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Pathways to climate neutrality in Europe with a spotlight in Greece, Athens, June 30, 2022

Greek NECP and Climate Law: are they ambitious enough? The role of natural gas en route to decarbonisation

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www.paris-reinforce.eu

REF — NECP (Reference Scenario) (2019)

CL — Climate Law (2022)

HA — High Ambition

The PARIS REINFORCE project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No 820846.

NECP (Reference Scenario) (2019)

Increased EV registration

30% registration by 2030

Reduced fossil fuel usage for energy generation

No lignite after 2028, 65% RES by 2030

Substitution of oil with natural gas

Higher use of NG (up to 50%, depending on the sector)

Energy Saving

1,1% of households and tertiary buildings refurbished annually

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On top of the Greek NECP scenario:

Prohibition of new fossil-fueled cars after 2030

100% of registered cars are EVs after 2030

Prohibition of new oil boilers after 2025

0% oil in household heating by 2040

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Faster rate of EVs registration

Doubling the registration of EVs in comparison to the Greek NECP scenario. 100% passenger EVs by 2050

Ambitious penetration of RES

80% RES by 2030 and 100% by 2035 in electricity generation; smooth natural gas phase-out by 2035

Faster rate of energy saving

Doubling the NECP building refurbishment rate

Phase-out of oil & natural gas by 2035 for heating

Substitution of oil and gas with heat pumps in heating

Hot water only from solar boilers by 2030

All boilers are solar by 2030

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Modelling Framework

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LEAP

Sectors:


Buildings (incl. tertiary, households)


Transport


Industry


Agriculture

Input:


Population Number of households

GDP


Economic activity across sectors


Technology (& efficiency) assumptions (e.g., % of EVs)

Output:


Fuel demand per sector


Electricity demand per sector

OSeMOSYS

Open Source Energy Modelling System

Technologies:


RES electricity generation


Fossil-fueled electricity generation

Input:


Electricity demand per sector


Energy policies


Techno-economic variables

Output:


Investments per technology

CO_2 emissions


Electricity generation per technology

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Energy demand for each scenario

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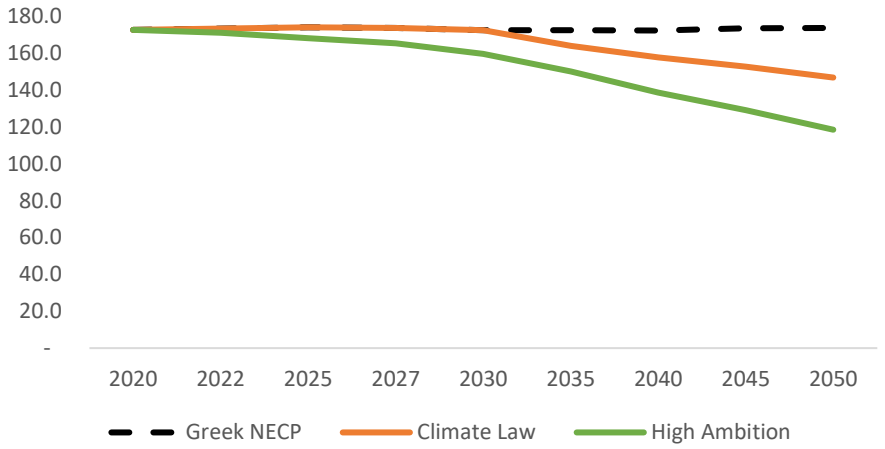
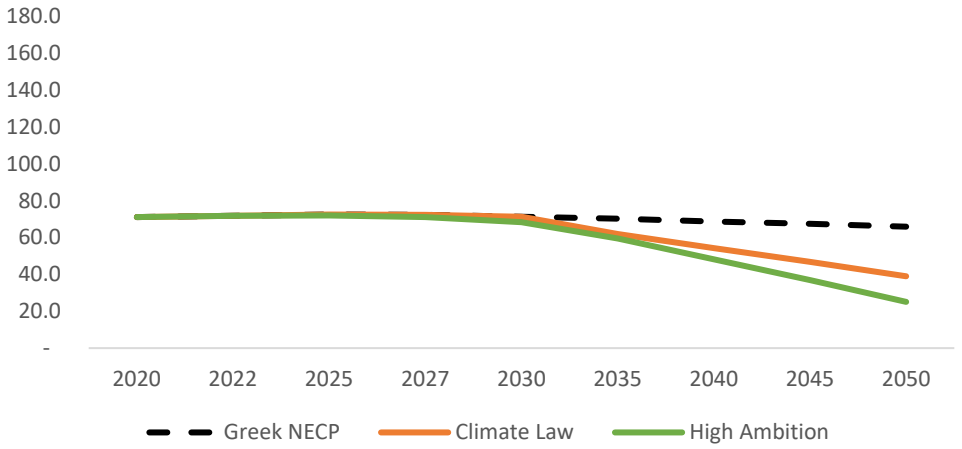
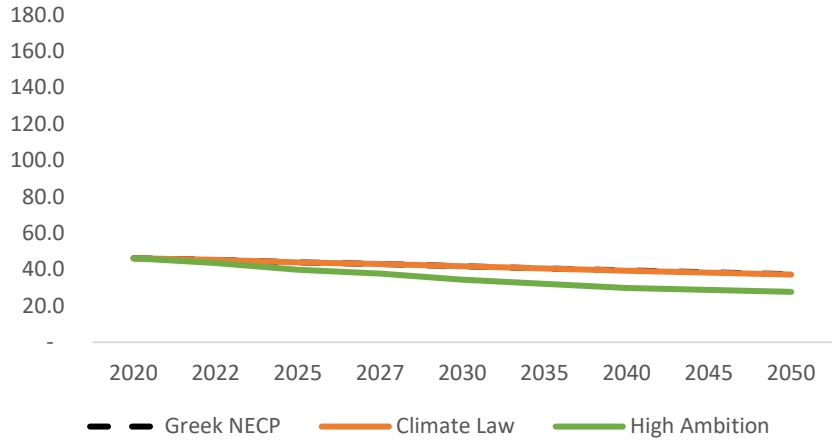
Total energy demand* (TWh)



