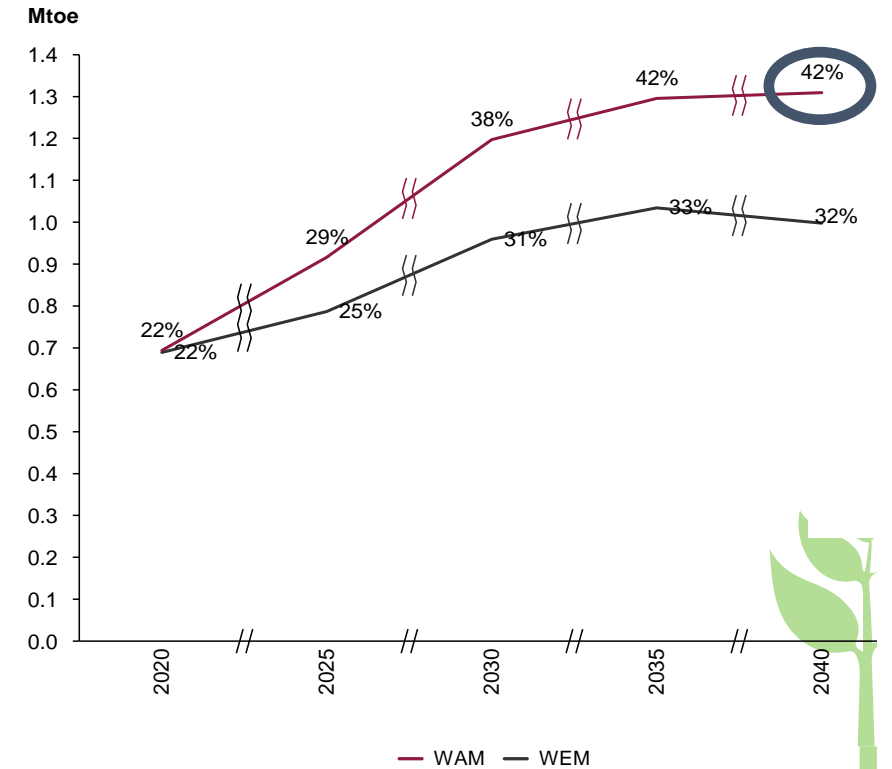
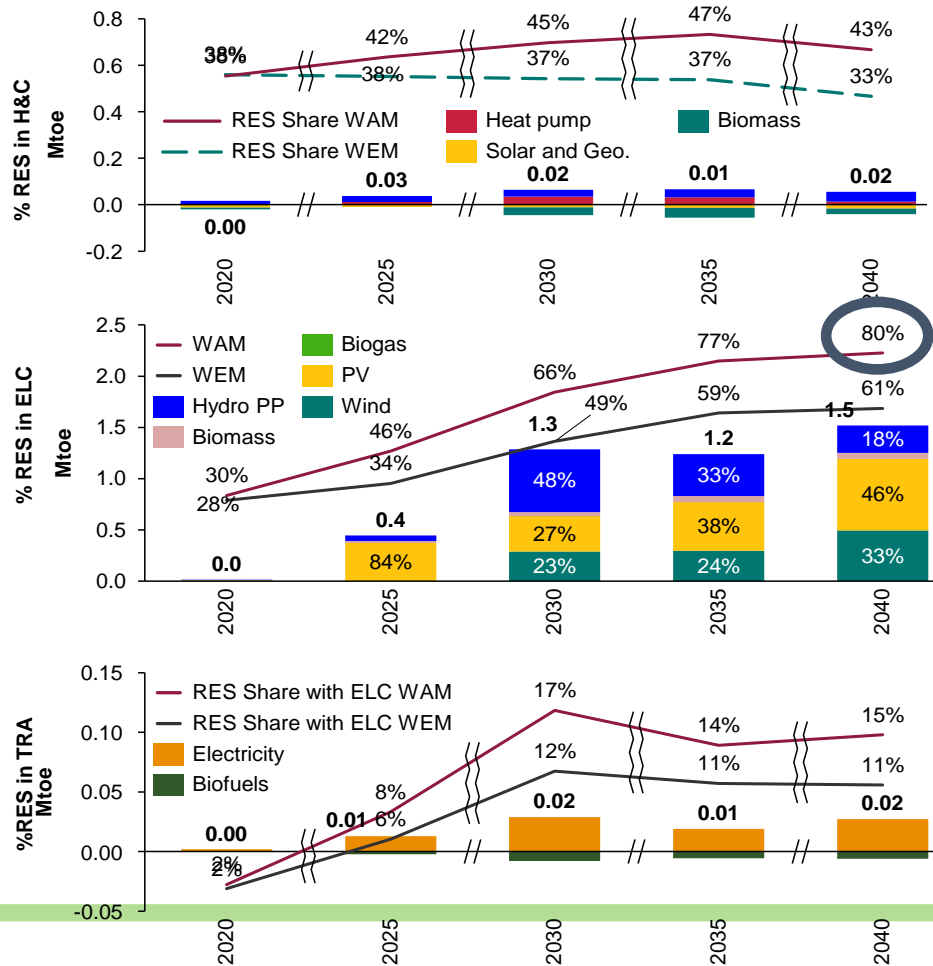
- **51% GHG emissions reduction**
- **82% net GHG emissions reduction**



Targets and objectives

Difference between WEM and WAM in indicative projections of **RES share in gross final energy consumption** and in different sectors (heating and cooling, electricity and transport) as well as per technology in each of these sectors

