



**MODELLING OF THE ROMANIAN
ELECTRICITY SECTOR 2025-2040**

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Executive summary (I)

- Romania **can reach a completely decarbonised electricity production mix in 2040 with no security of supply risks** by aiming to install less gas-fired capacities by 2030 compared to current plans assumed through the draft revised NECP and LTS.
- A higher focus on **wind energy and a higher deployment of storage** technologies can contribute to decarbonising the power sector by 2040.
- The market value factor of wind increases slightly above 100%, indicating that **Romania might have a competitive advantage in wind deployment**, especially, given the regional context with lower wind investments expected in Hungary and Bulgaria.
- Extensive installation of **renewables** leads to **lower electricity price**.
- Even with considerable solar and wind power development, there are **enough reserve capabilities** to handle the variable RES production.
- Increased **CO2 quota prices** can **increase wholesale electricity prices in Romania significantly**, with more than 40 EUR/MWh in 2040, which is an important risk element of the Romanian electricity sector.

Executive summary (II)

- **Higher deployment of natural gas** leads to lower prices on the short run (until 2030), however on long run it results in **higher prices and higher CO2 emission** relative to a case with lower gas but higher deployment of renewables.
- **Operating natural gas power plants with hydrogen is not a feasible solution for Romania**, as the fuel costs are too high, leading to almost 0% utilisation.
- **Hard coal and lignite phaseout are manageable from a security of supply perspective**, even in 2025 and in a context with lower than planned investments in gas capacities.
- New nuclear capacities provide flexibility in Romania's downward reserve mix. **Delayed nuclear deployment** will lead to slightly higher prices and slightly higher CO2 emissions in 2030, but **not result in security of supply issues**.
- Existing hydro power facilities are key for balancing a renewables-dominated power sector. However, **new investments in hydro capacities would only have a limited effect on electricity prices and security of supply** – assuming the mentioned battery storage investments are realised.

Policy recommendations

- Investments in new **gas-fired capacities should be reassessed and resized** according to the actual needs of the power sector.
- **New natural gas capacities cannot switch economically to hydrogen; therefore, these plans should be carefully reconsidered** for any new investment.
- Romania should continue supporting the **deployment of additional renewable capacities**, with an increasing focus **on wind and storage. Offshore wind investments should become a priority** for the following decade, coupled with an expansion of utility-scale storage technologies.
- **Ramping up grids investments is required** to accommodate higher shares of renewables and enabling cross-border electricity flows.
- **Coal is quickly becoming uneconomical and is not needed for security of supply**, authorities should therefore not subsidise coal-fired capacities, instead reallocating funding for new renewable and storage capacity.
- **Rather than focussing on investments in new hydro capacities**, which may not have a significant impact, **investments in retrofitting existing assets should be prioritised**.

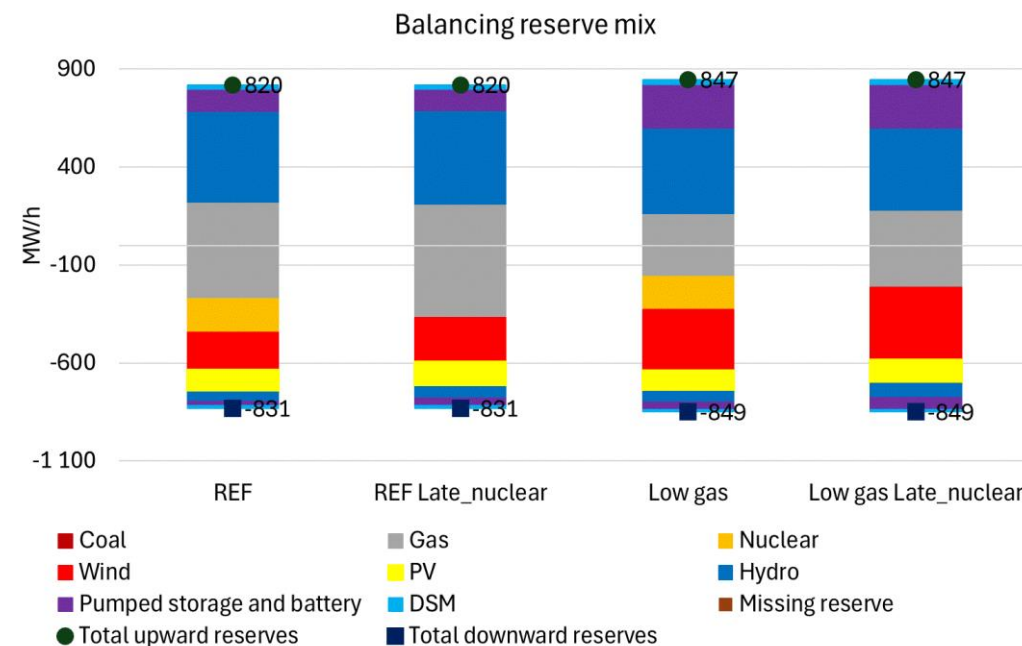
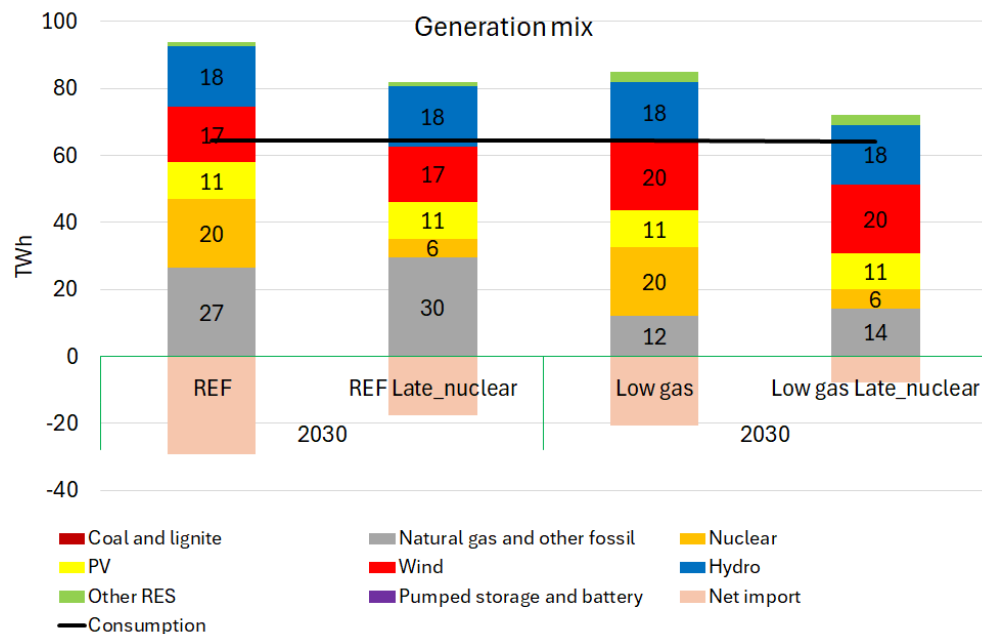
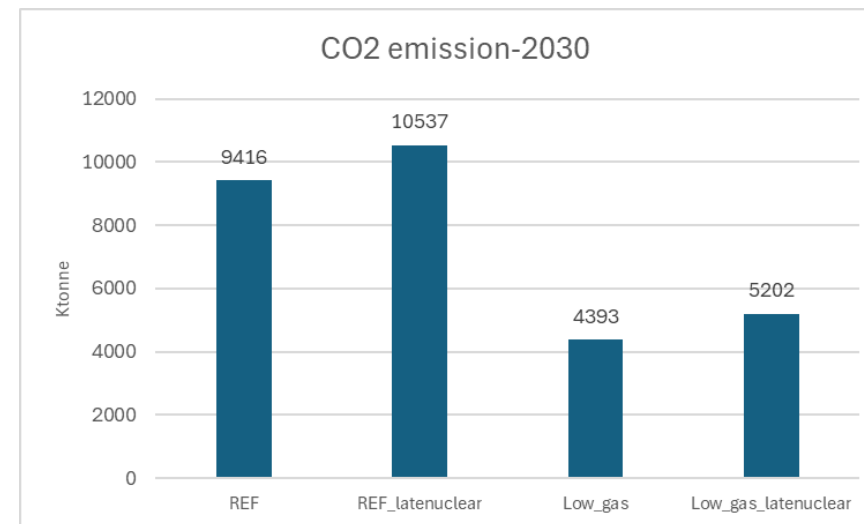
FUTURE ROLE OF ENERGY CARRIERS IN ELECTRICITY PRODUCTION

Coal is priced out in Romania even in 2025

- The **utilisation of coal power plants is basically 0%** in all scenarios for all years modelled.
- This means, that even though coal generation capacities are present until 2030, they are **not competitive** electricity production technologies in Romania.
- **It is possible to phase out coal in Romania until 2025, without** consequences on the security of supply and prices. The outcome is similar even in a delayed nuclear deployment sensitivity.