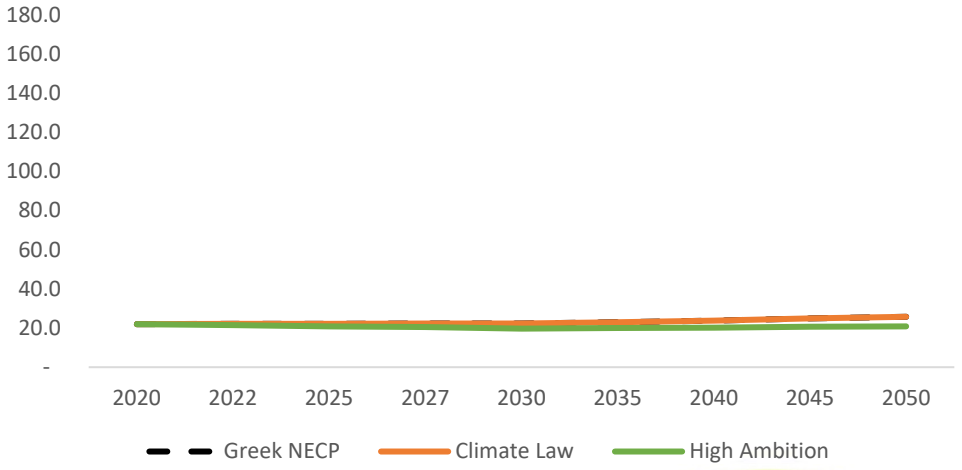
Transport energy demand (TWh)



Household energy demand (TWh)



Tertiary energy demand (TWh)



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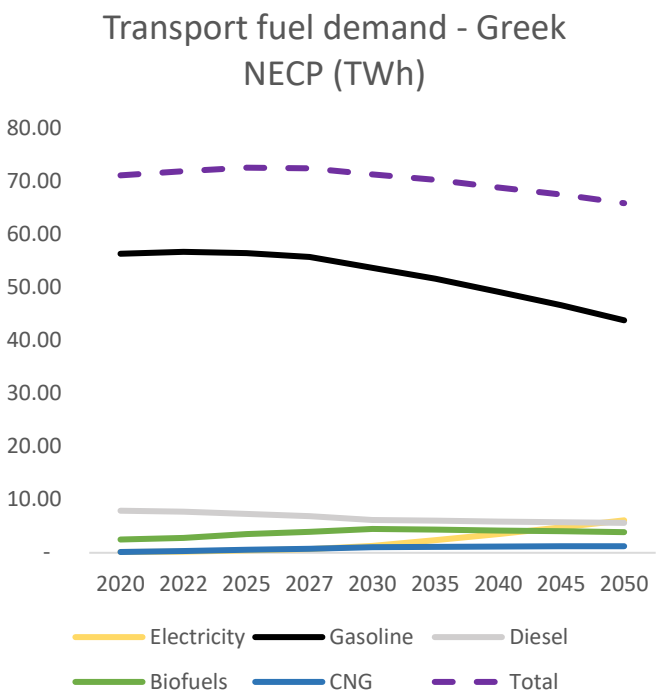
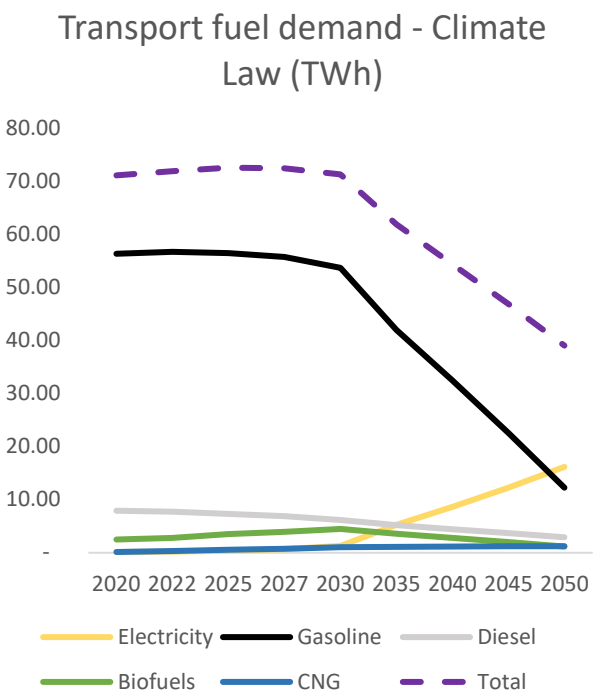
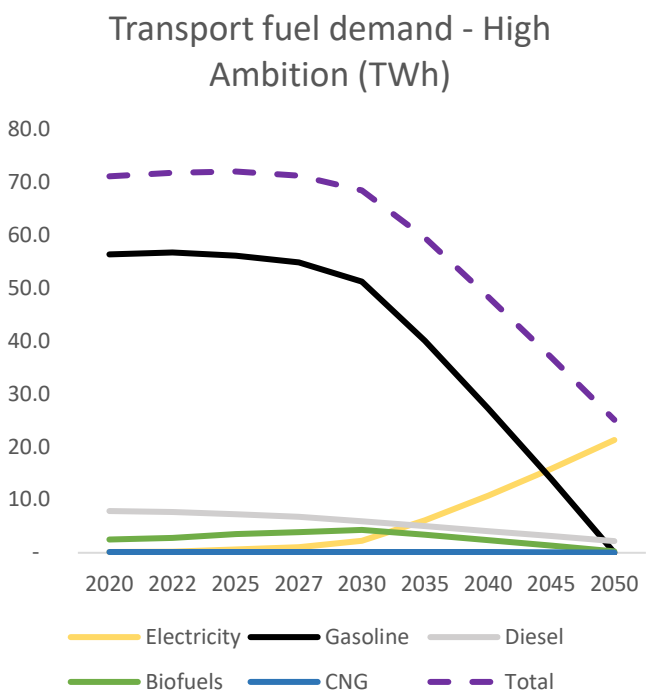
*including agriculture and industry