- Electrification of the heating and cooling sector



- Electrification of the transport sector



New installed capacity

2022 requests

>2000 MW

750 MW



Wind

1400 MW



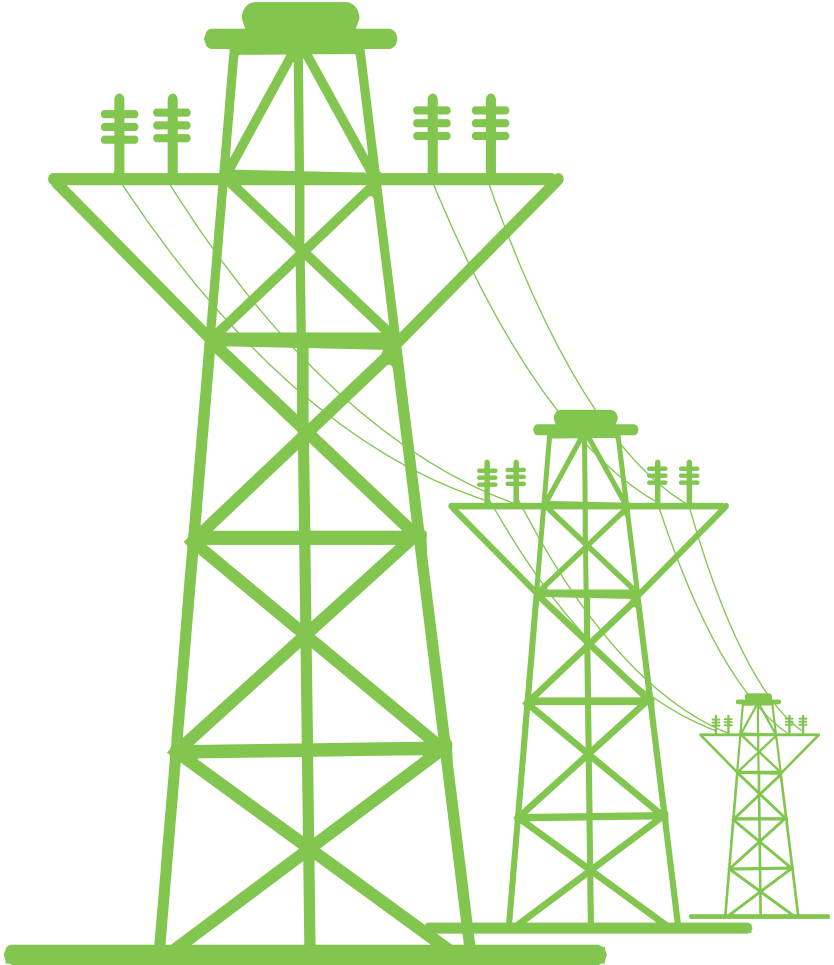
Solar

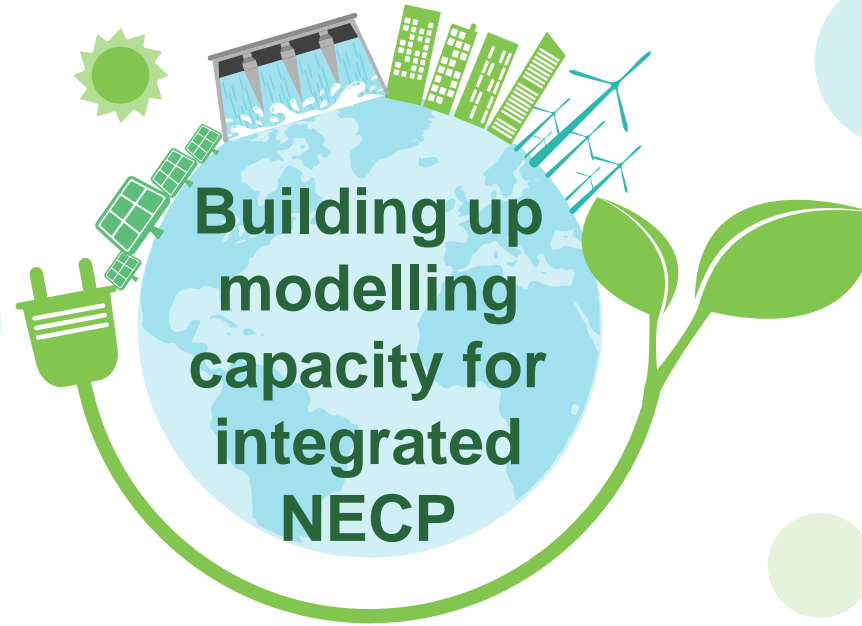
>2000 MW

Hydro pump storage



Hydro

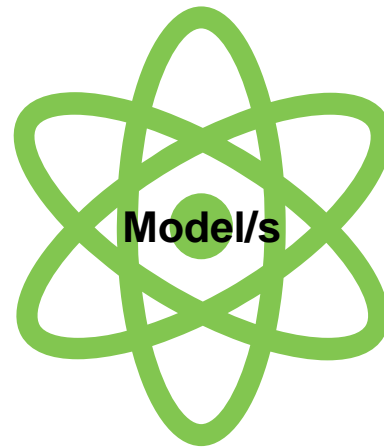
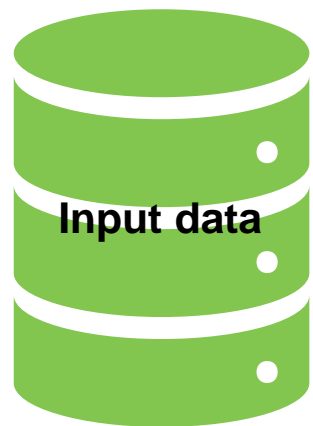




Input data

Coal phase-out in North Macedonia:
The model behind the decision

Methodology



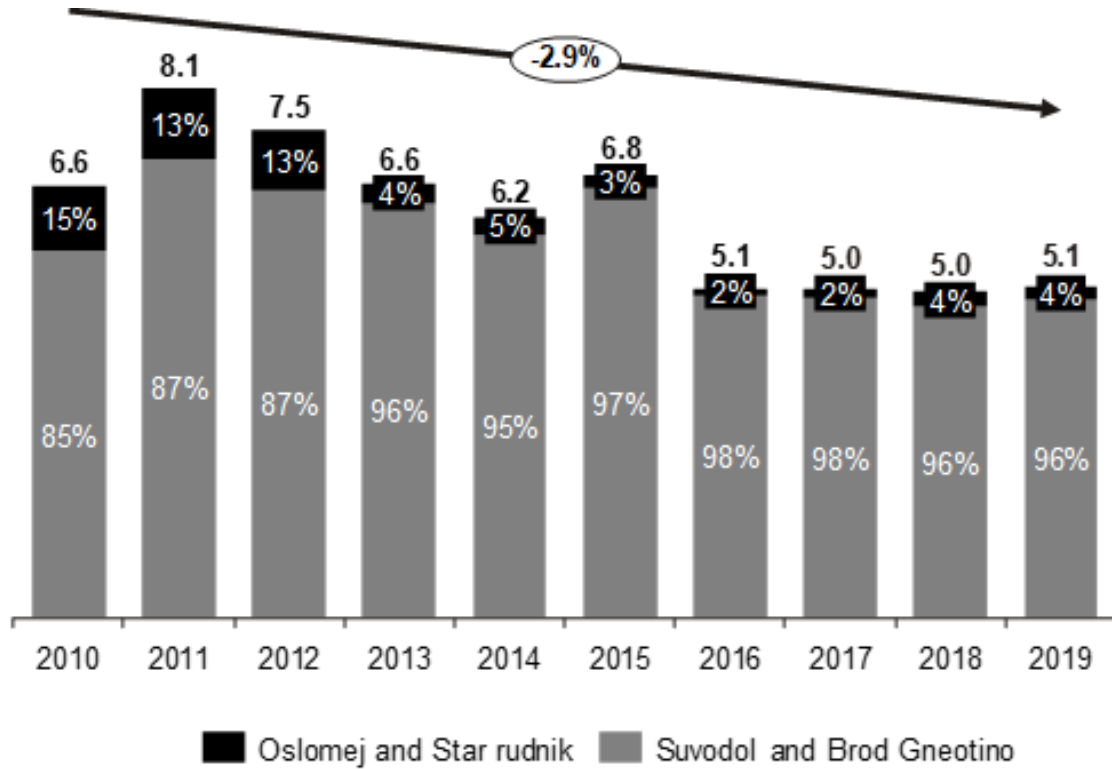
Methodology

Without good and reliable input data even, the best model will generate wrong or unreliable results

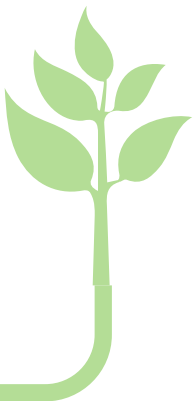
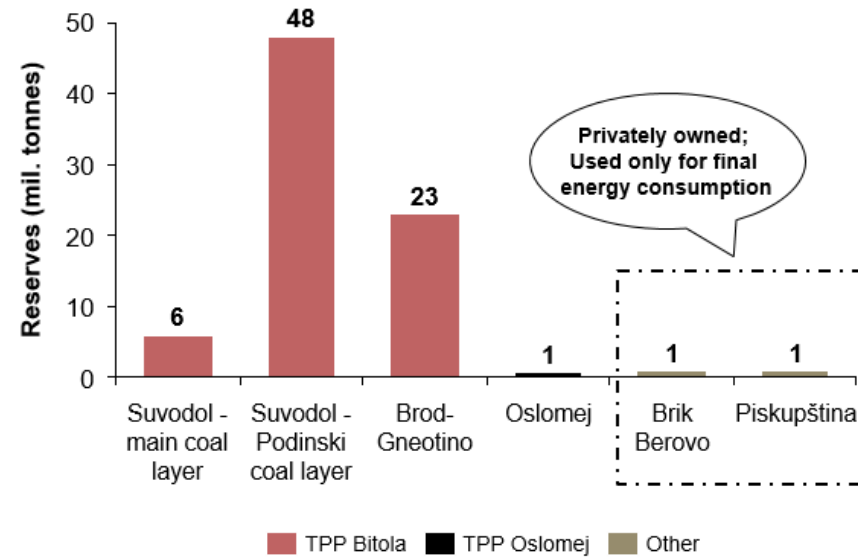
Garbage in garbage out (GIGO)