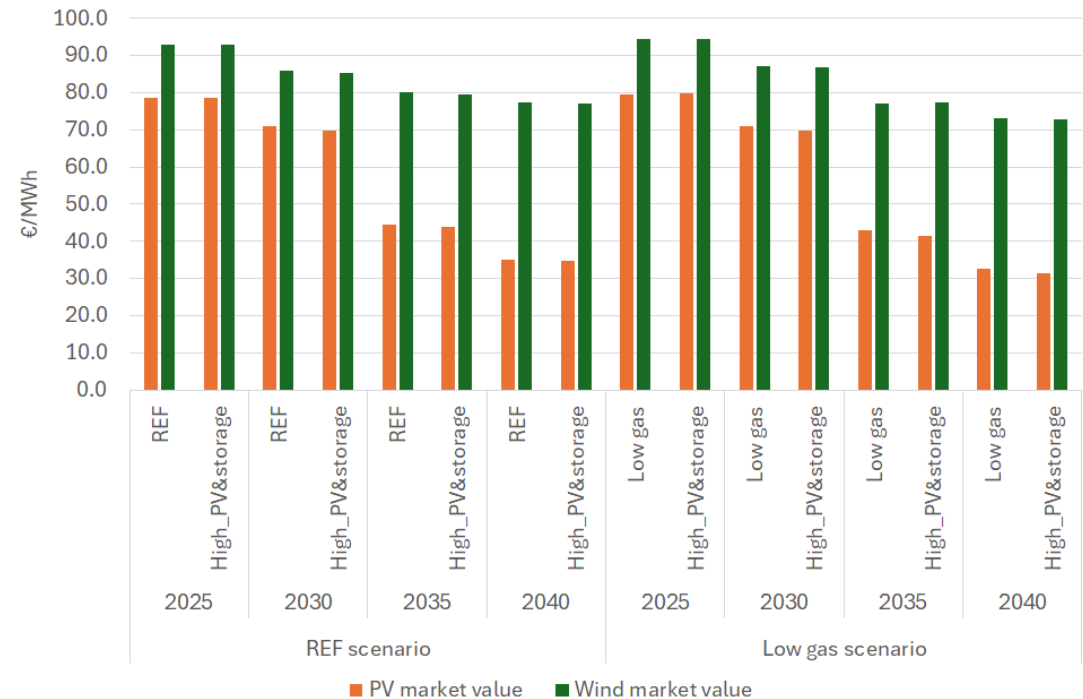
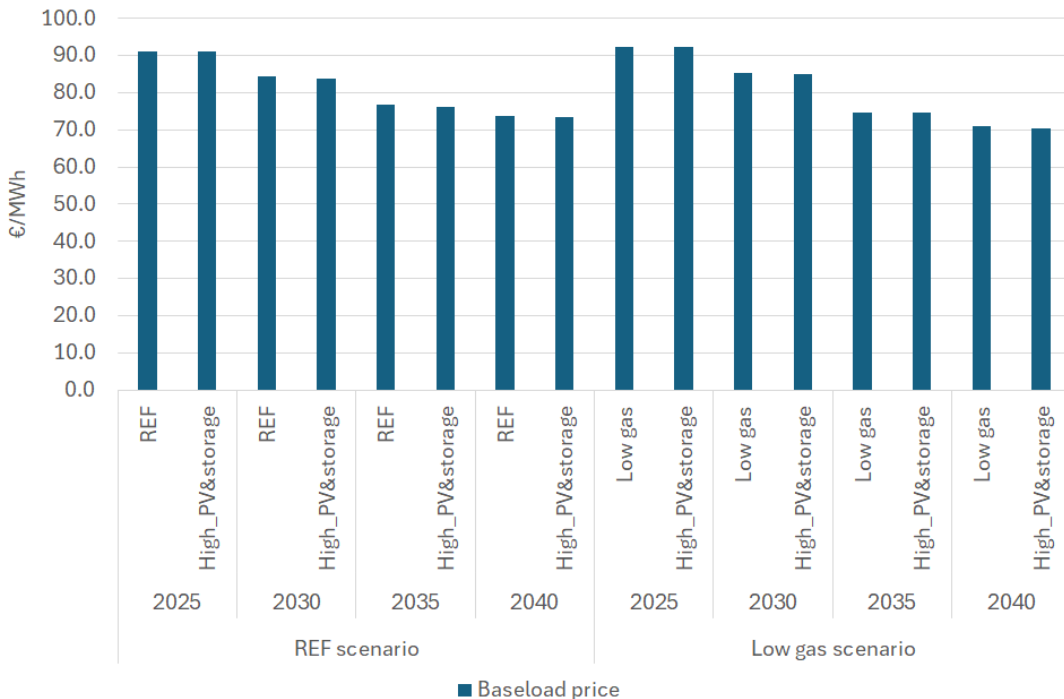
No security of supply risks even if nuclear capacities are delayed

- Almost **2 GW new nuclear** capacity is considered to come into operation in Romania between 2025 and 2035.
- The new nuclear capacities **increase the diversity of downward reserve mix**, as nuclear is present in all scenarios with a relevant share.
- If the new Nuclear capacities are in short **delay** (in 2030), there is **no security of supply risk** present for Romania.
- Until the capacities are completed however, the **market price is higher with 2 EUR/MWh**, which is a relatively small increase.
- Most of the missing nuclear generation is **reducing export**, and slightly increase gas-based generation.



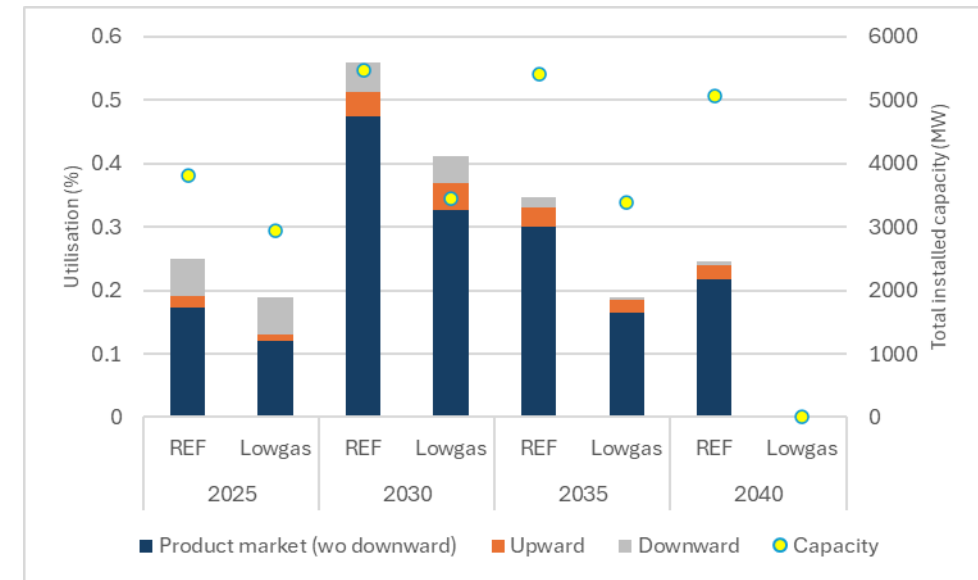
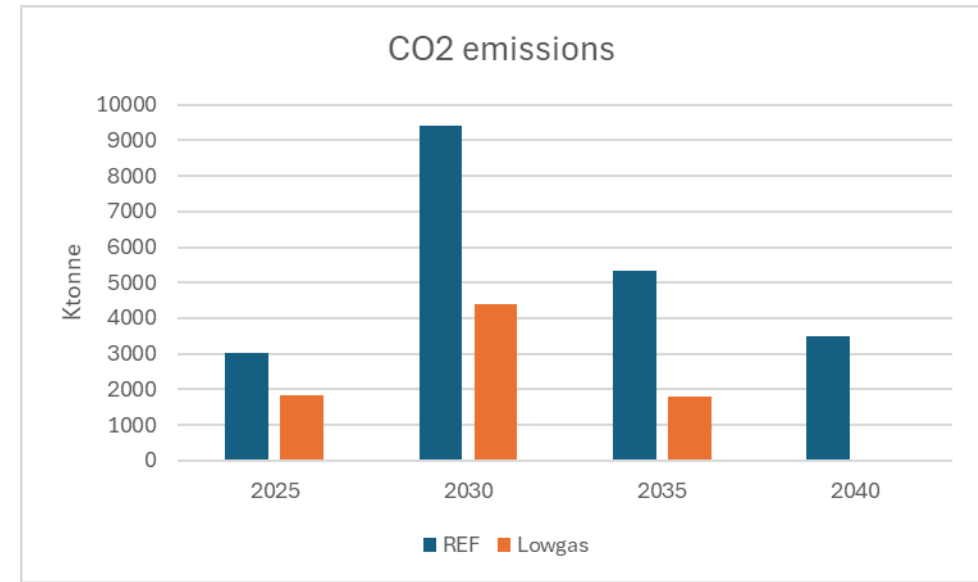
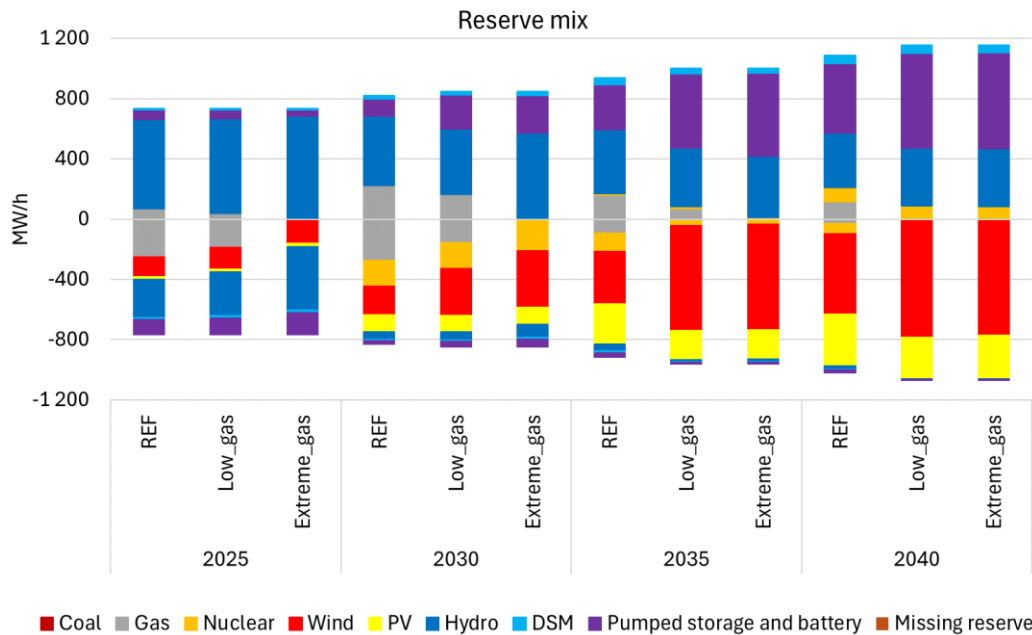
More RES results in lower prices and less emissions

- With more intermittent RES capacities installed instead of gas, the **price** can be **reduced with up to 3 EUR/MWh**, in 2040
 - Extensive installation of **household PV** systems with storages can **further reduce** price with **0.5 EUR/MWh**, which is a small decrease.
- Market value factor of PV** decreases drastically and reaches **50%** until 2040. For **wind** the market value factor is **100-110%** depending on year and scenario. The latter shows that **wind may have a competitive advantage** in Romania compared with PV.
- RES curtailment** is less than 0.5% in all the modelled scenarios, which can be **negligible**.
- High renewables scenarios are not associated with market operation problems, there is always **sufficient reserve capacity** present in the system.
- PV and Wind power plants participate at in increasing extent in the **downward reserve market**.