Energy demand on the transport sector per fuel







- E-mobility to different extents; fluctuations as EVs are more efficient than fossil-powered vehicles.
- NECP: Low increase of EVs, low drop of energy demand
- Climate Law: Moderate increase of EVs, significant drop in gasoline demand, drop in total demand
- Both NECP and Climate Law: slight increase of CNG (NG increase in all sectors, assumed in NECP)
- High ambition: High EV penetration, zero gasoline, big drop in total demand, diesel still in freight

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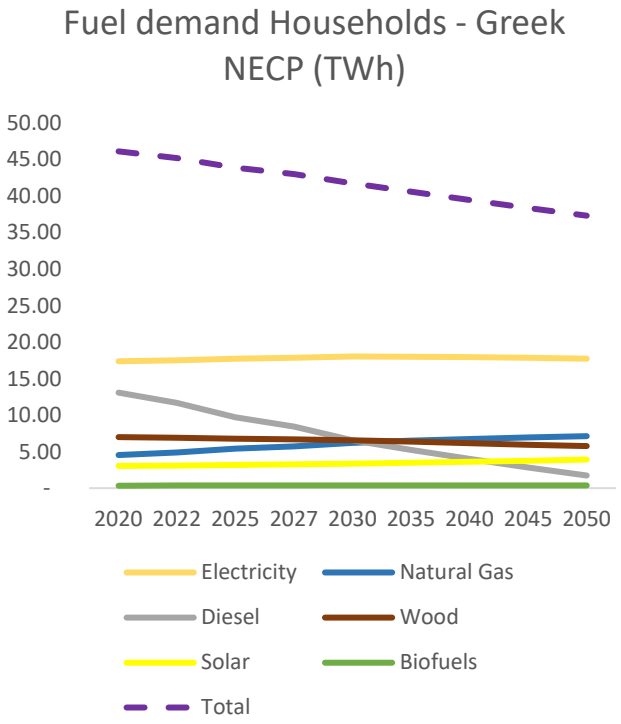
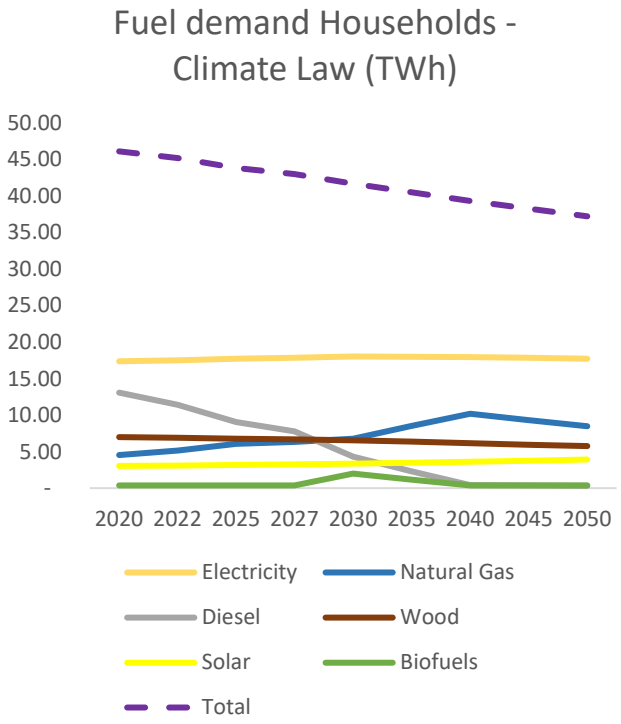
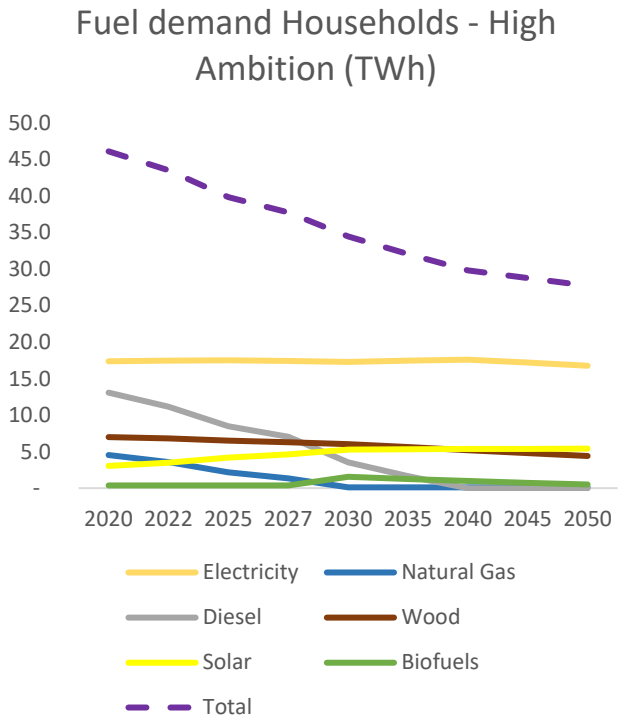
Energy demand on the household sector per fuel