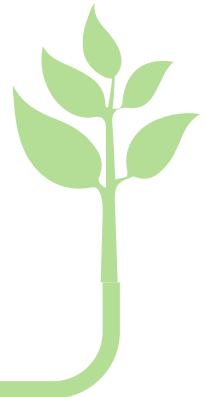
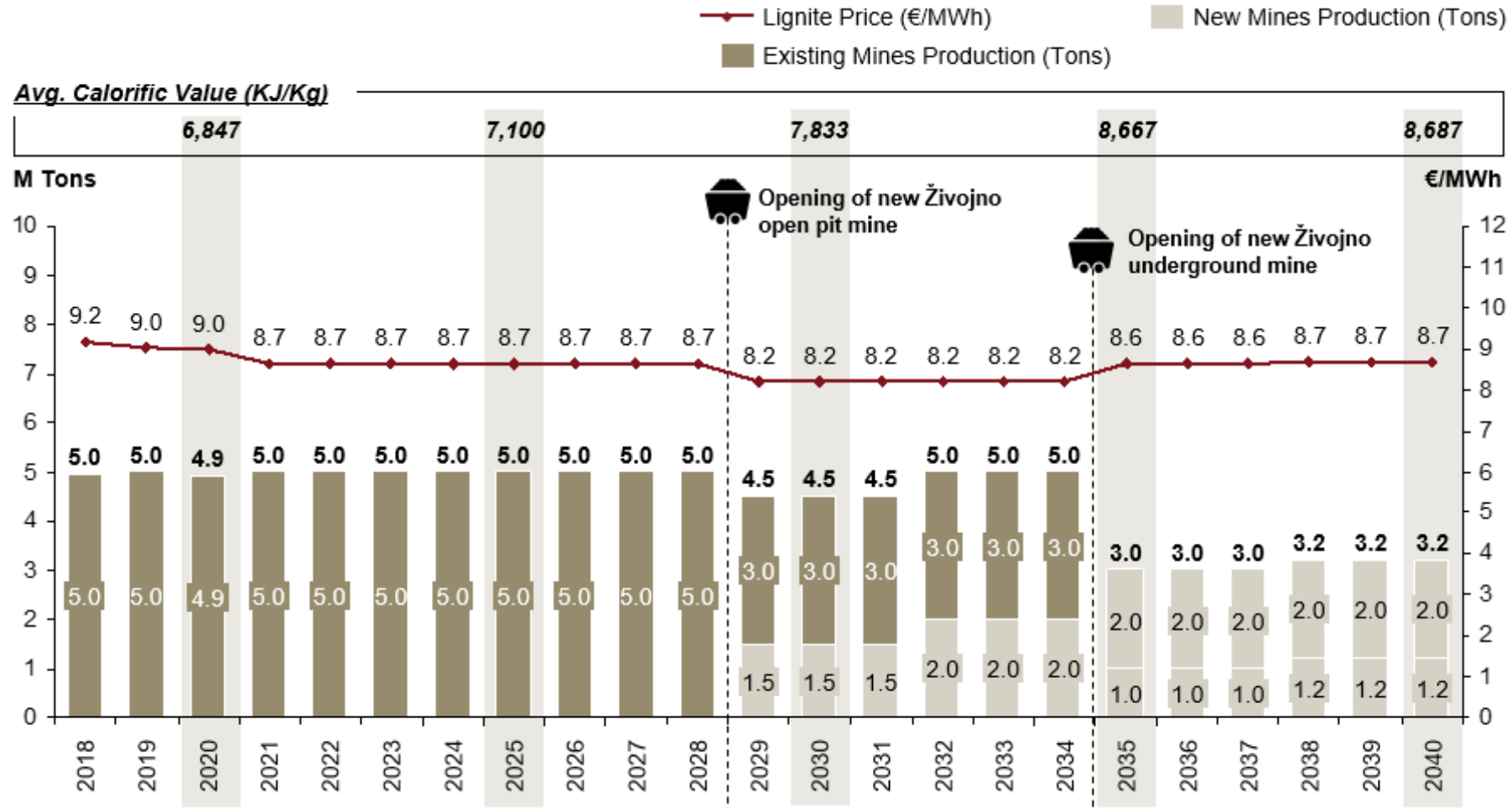
Coal mines current situation



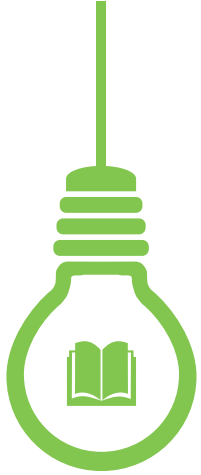
Years of production left since 2014 ¹					
4.0	16.0	11.5	2.0	2.5	2.5
Annual exploitation (mil. tonnes)					
1.5	3.0	2.0	0.35	0.04	0.04