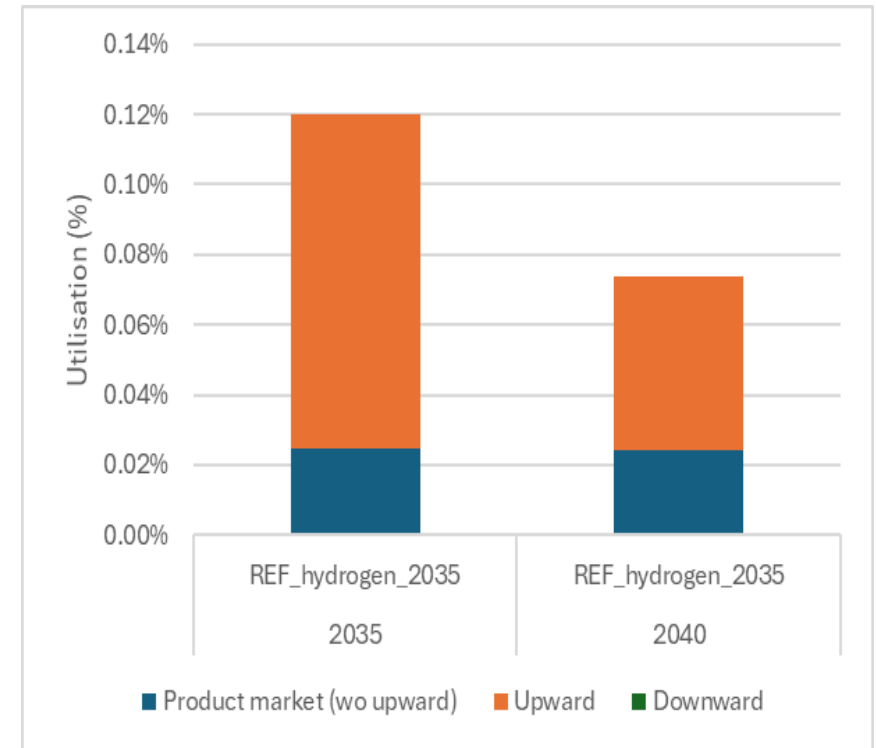
Role of gas is decreasing after 2030 even with new capacities installed

- The **utilisation of natural gas** power plants reaches its **peak in 2030**, after that **role of gas is decreases** in both the product and reserve market.
- With larger installed gas capacities prices tend to be lower until 2030, but **higher in the later modelled years.**
- **Higher CO2 emissions** are present in Romania if more new gas capacities are installed instead of renewables.
- **From 2030** there are **no security of supply risk** associated with the full phase out of gas.
- **In 2025 gas is needed** to provide the necessary balancing reserves for the market



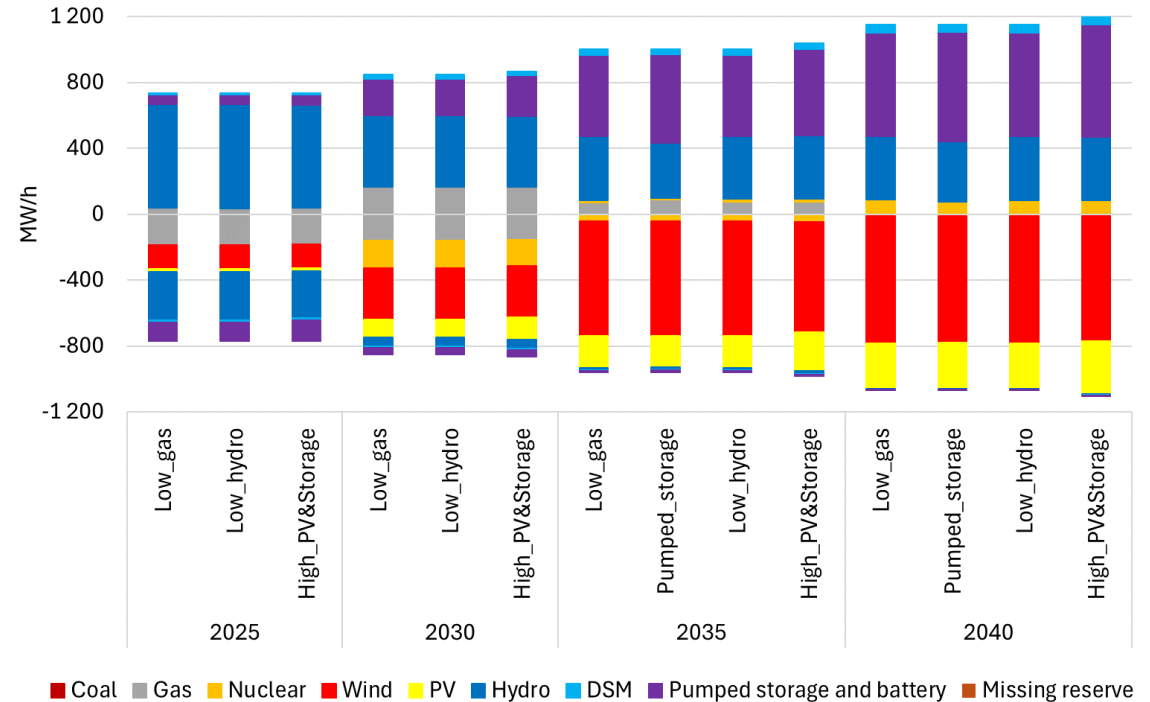
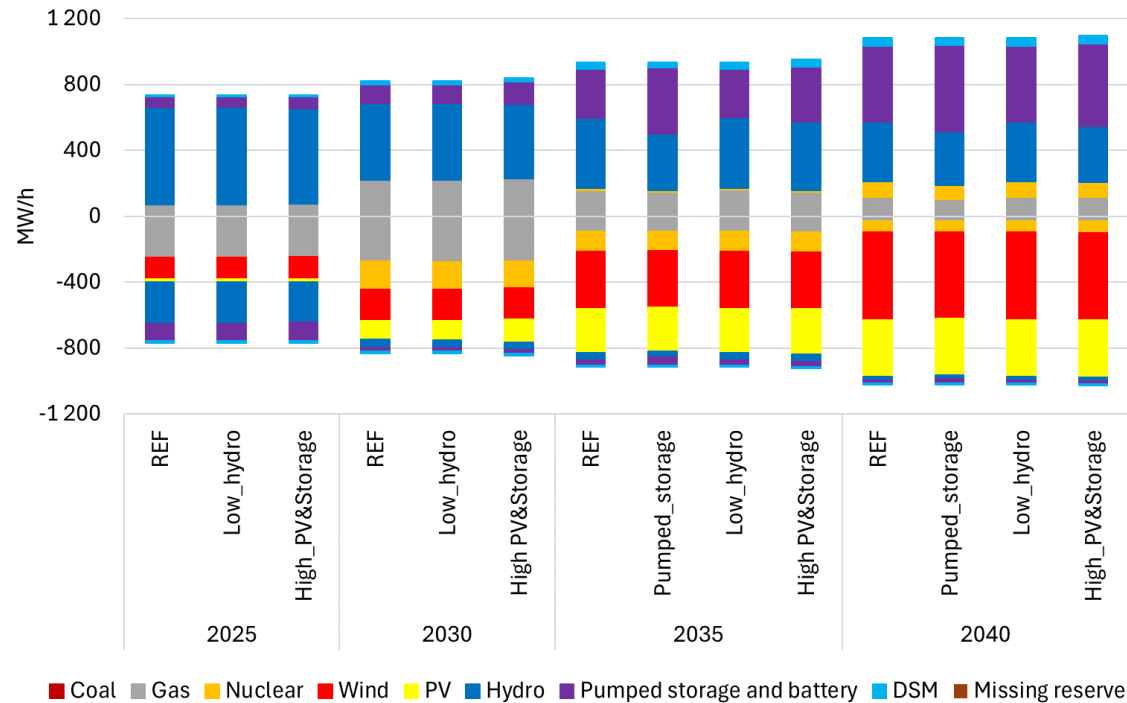
Hydrogen fueled gas power plants won't be utilised

- With 82 EUR/MWh operation cost assumed, the **hydrogen fuelled gas power plant operation is financially not feasible**.
- The **utilisation rate** of the hydrogen power plants will be **around 0.1%** in both 2035 and 2040.
- The non-operation of gas power plants does not cause security of supply problems in the Romanian system.