- Energy savings across all scenarios but with varying ambition
- NECP and Climate Law: same ambition of energy savings; small differences due to new oil boilers ban, increase in biofuels (w/ diesel). In latter, NG over oil, diesel = 0 in 2050 (boiler ban post-2025)
- High ambition: important energy demand drop (refurbishment rate > heating electrification)

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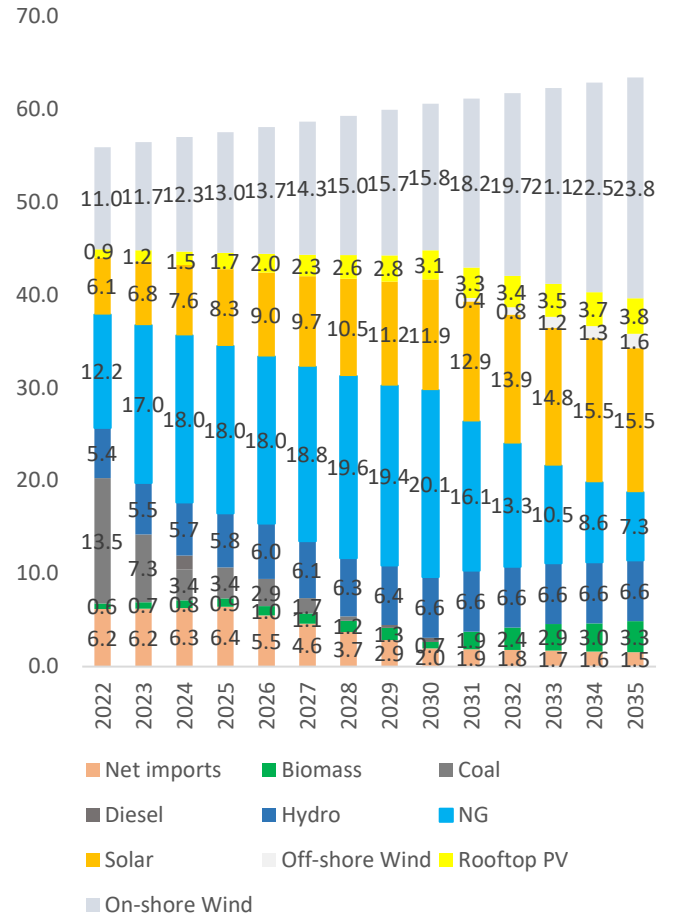
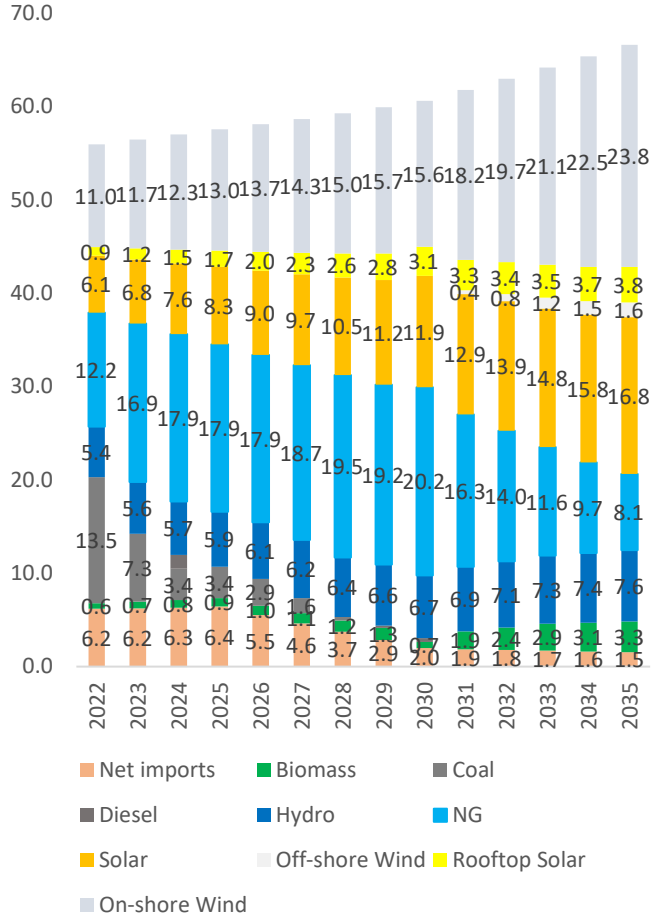
Electricity Generation