Lignite price and supply



Regulation



**Large
combustion
plant directive
2025**

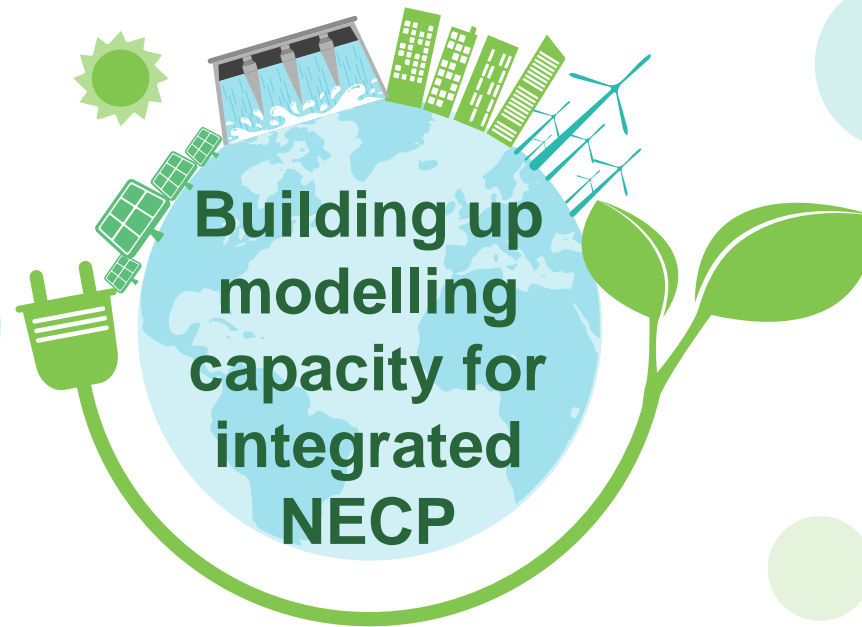


**Industrial
directive
2028**



**Introduction
of CO2 tax**





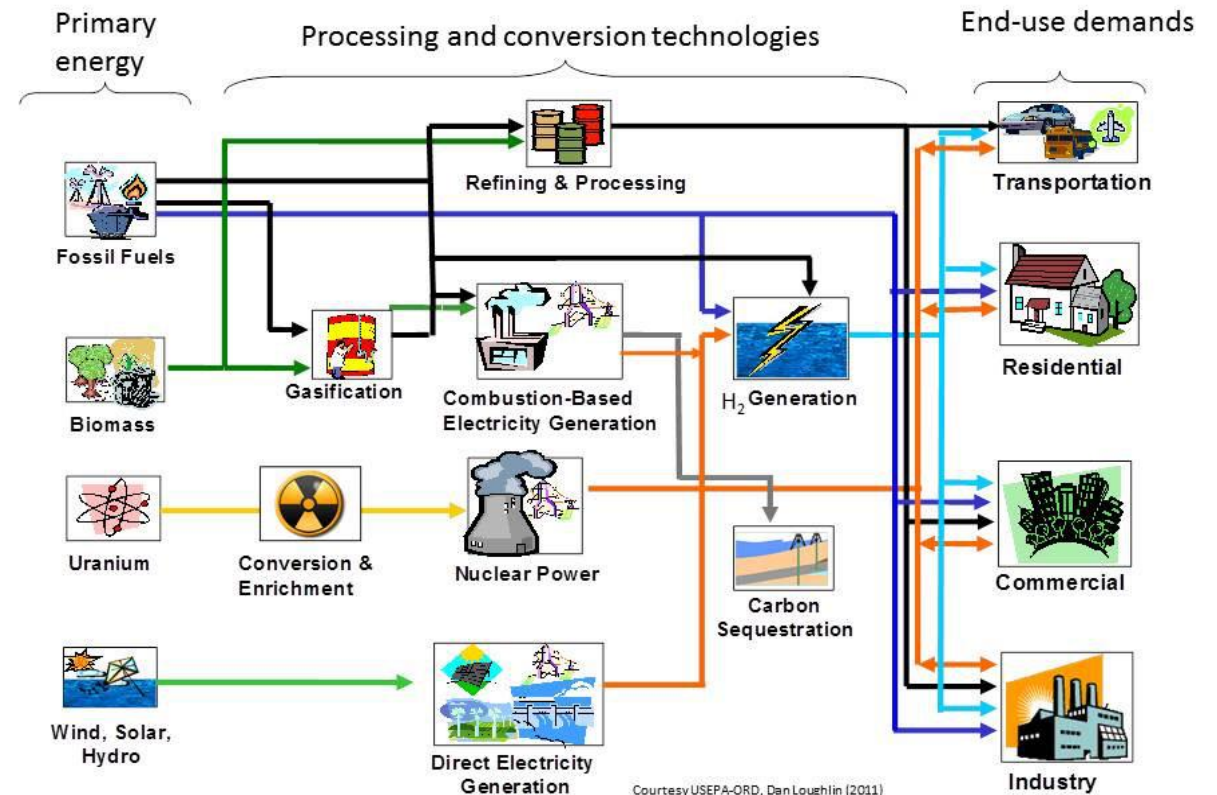
Methodology

Coal phase-out in North Macedonia:
The model behind the decision

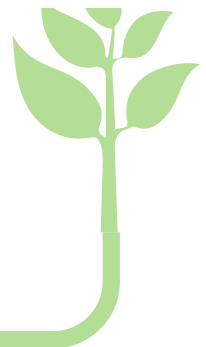
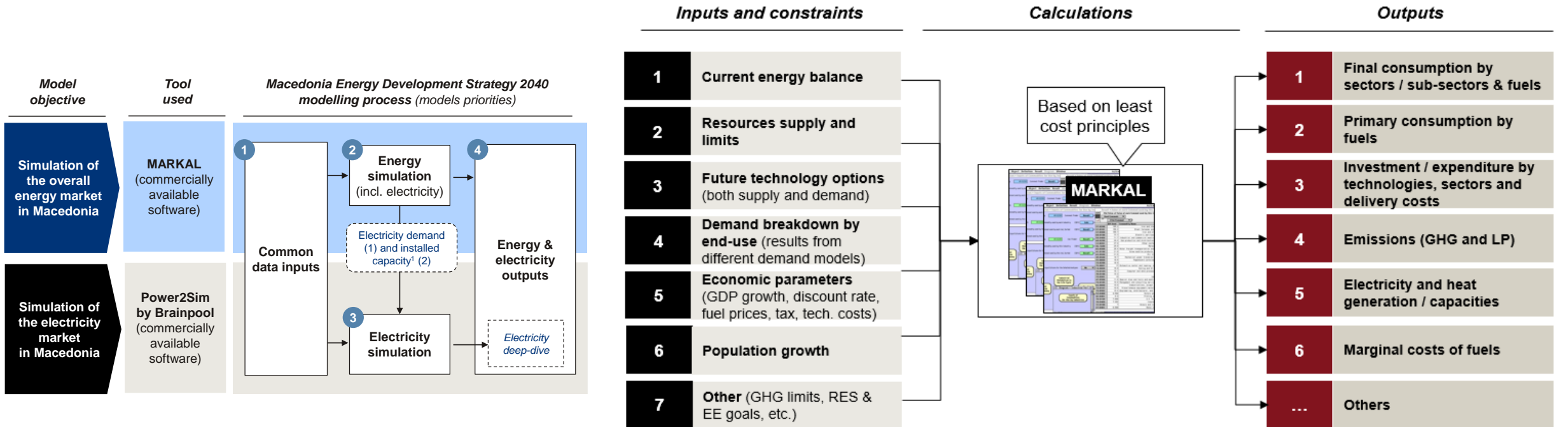
Key Aspects of MARKAL/TIMES

- ❖ Encompasses an *entire energy system* from resource extraction through to end-use demands as represented by a Reference Energy System (RES) network
- ❖ Employs least-cost *optimization*
- ❖ Identifies the most *cost-effective* pattern of resource use and technology deployment over time
- ❖ Provides a framework for the evaluation of mid-to-long-term *policies and programs* that can impact the evolution of the energy system
- ❖ Quantifies the *costs and technology choices* that result from imposition of the policies and programs
- ❖ Identifies the *benefits* arising for various policies and programs (e.g., increase energy security and economic competitiveness, reduced emissions)