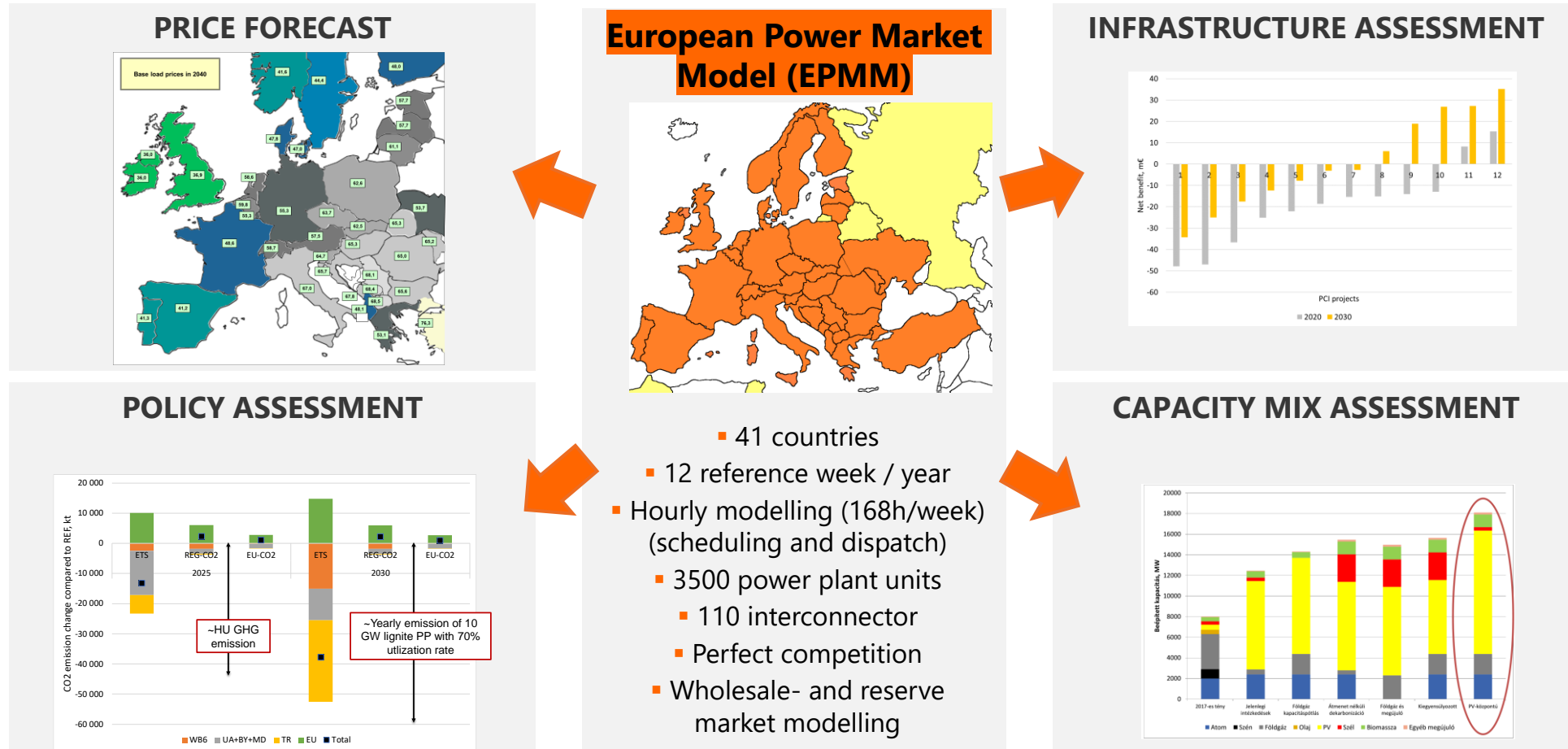
New hydro and pumped storage capacities have small market impact

- Higher **pumped storage** or **battery storage** capacities lead to **higher participation** of these technologies, especially for **upward reserves market**.
- At the **product market** these new installations has **marginal effect**, related to price or electricity mix.
- The completion of new **run of river** capacities have a **marginal effect** both on the product and on the reserve market.



ANNEX – DETAILS OF THE MODELLING

ESTIMATED SCENARIOS



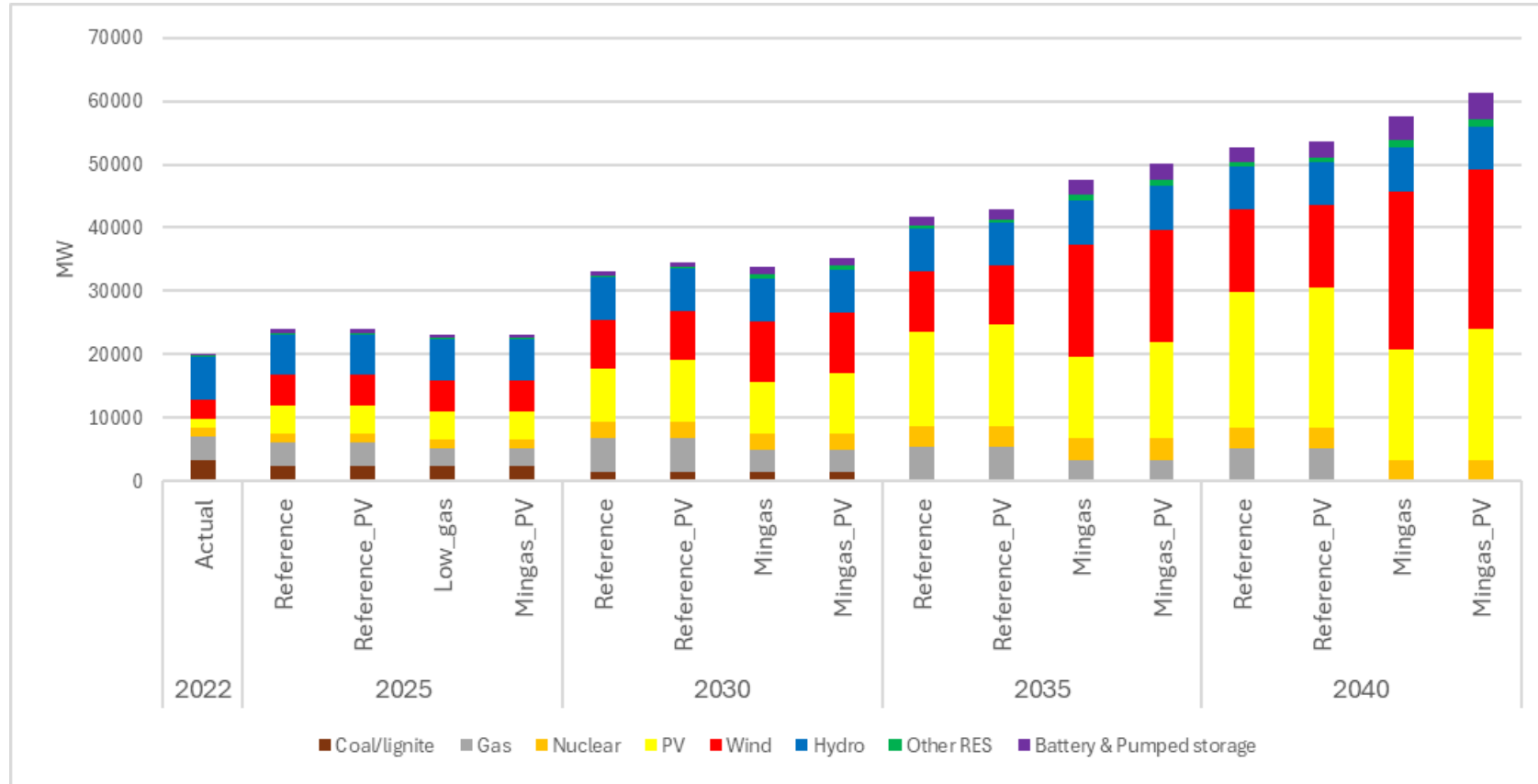
European Power Market Model (EPMM) is a unit-commitment model for Europe, able to calculate electricity mix, reserve capacity mix, electricity price, interconnector utilisation and other relevant market outcomes based on various input parameters.

Scenarios description

Scenarios		
#	REF_Scenario	Low gas_Scenario
1	New natural gas extraction	Reduced natural gas extraction
2	Extensive natural gas power plant capacity extension (5.5 GW in 2030)	Conservative natural gas power plant capacity extension (3.5 GW in 2030)
3	Solar & wind energy deployment (21.5 GW solar and 13.1 GW wind capacities in 2040)	Dynamic solar & wind energy deployment (17.5 GW solar and 25 GW wind capacities in 2040) ¹
4	Battery storage installation (2.2 GW in 2040)	Dynamic battery storage installation (3.4 GW in 2040)

Sensitivities	
1	Late_nuclear: Refurbishment of Cernavoda's U1 is delayed to 2031 (instead of 2030). Delay in new capacity installations: U3 to 2033 (instead of 2030), U4 to 2034 (instead of 2031), Doicești SMR to 2031 (instead of 2029).
2	Pumped_storage: A new pumped storage power plant is installed within the system in 2032, respectively 1 GW capacity.
3	High_PV & storage: 800 MW of rooftop PV and 120 MW of storage is installed in all years until 2040.
4	Low_hydro: Relative to the main scenarios 300 MW run of river hydro capacity is not completed between 2024 and 2030.
5	High_CO2 Price: EU Commission WAM CO2 price is assumed, which reaches 250 EUR/t in 2040.
6	Hydrogen_2035: In reference scenario after 2035, natural gas-based power plants are fully fueled with hydrogen, with a fuel price of 82 EUR/MWh.
7	Extreme_gas: In the reference scenario 300 EUR/MWh gas price is assumed for Romania, meaning that gas is basically unavailable for the country.

Installed generation capacities by scenarios



Late_nuclear scenario: In 2030 the repowering of Cernavoda 1 and installation of Cernavoda 3 and Doicesti SMR are not completed – available nuclear capacities: 707 MW.