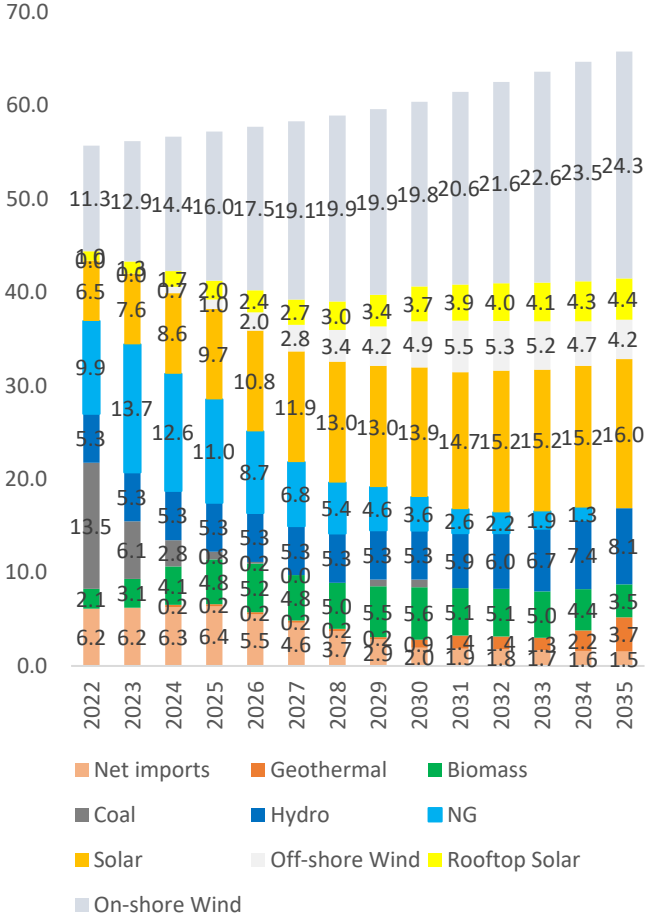
Electricity Generated per technology - Greek NECP (TWh)



Electricity generated per technology – Climate Law (TWh)



Electricity generated per technology – High Ambition (TWh)



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Capacity installed

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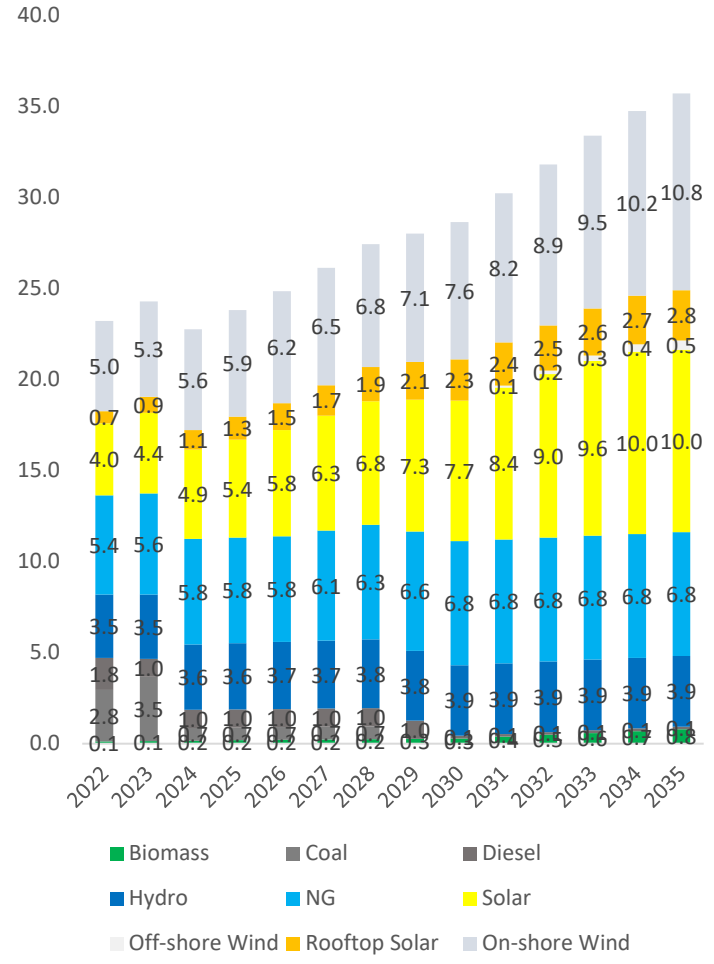
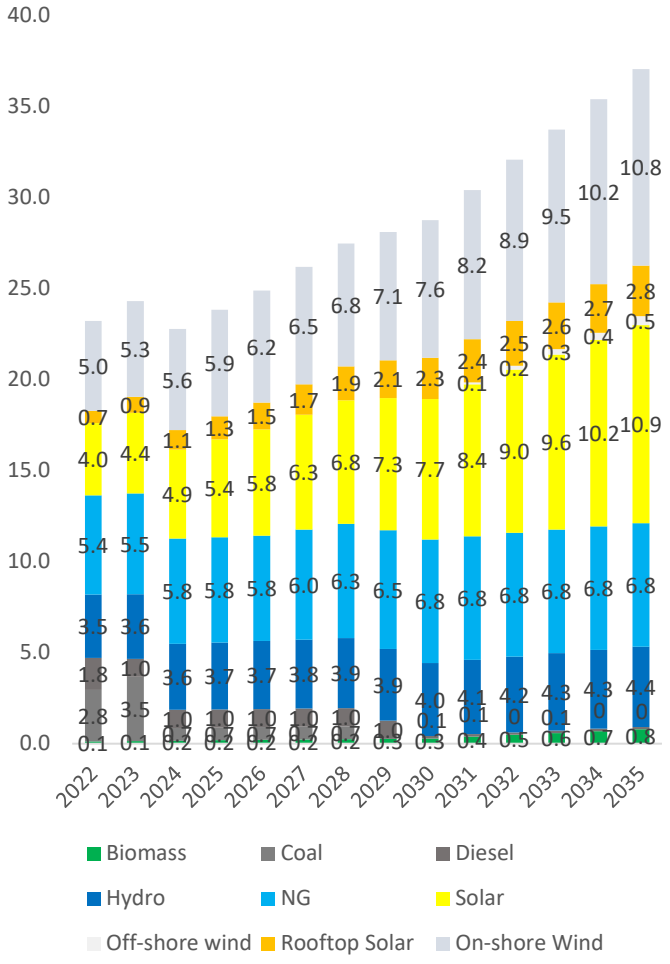
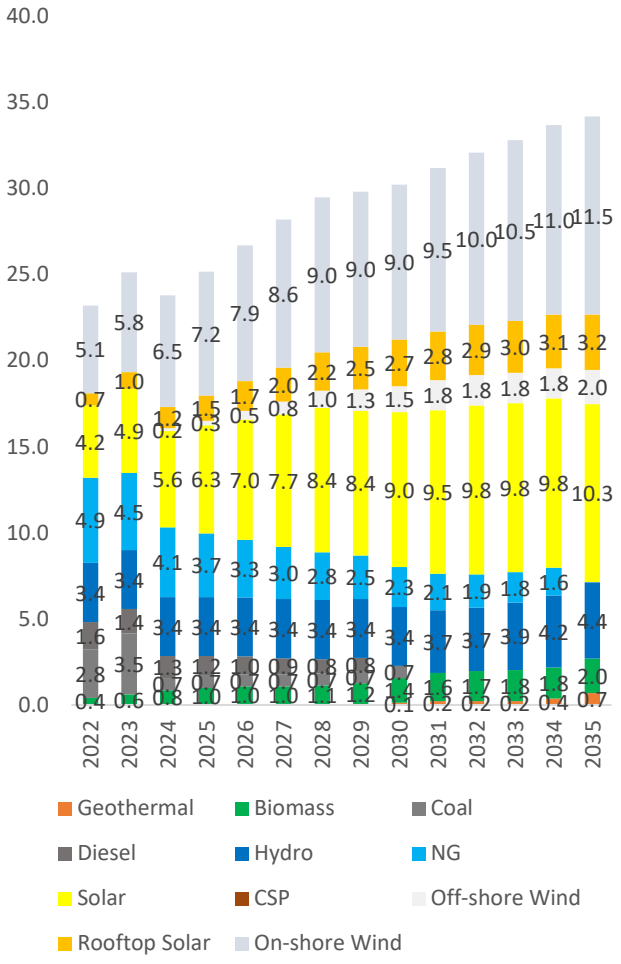
Installed Capacity per technology - Greek NECP (GW)