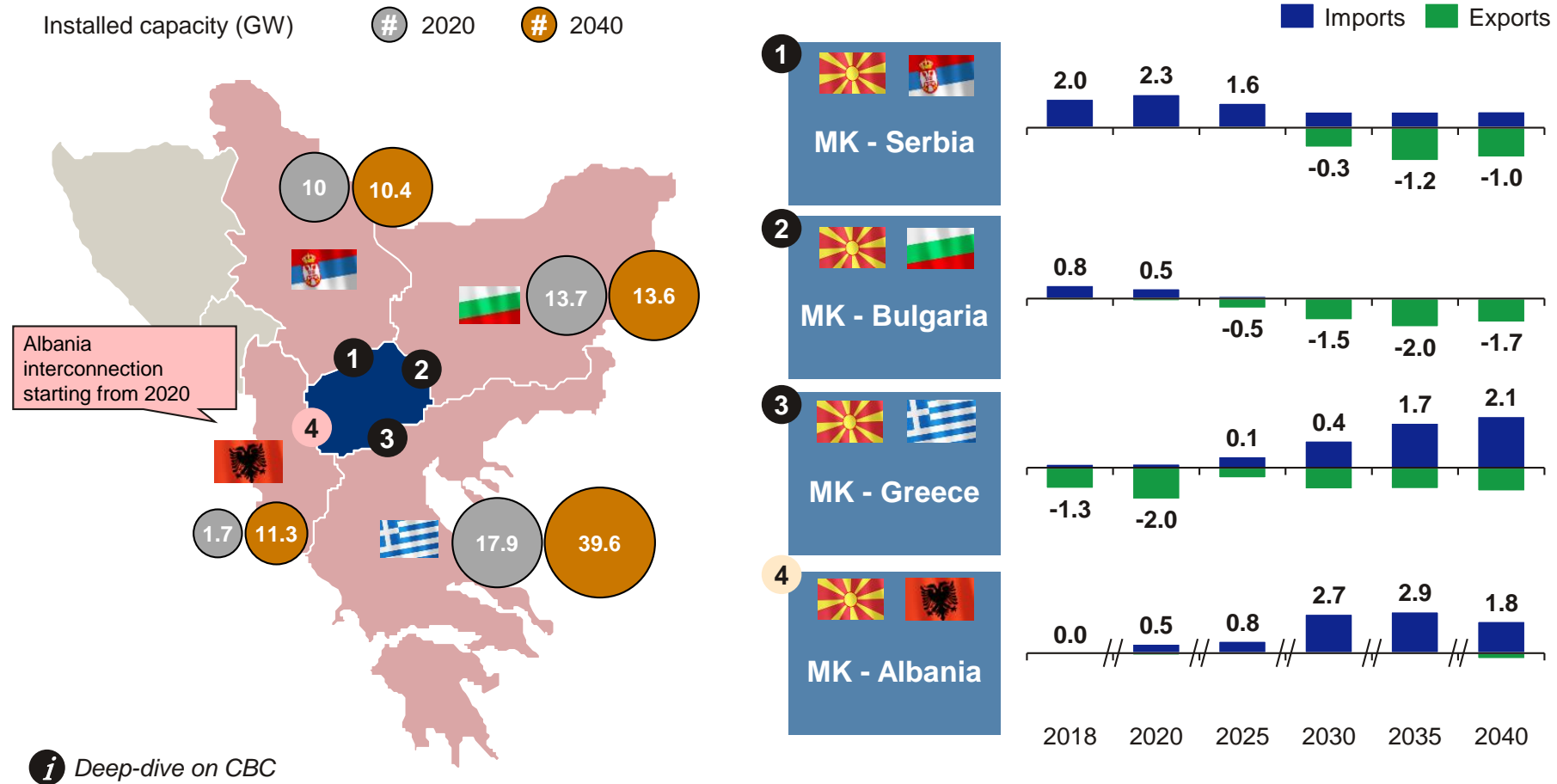
MARKAL/TIMES Energy System Model



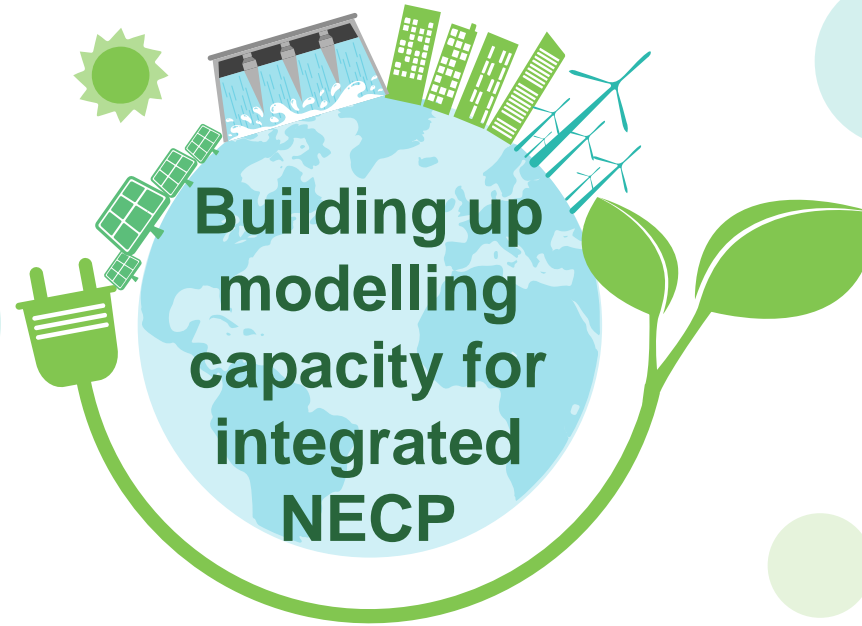
Methodology



Methodology



Note: These analyses were done in the period 2018 and 2019 and ENTSO-E data and maps were used. Data for Kosovo are merged because at that time KOSTT was in the same regulatory zone with Serbia