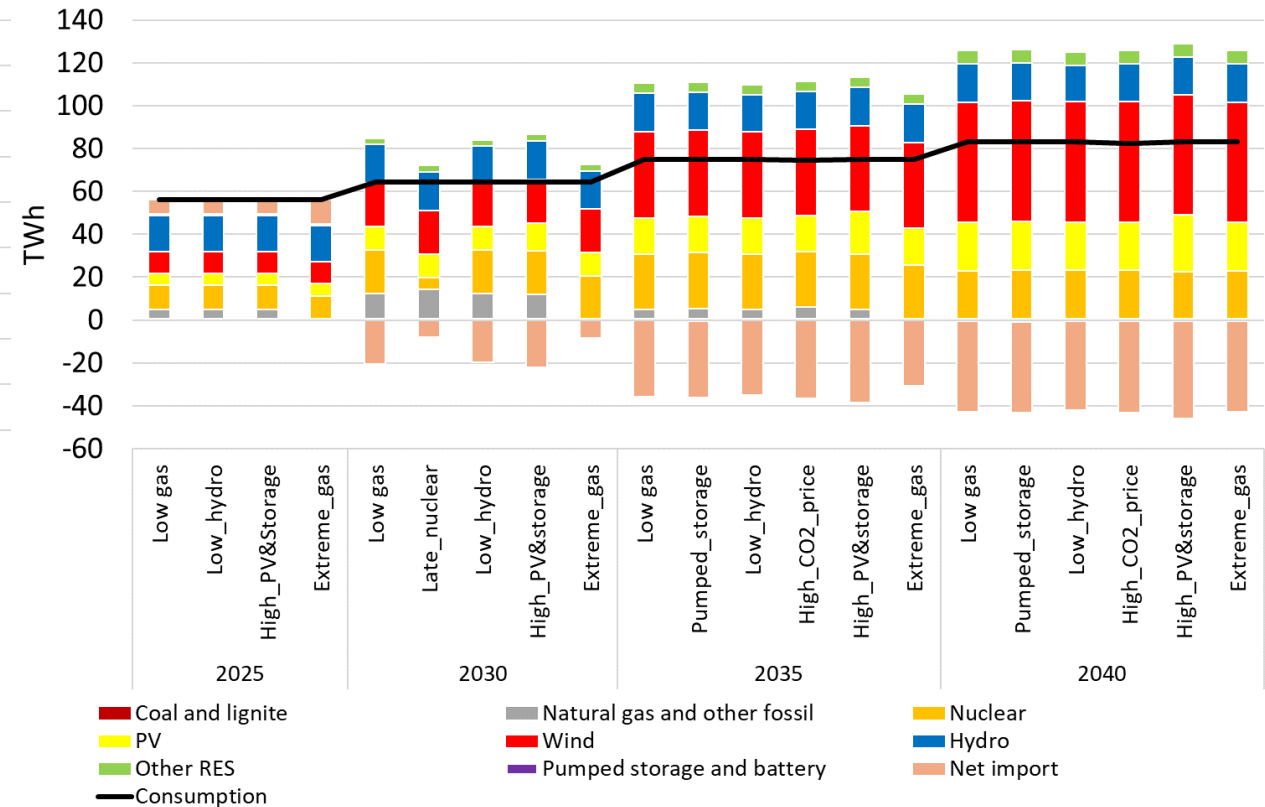
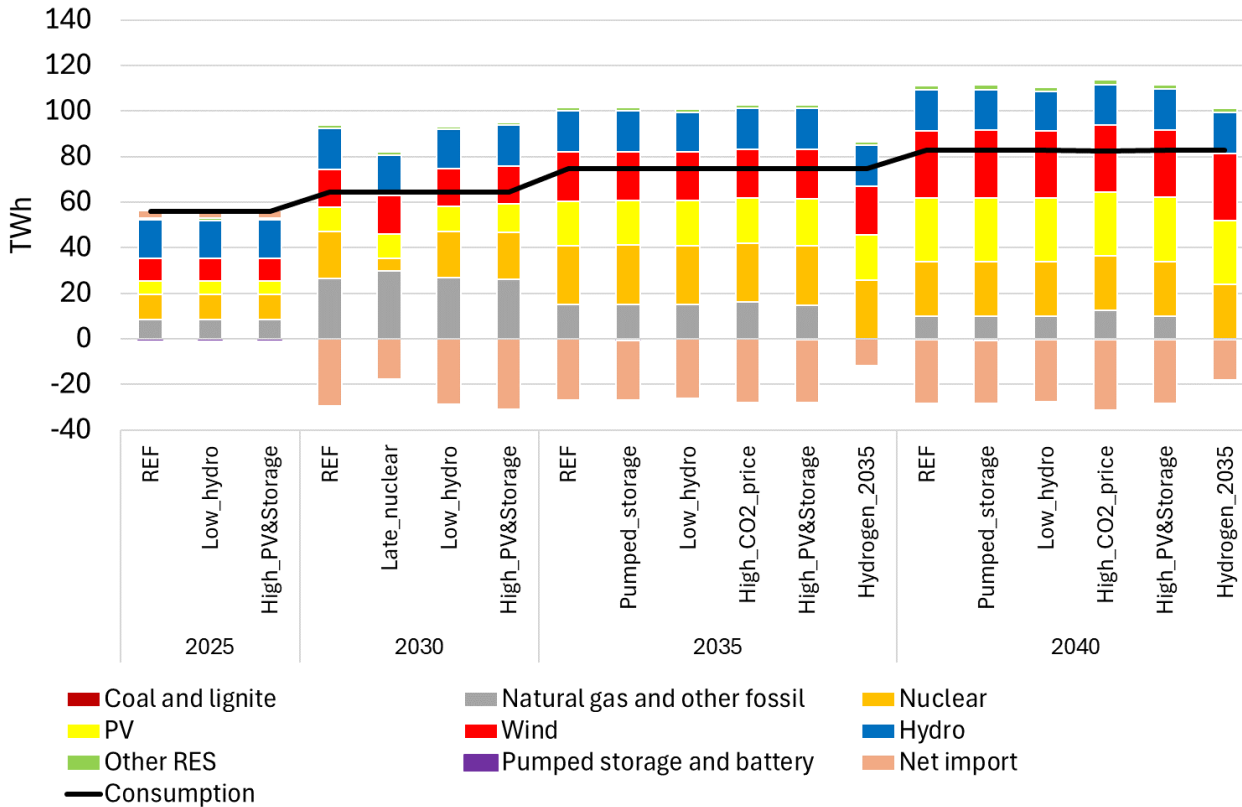
Pumped_storage scenario: In 2035 and 2040 additional 1000 MW of pumped storage capacity is modelled.

Low_hydro scenario: In 2025 run of river capacities are 77 MW less, in all other years this difference is 304 MW.

No difference in installed capacities in the **Hydrogen_2035** and **High_CO2_prices scenarios**.

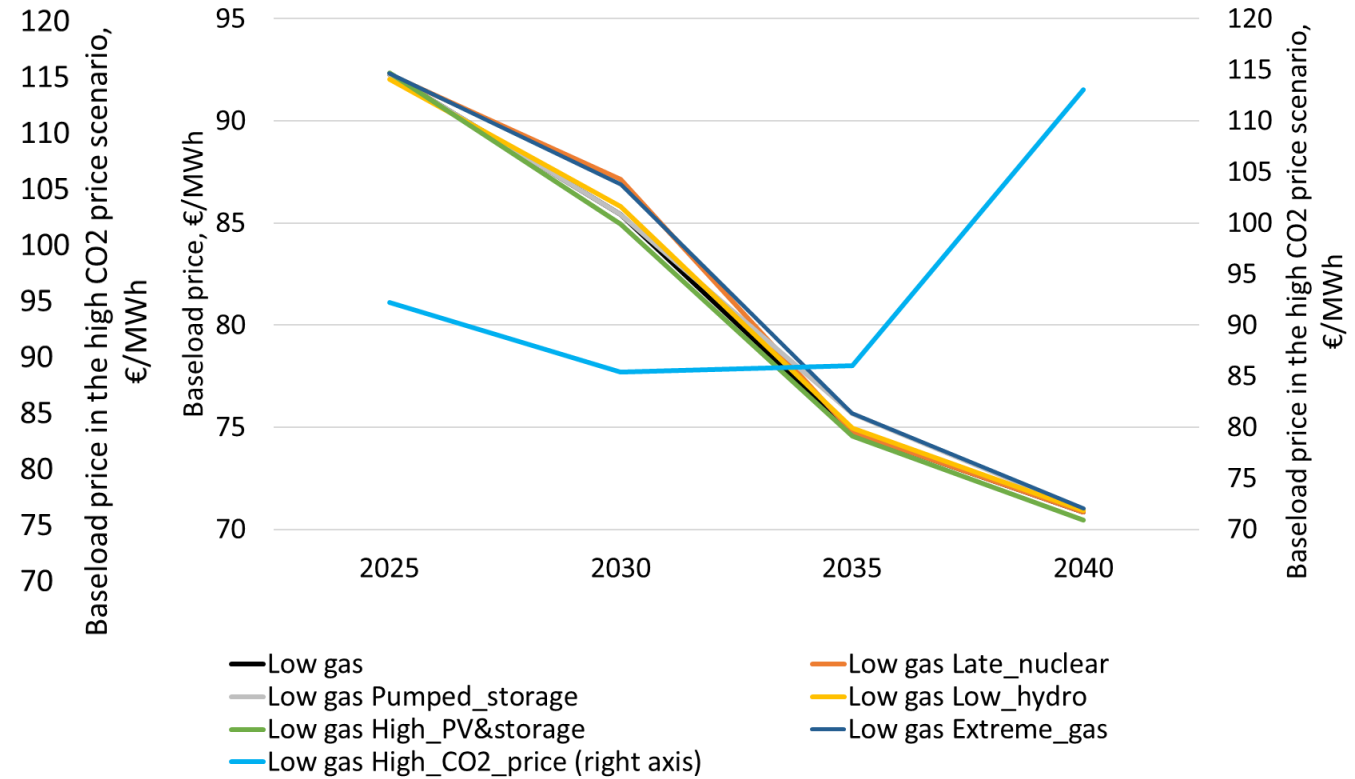
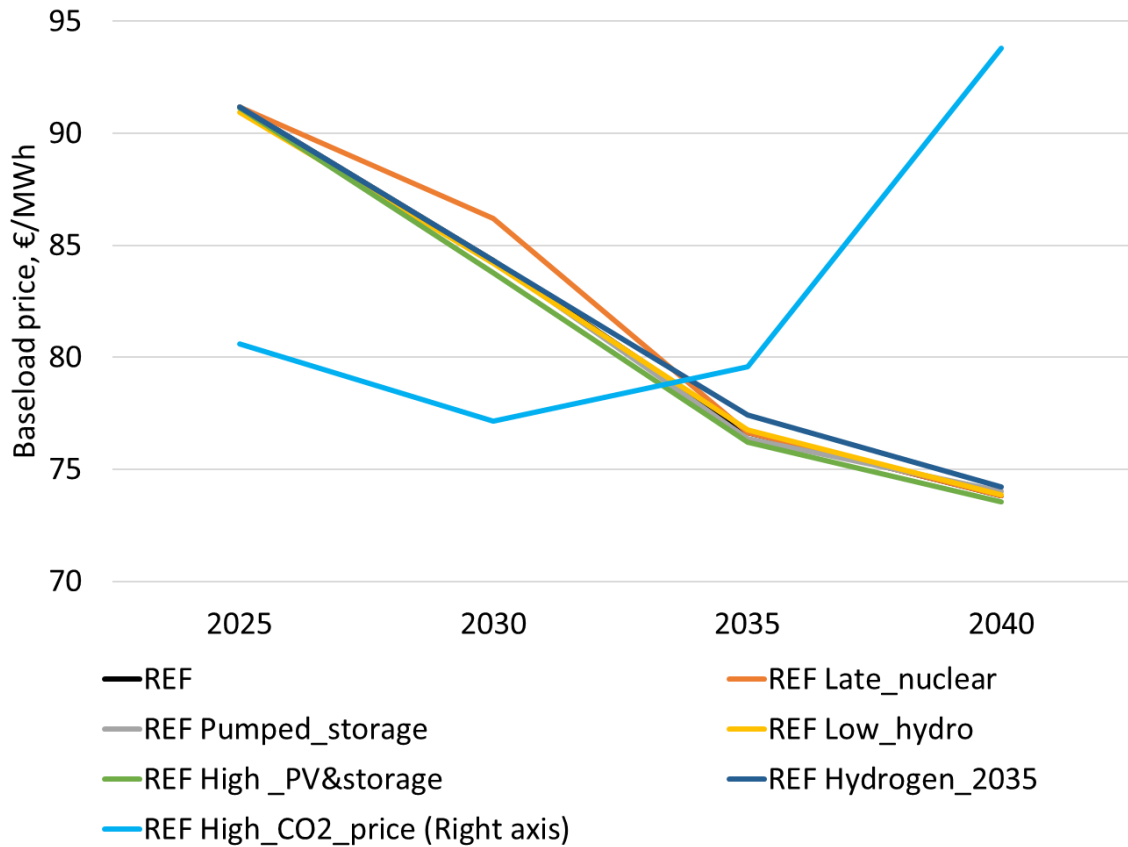
RESULTS OF THE MODELLING