Installed Capacity per technology – Climate Law (GW)



Capacity installed per technology - High Ambition (GW)



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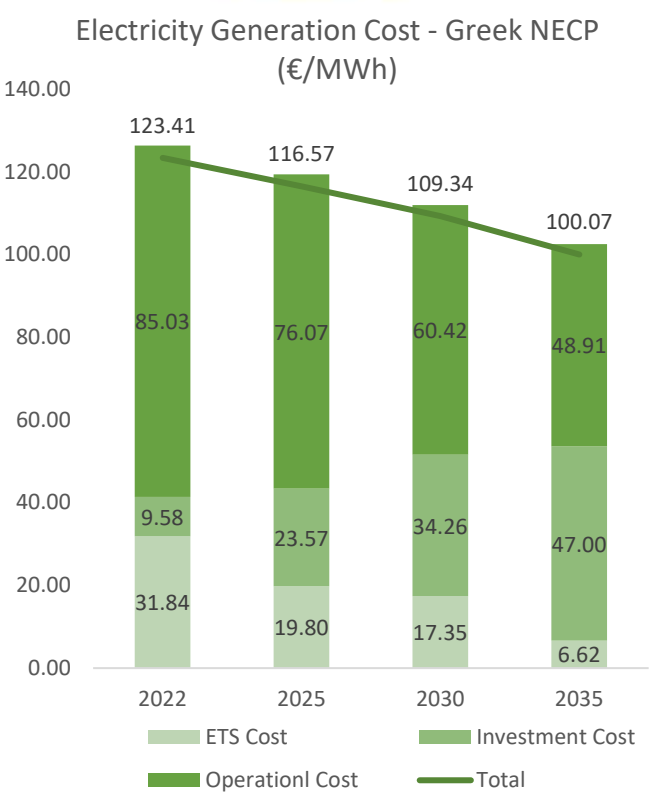
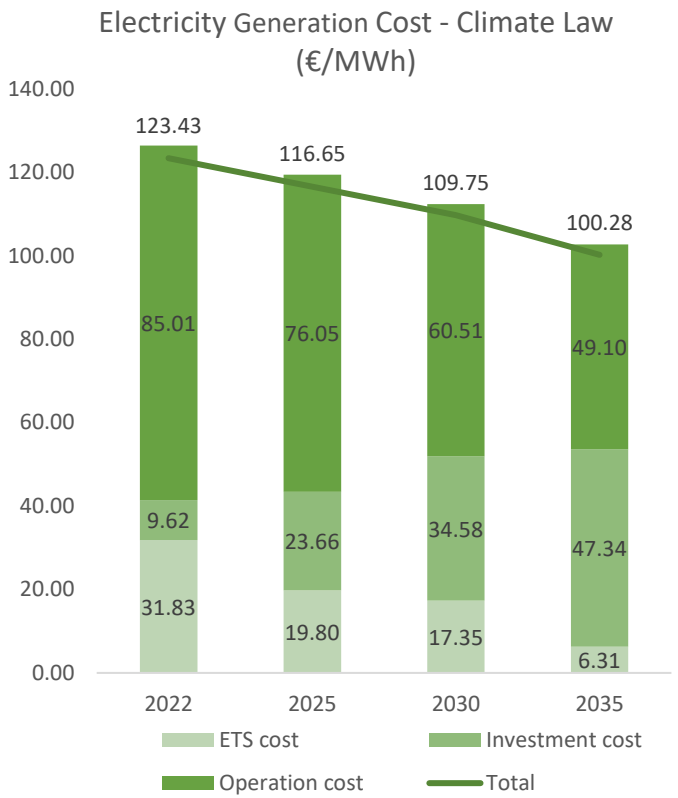
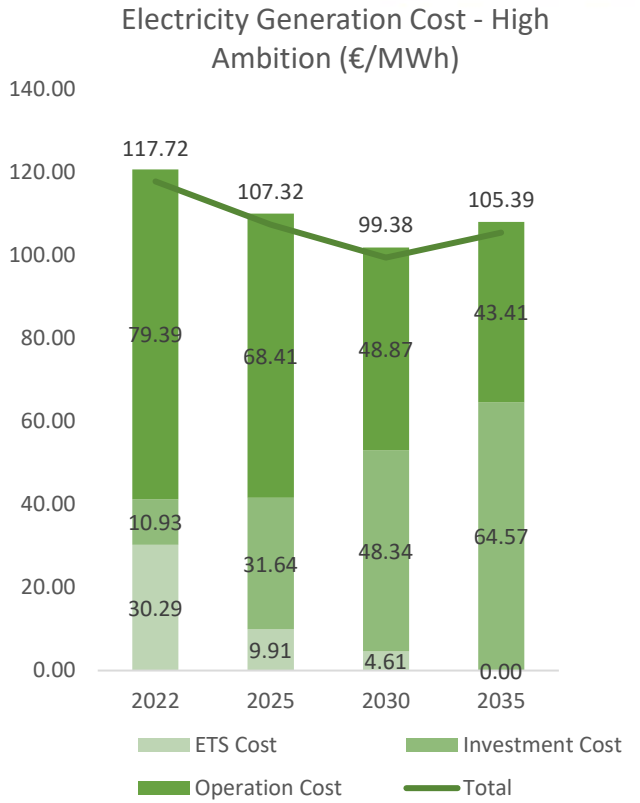
Electricity Cost