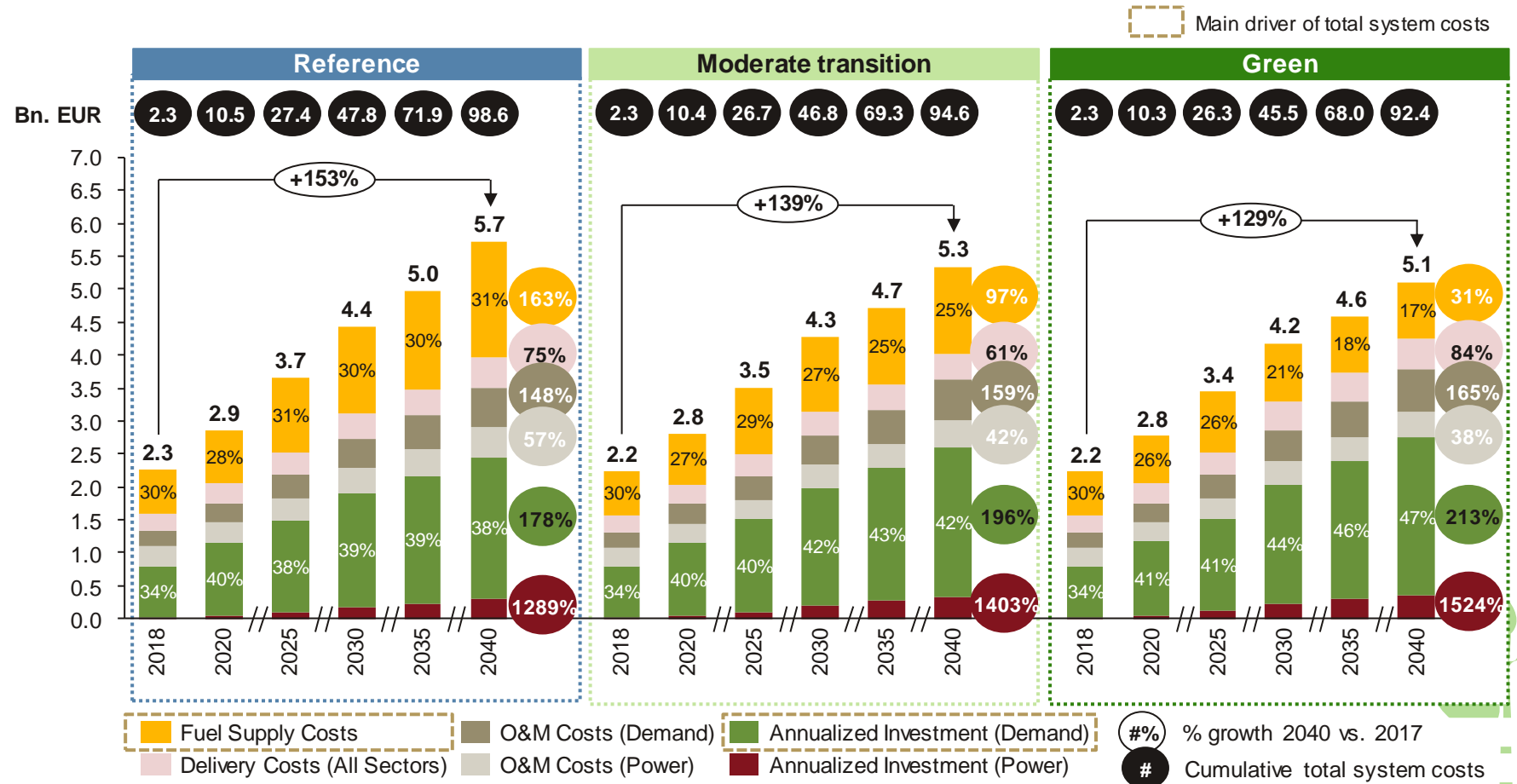


Results

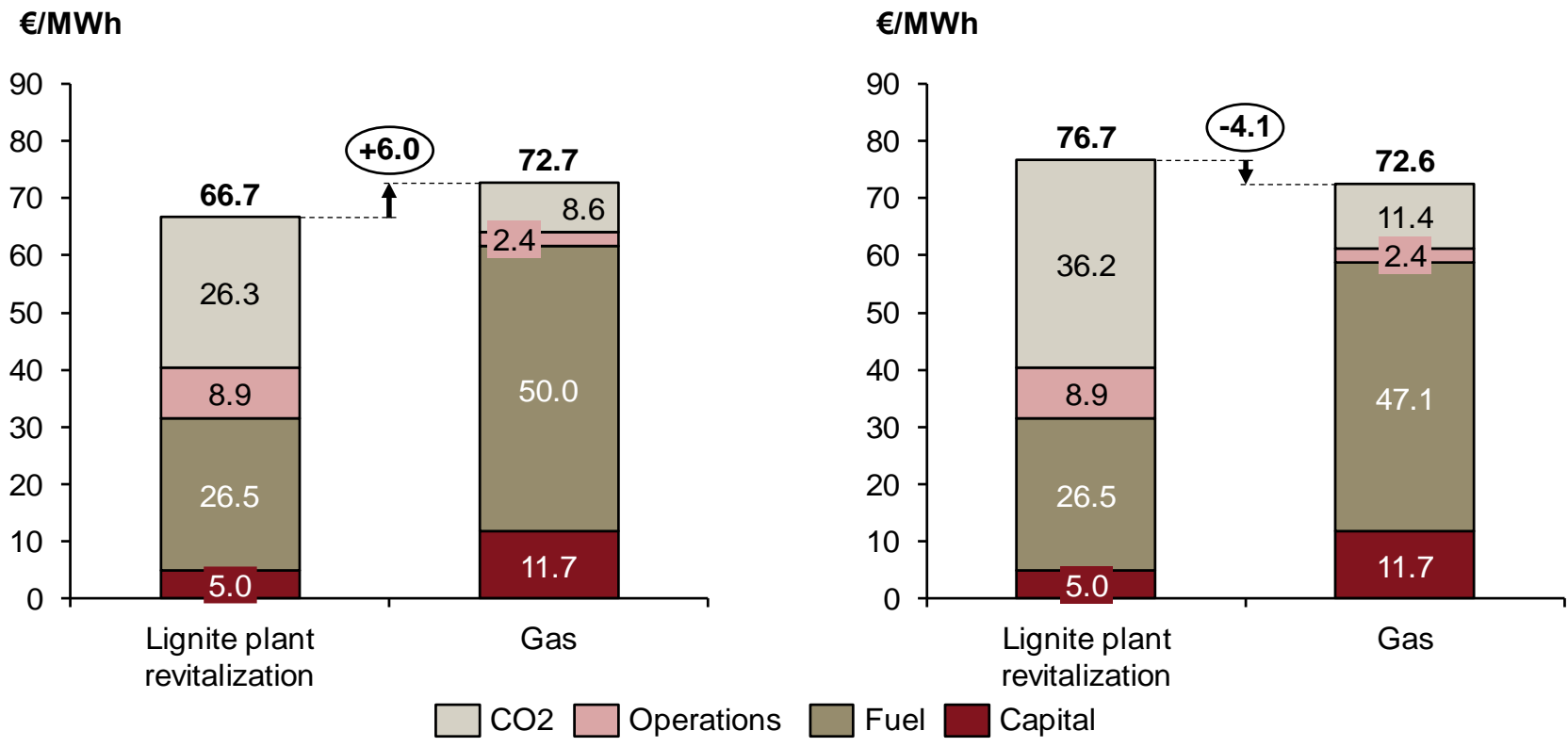
Coal phase-out in North Macedonia:
The model behind the decision

Results

- Financial
- Technical

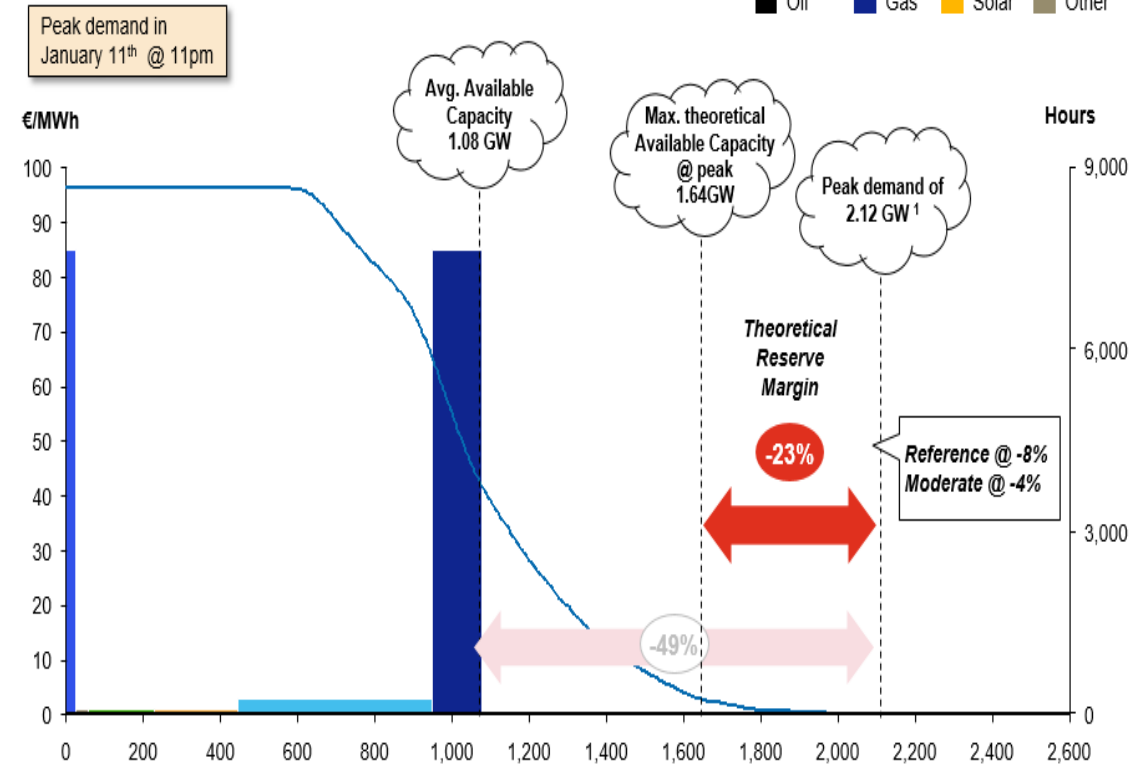
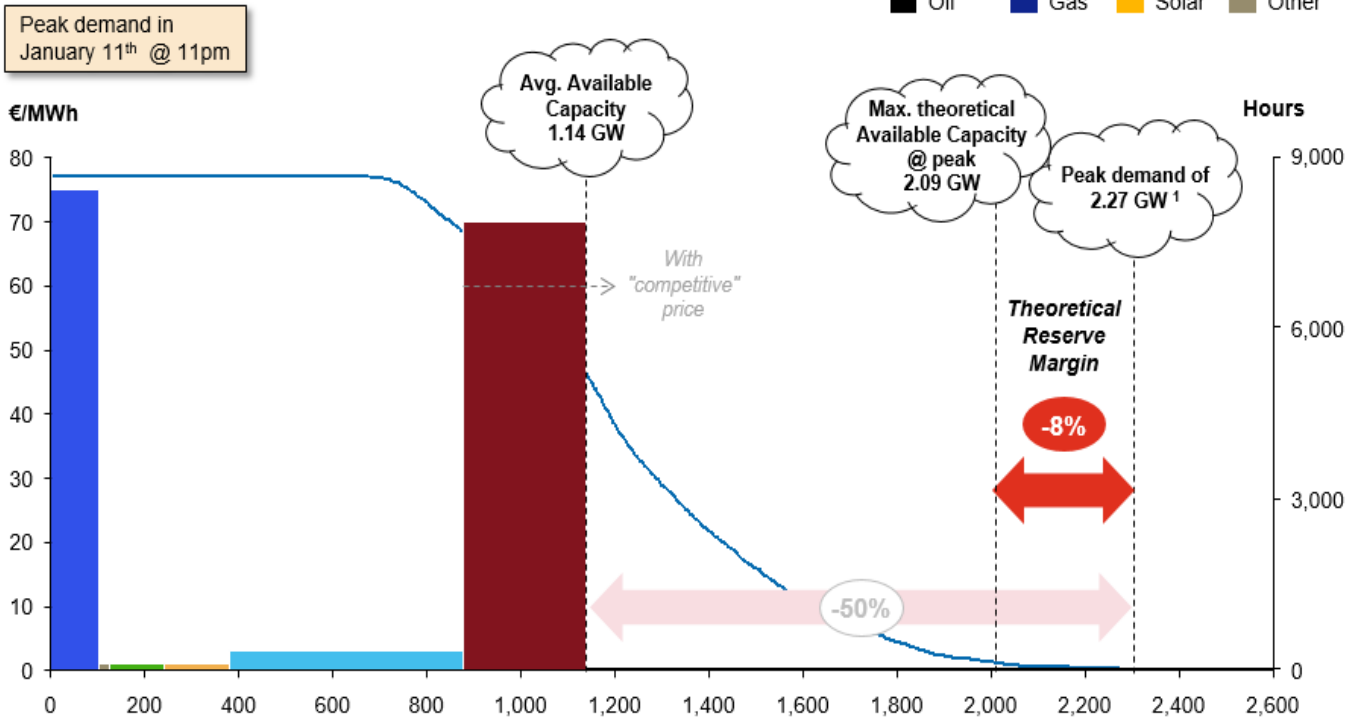