Electricity mix



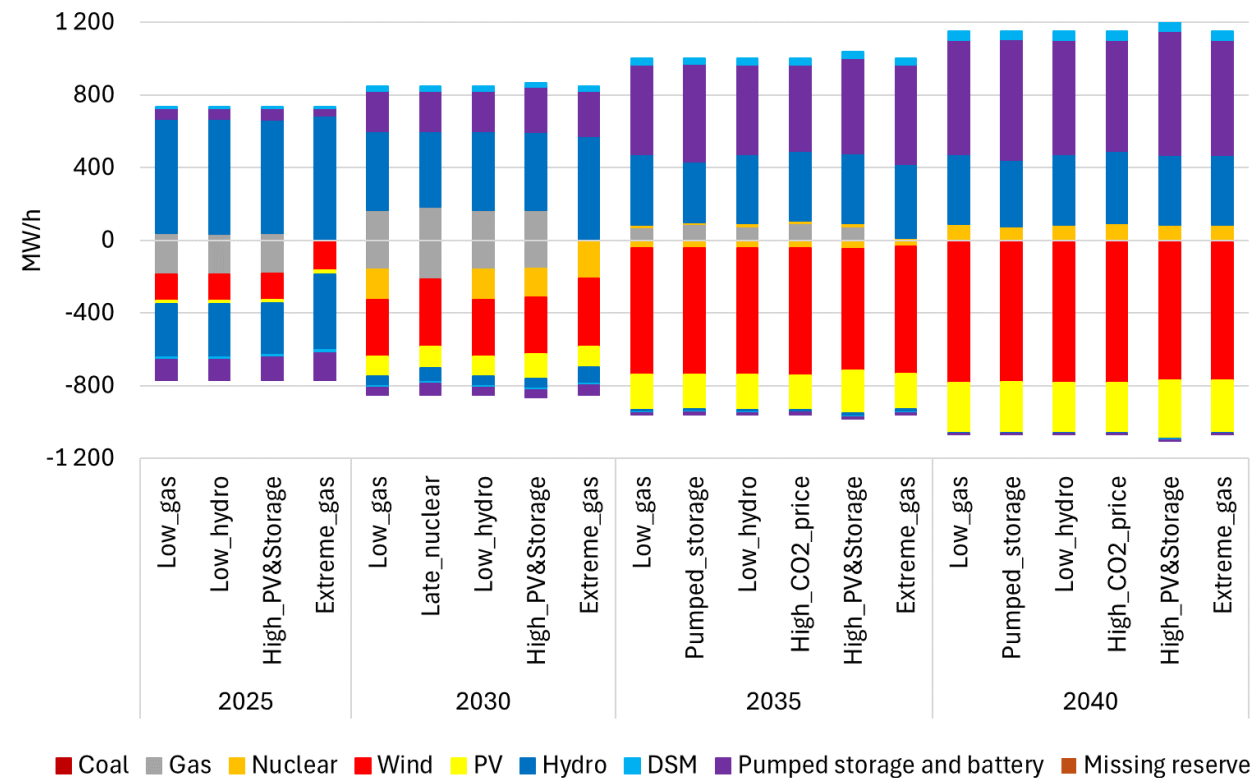
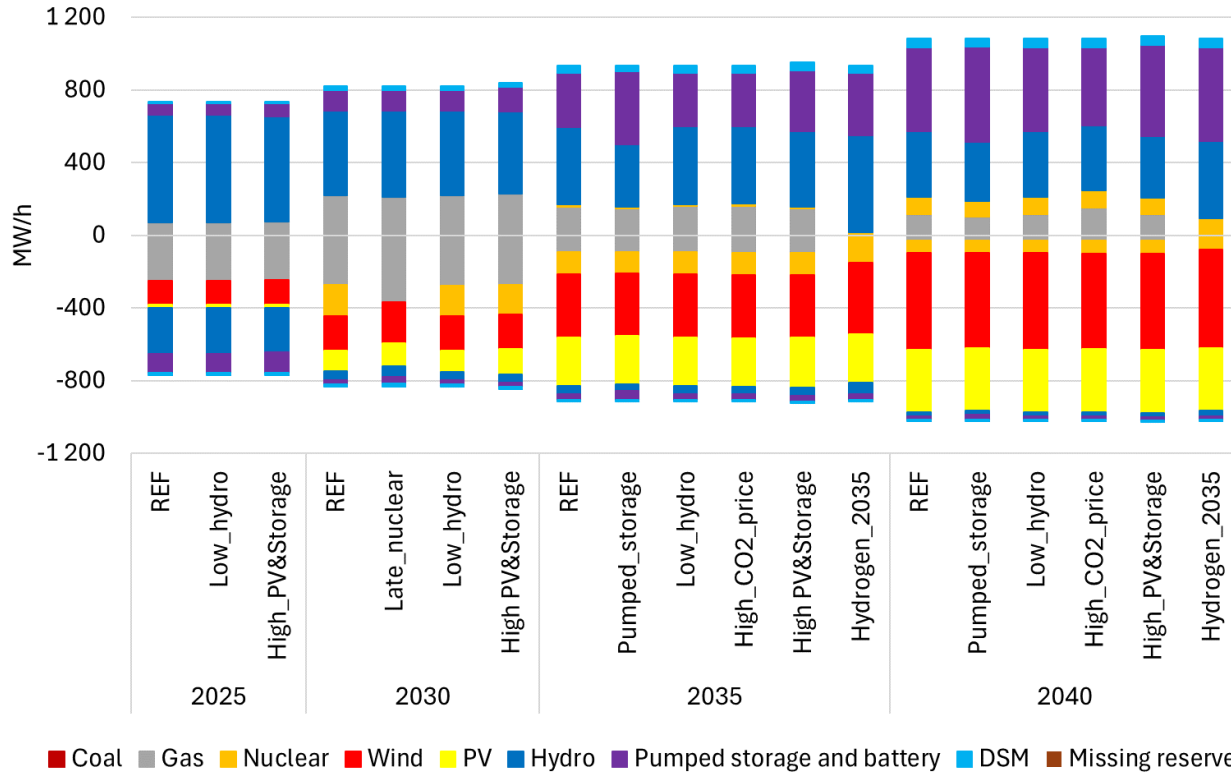
- **Reference scenario has higher gas-based production, but lower renewable based production** especially at the end of the modelling period.
- Late nuclear and Hydrogen_2035 scenarios have the largest effect on the electricity mix. The late deployment of nuclear facilities reduces the nuclear based power generation by around 9 TWh in 2030.
- In Hydrogen_2035 scenario production is significantly lower, as hydrogen-based capacities does not produce, their utilisation of hydro fuelled gas power plants are less than 1%.