- NECP and Climate Law: downward tendency on electricity prices (lower ETS costs)
- High Ambition: 0 ETS costs, increasing electricity price post-2030 (investments for 100% RES target by 2035.
- Average cost in 2022-2035: NECP & Climate Law ~113 €/MWh, High Ambition ~107 €/MWh

ETS prices from 2020 EU Ref scenario, Fossil fuel prices from IEA WEO 2021, see Annex

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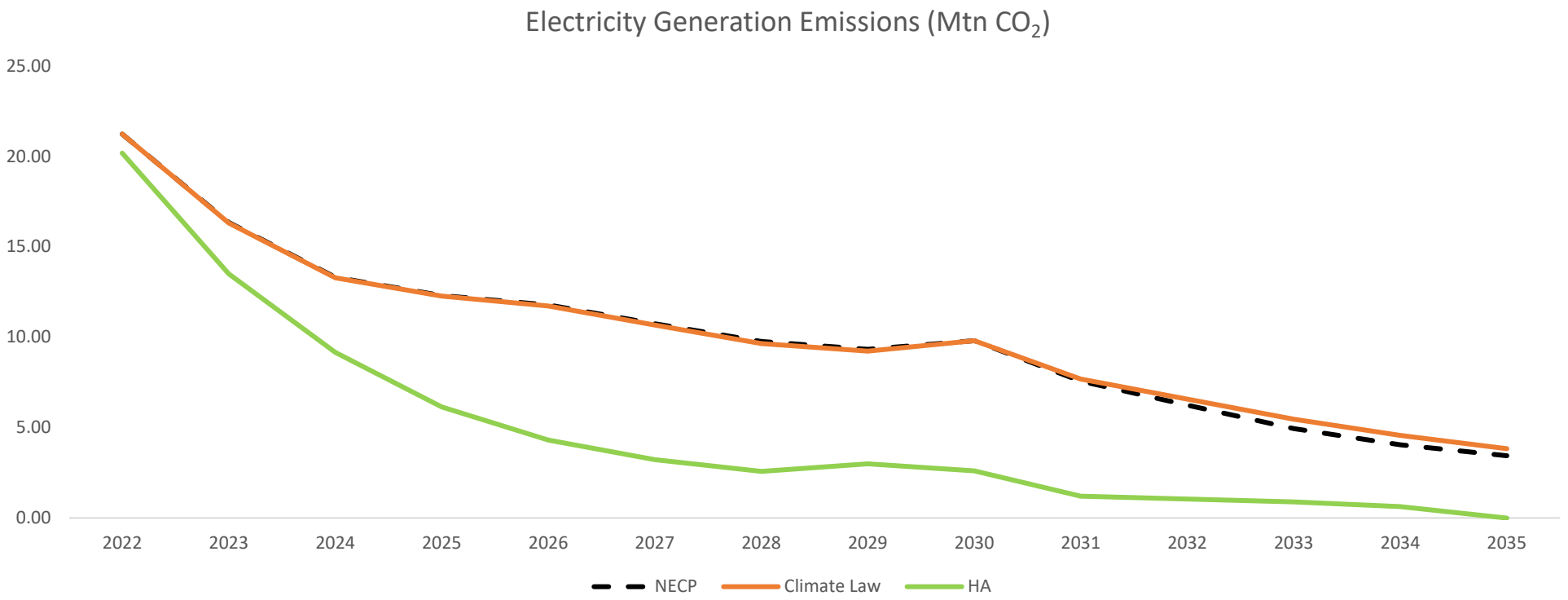
Electricity Generation Emissions



- NECP and Climate Law: similar emissions (same electricity mix with slight changes in energy demand patterns). Climate Law slightly higher (EVs: higher electrification)
- High Ambition: significant difference in emissions aiming for higher RES penetration, reaching 100% by 2035, zeroing electricity generation emissions.