• Results



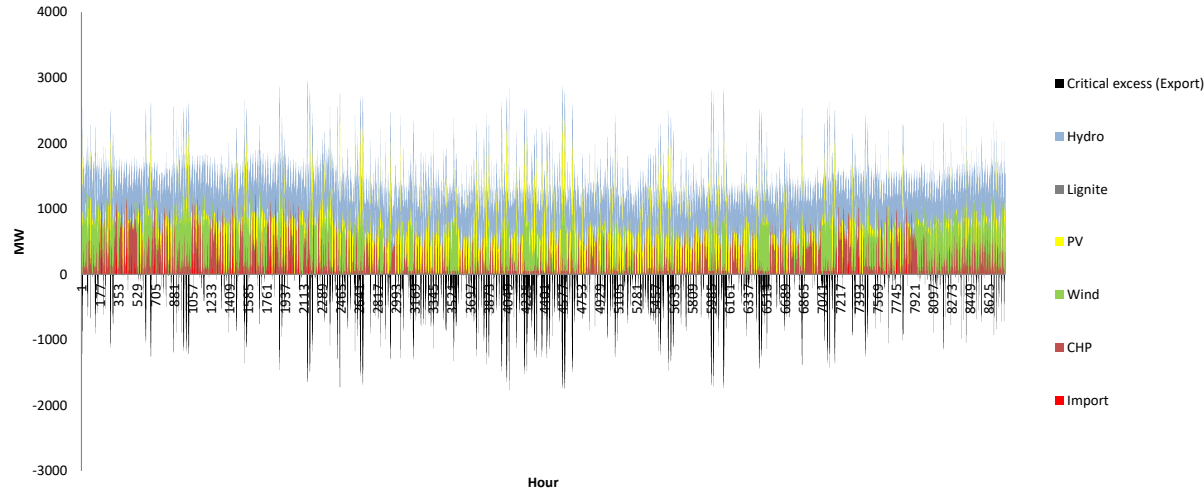
Results

- Technical, security of supply, flexibility of the system
- Macedonia merit order curve in 2040

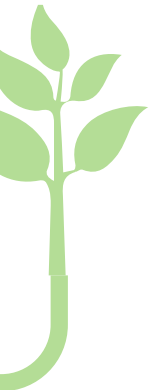
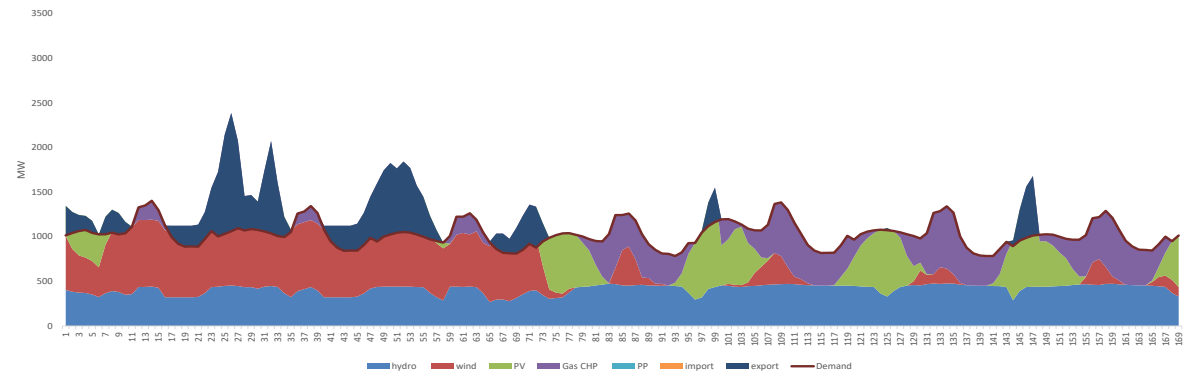
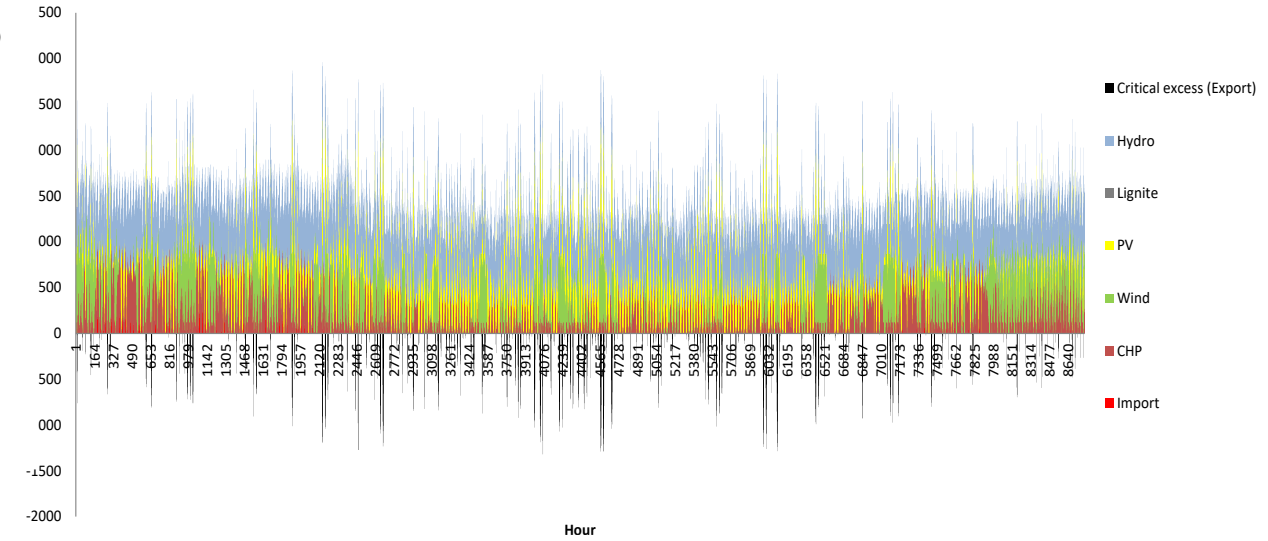