Electricity price



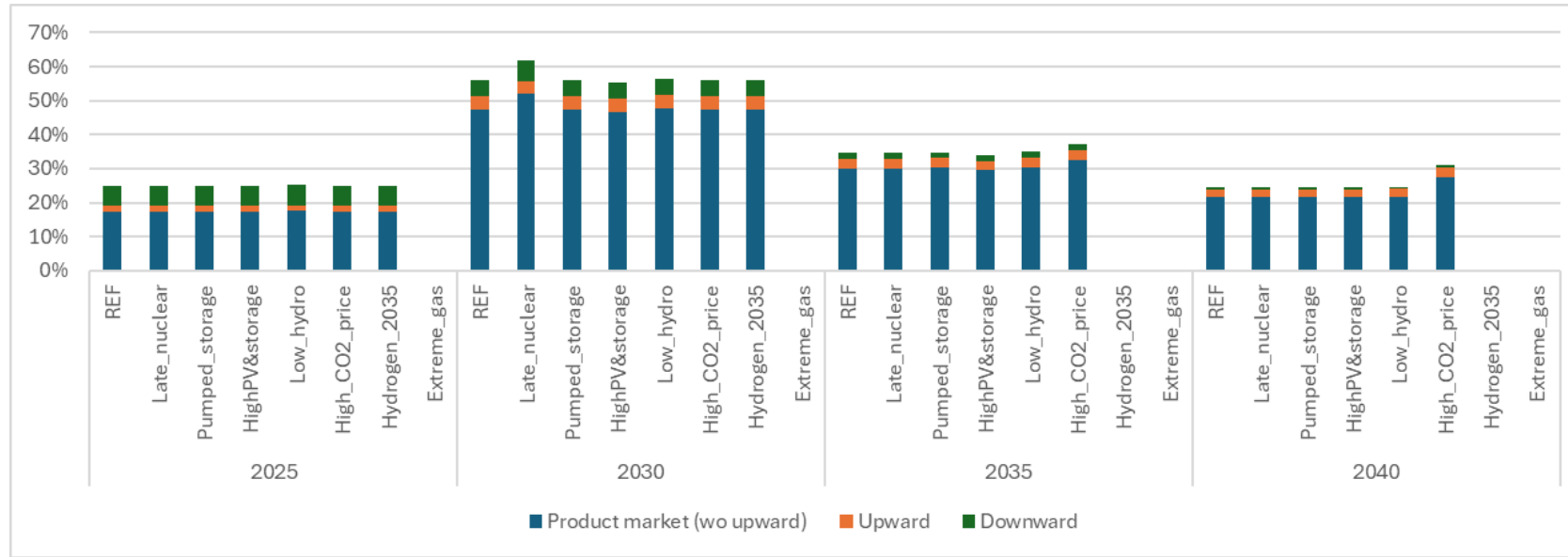
- Higher CO2 has the largest price increasing effect: 10-15 EUR/MWh in 2025, 35-45 €/MWh in 2040.**
 - CO2 price not only increase price through the direct effect in Romania, but through increasing prices in the whole region (and EU)
- Delayed completion of nuclear capacities increase** the baseload price by **1.5-2 EUR/MWh** relative to the reference in 2030

Reserve mix

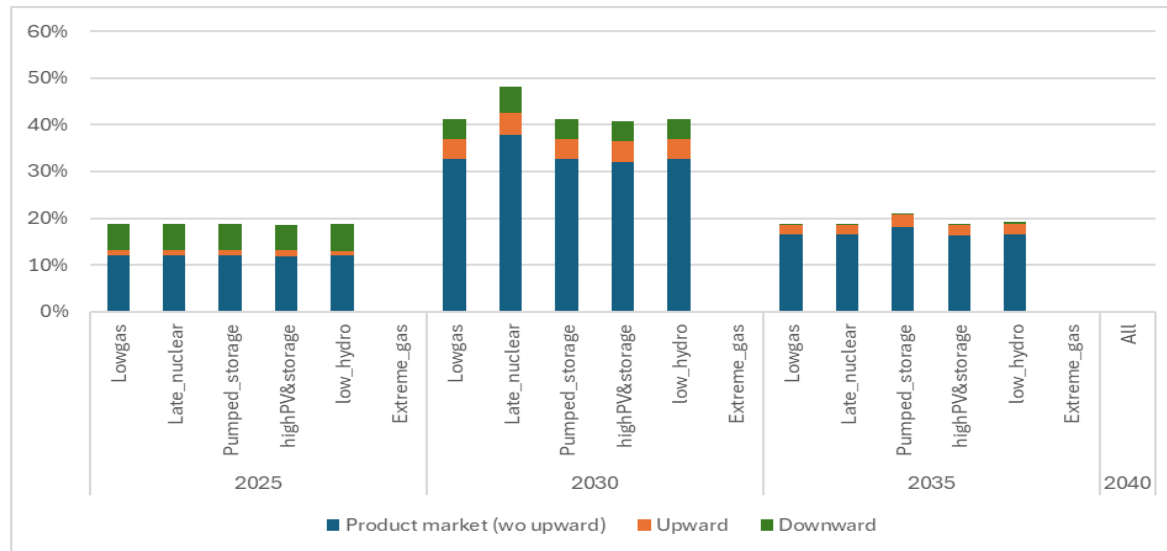


- **Reserve requirements can be met in both scenarios and in all modelled years.**
- The **role of natural gas is decreasing at reserve market** in both scenarios after 2030.
- Upward balancing capacity is mainly provided by hydro, natural gas, pumped storage and a growing share of batteries over time, while new nuclear capacity also participates to some extent in this market.
- In the downward direction, natural gas is mainly replaced by renewables and partly by nuclear over time.

Utilization of gas power plants

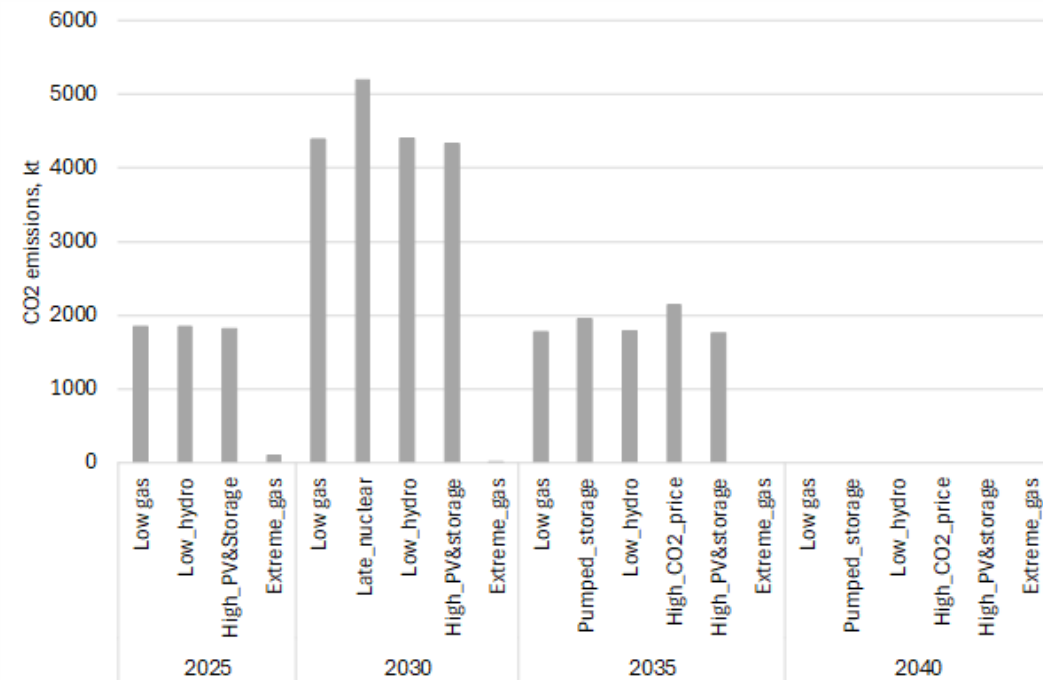
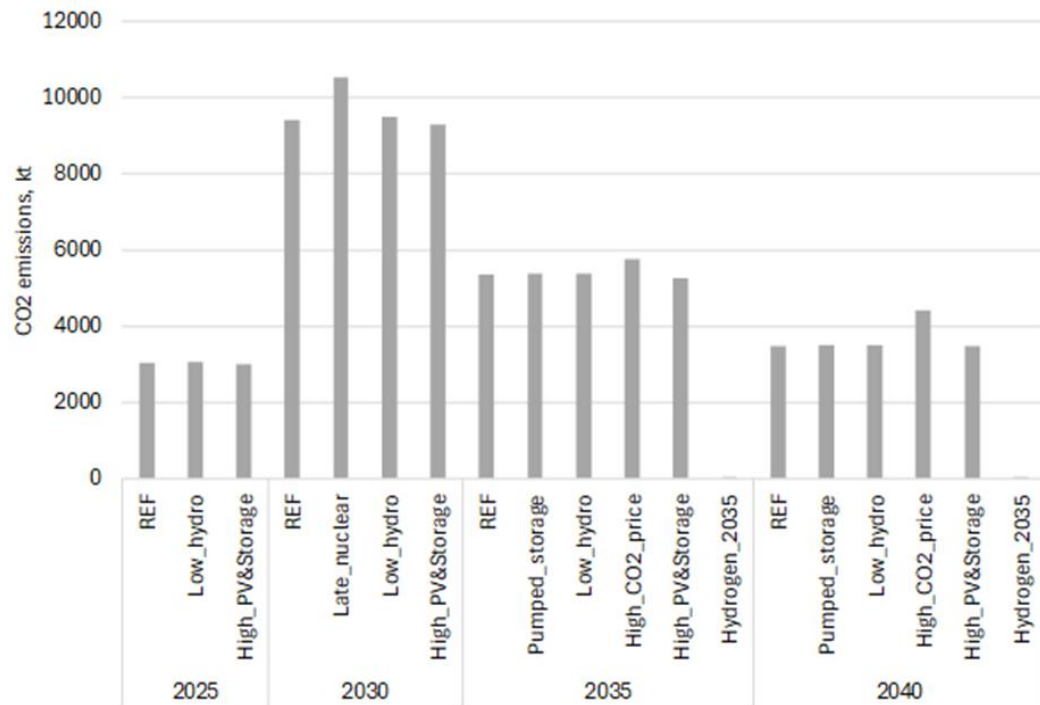


- Utilisation of gas power plants is higher in the reference case than in the Low gas scenario.



- Utilisation in the sensitivities are like reference and low gas, higher utilisation of gas is identifiable in the late_nuclear in 2030 and in the high CO2 from 2035.

CO2 emissions

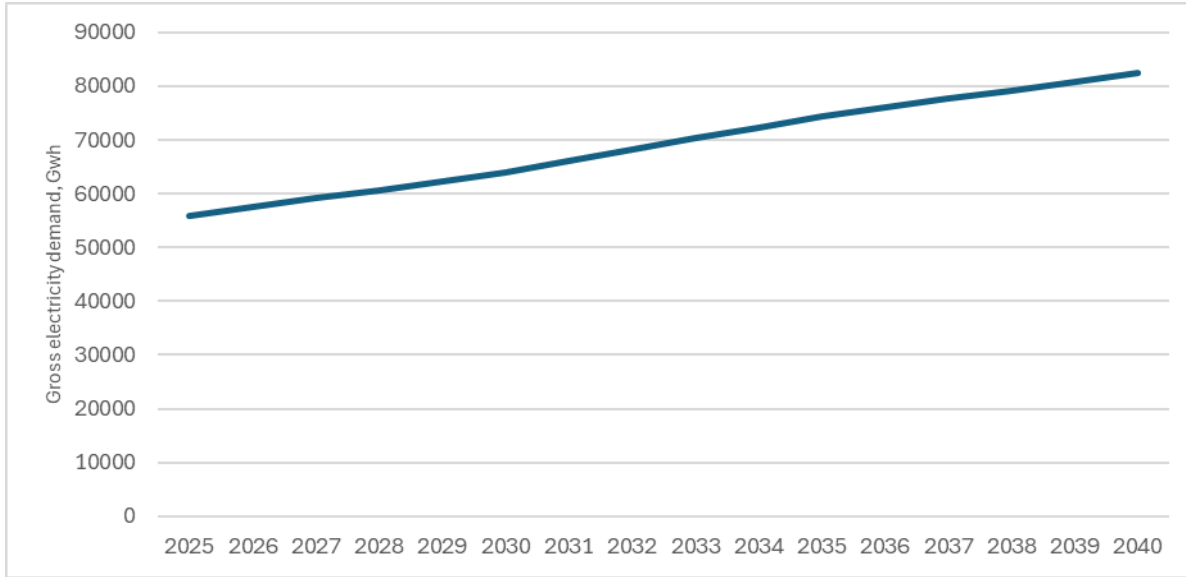


- The CO2 emissions are very much in line with the utilisation of gas power plant.
- Higher CO2 is associated with the late_nuclear scenario in 2030, the high_CO2 price and the pumped storage scenarios.
 - In high CO2 modern Romanian gas power plants substitute foreign, not coal plants with large emissions.
 - In pumped storage, the new power plant substitutes gas in the upward reserve market, the substituted gas however participate in the product market.

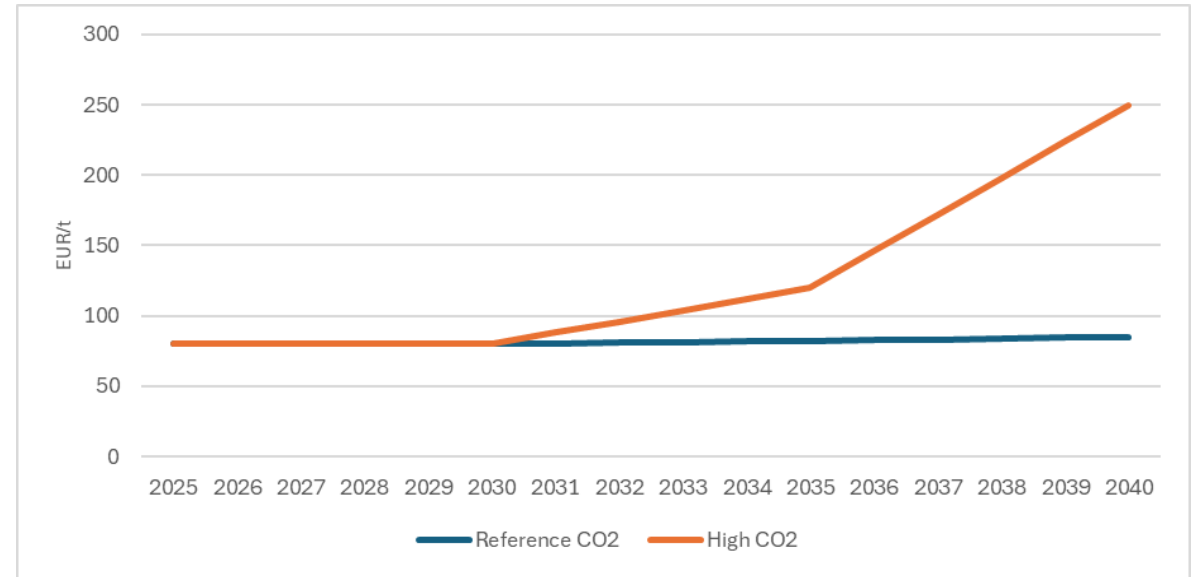
ASSUMPTIONS

Assumptions

Electricity demand - RO



CO2 price



Coal & Lignite prices

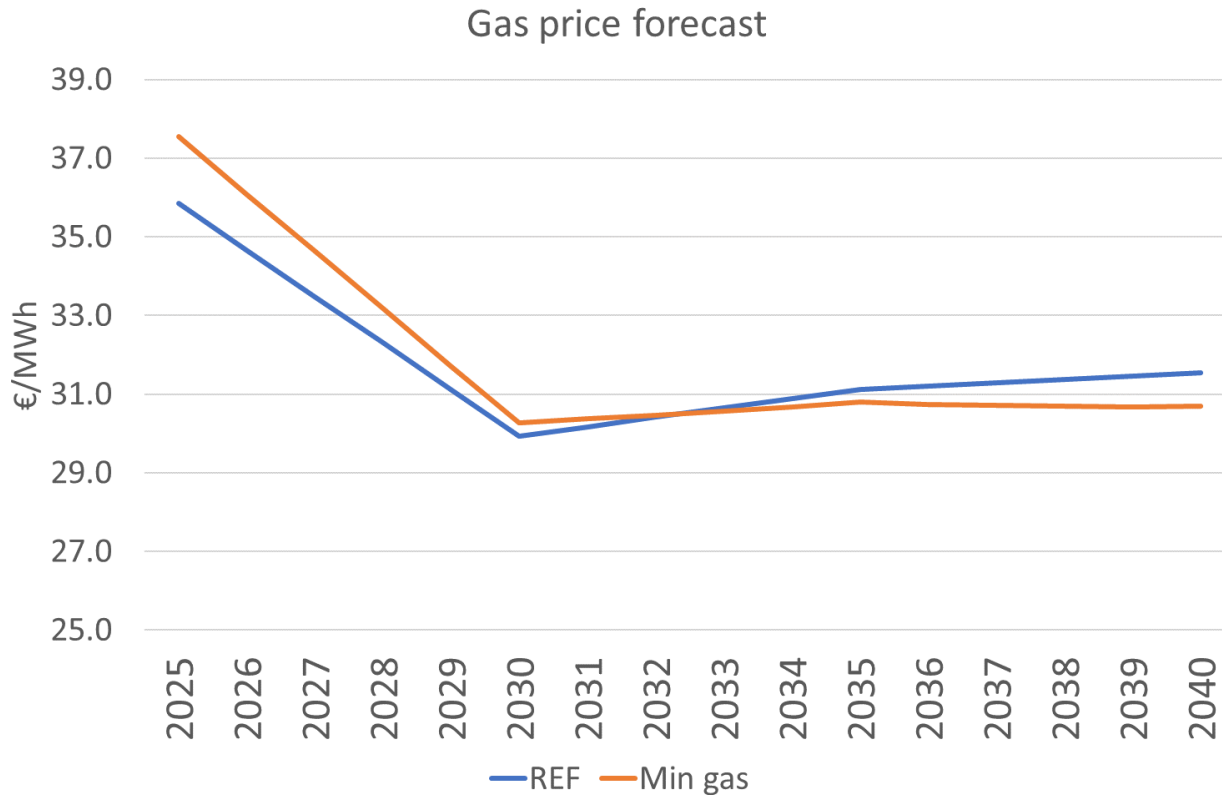
		2025	2030	2035	2040	2045	2050
Coal price	\$/t	104	53	48	48	48	48
	€/GJ	3.50	1.79	1.63	1.63	1.63	1.63
Lignite price in RO	€/GJ	2.77	2.77	2.77	2.77	2.77	2.77

New interconnection capacities - RO

New capacities				
Origin and destination country		Year of commissioning	NTC, MW	
From	To		O → D	D → O
RO	RS	2027	844	600
RO	HU	2027	617	335
RO	HU	2031	1117	685
RO	MD	2024	500	500
RO	MD	2029	500	500
UA	RO	2029	1000	1000
RS	RO	2030	680	720
GE	RO	2030	1000	1000
BG	RO	2025	600	600

- CO2 prices: EC proposed WEM and WAM scenario for NECP
- Demand: NECP of Romania
- Interconnectors: ENTSO-E TYNDP 2022
- Coal price: IEA WEO

Natural gas price development – Romania



Main assumptions:

- Moderate gas consumption decrease in EU (gas demand and production data is based on EU Primes reference scenario)
- 90% storage target for EU storages
- 30 bcm Russian import gas to Europe
- 35 €/MWh Japan price
- The two scenarios differ in the assumption for Romanian gas production and also take into account the different gas consumption of new gas-fired capacities.

Price development:

- The price in minimum gas scenario is slightly higher until 2035 due to the lower RO production
- By 2040 the relationship changes, as Romanian production in the reference is assumed to decrease again

The assumed gas production in Romania:

bcm	Reference scenario					Min gas scenario				
	Existing fields	Midia	Neptun deep	Caragele deep	Total	Existing fields	Midia	Neptun deep	Caragele deep	Total
2025	8.04	1	0	2	11.0	8.04	1	0	0.08	9.1
2030	5.64	1	10	2	18.6	5.64	1	6	2	14.6
2035	3.17	0	10	2	15.2	3.17	0	10	2	15.2
2040	1.47	0	0	0	1.5	1.47	0	6	2	9.5