Electricity deep dive

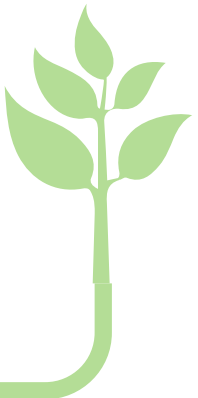
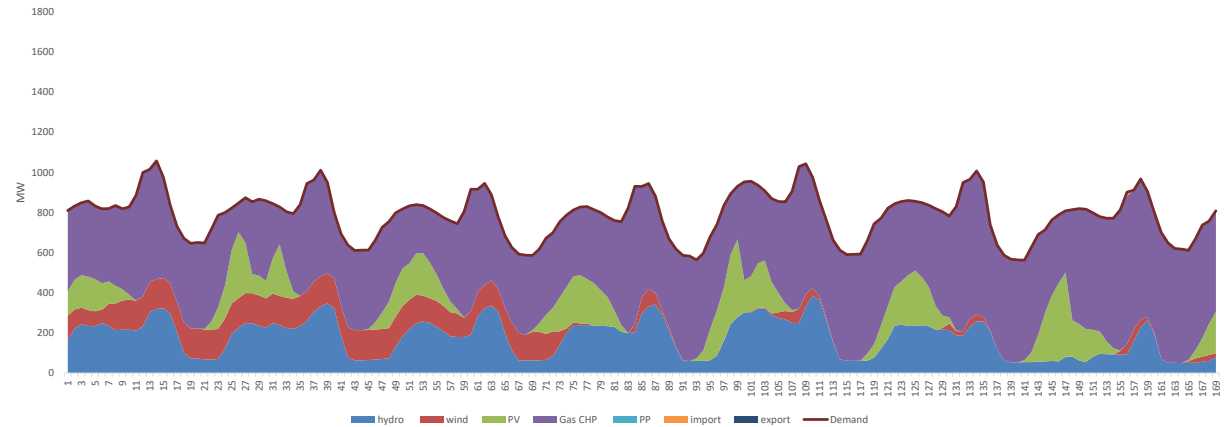
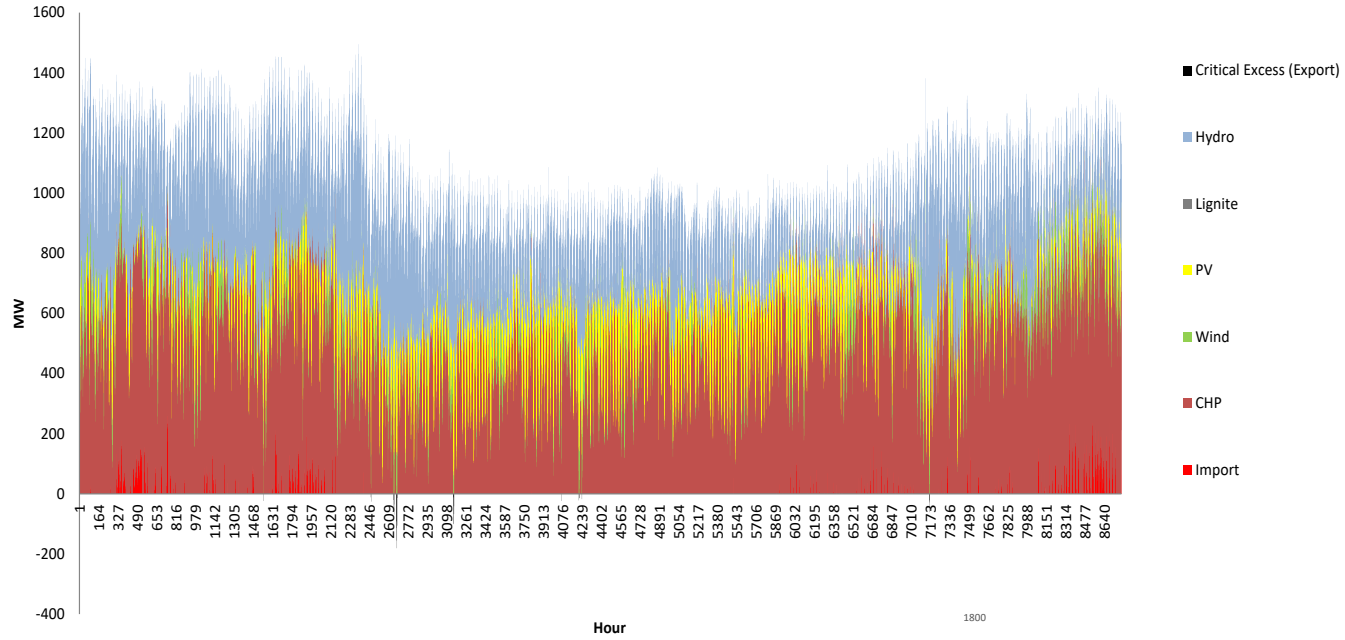
Without pump storage



With pump storage

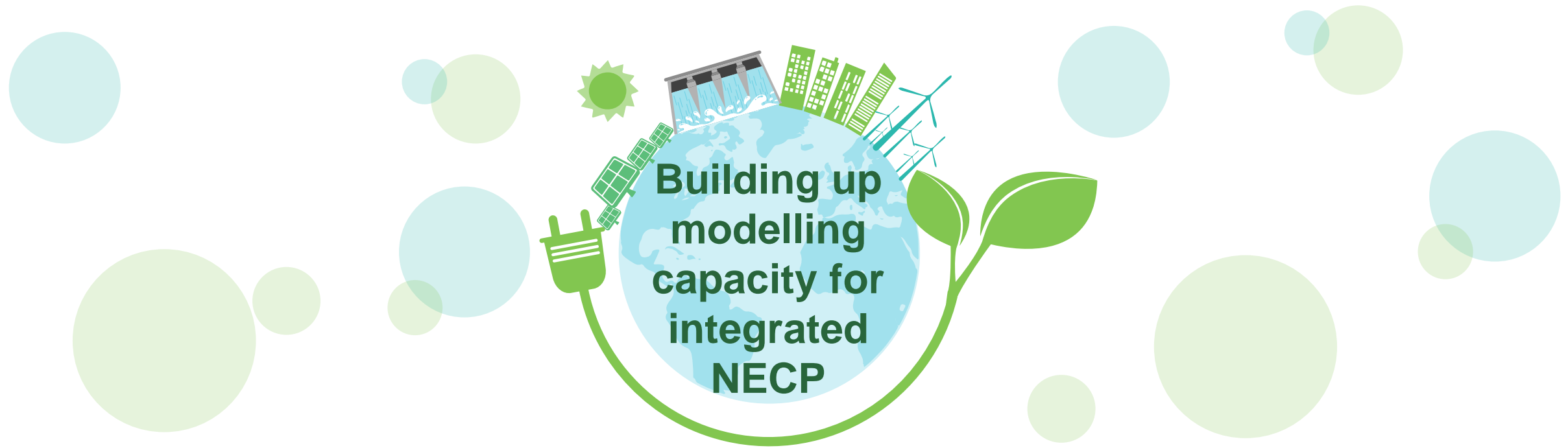


Electricity deep dive



Deep-dive analyses on the electricity generation portfolio

	2025		2040				
	Green scenario (TPP Bitola still working)	Green scenario (TPP Bitola not working)	Green scenario	Green scenario + coal (400 MW)	Green scenario + coal PP (400 MW) + gas PP (400 MW)	Green scenario + coal PP (400 MW) + gas PP (400 MW) - Vardar valley (308 MW)	Green scenario - Vardar valley (308 MW)
% of working hours at full capacity of coal PP	2%			2%	0%	0%	
% of working hours at full capacity of gas PP (450 MW new + 290 MW existing)	75%	75%	42%	41%	42%	42%	56%
% of working hours at full capacity of additional gas PP (400 MW)					2%	33%	
# of hours with electricity excess	0	0	871	871	871	886	886
% of excess in total electricity demand	0%	0%	3%	3%	3%	3%	3%
% of import in total electricity demand	0%	2%	1%	0%	0%	0%	2%



Recommendations

Coal phase-out in North Macedonia:
The model behind the decision

Recommendations

- *Reliable input data*
- *Development of sustainable policies.*
- *Using modern tools*





Thank You

Coal phase-out in North Macedonia:
The model behind the decision