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Additional Costs and Infrastructure

There is a very critical caveat regarding our modelling exercise.

Apart from costs related to investments in new electricity plants, there are also other costs, that cannot be endogenously calculated in typical energy system models, such as OSeMOSYS or LEAP.

In our case, the most notable relevant costs are linked to two different types of infrastructure:

1. Natural Gas Infrastructure (e.g., FSRU plants and Pipelines to other countries)

2. Electricity grid upgrades (e.g., energy storage capacity and expansion of the grid)

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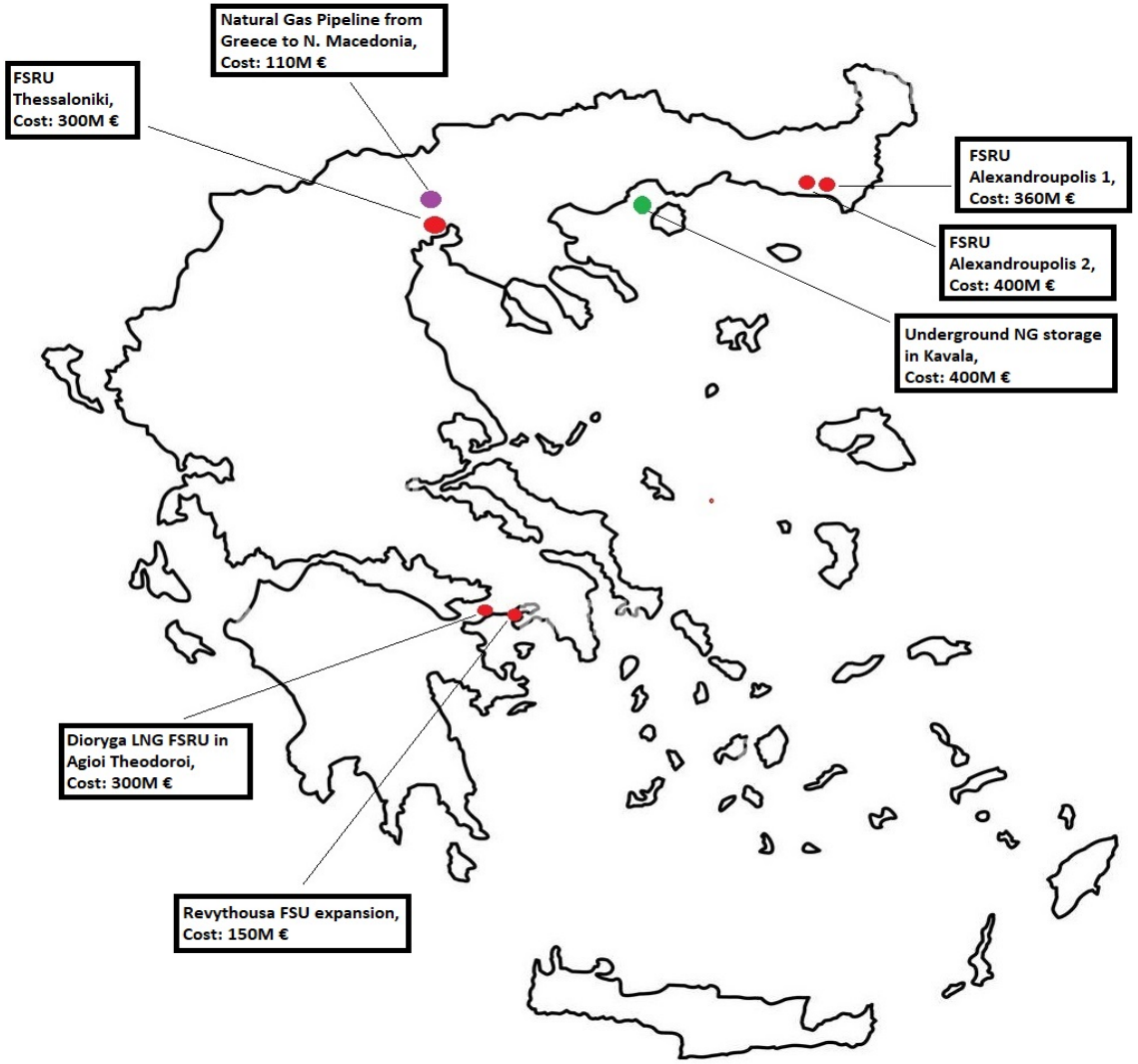
Natural Gas Infrastructure



Total Capital Cost: 2.02 billion €
Total maximum NG supply: 22.26 bcm
Total storage capacity of NG: 1.467 bcm
Total annual operation cost: 41.6 million €

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1. Electricity Storage Required for 80% and 100% RES

Total energy storage capacity required: 2.13 GW (100% RES)
Total Cost: Ranges from 0.672 billion € to 3.784 billion €

2. Electricity grid expansion required for 100% RES

Total Cost: At least 5.615 billion € (adapted from ENTSO-e assumptions), and could very well exceed 10.5 billion € (adapted from NECP document assumptions), additionally to the Greek NECP costs

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Thank you!

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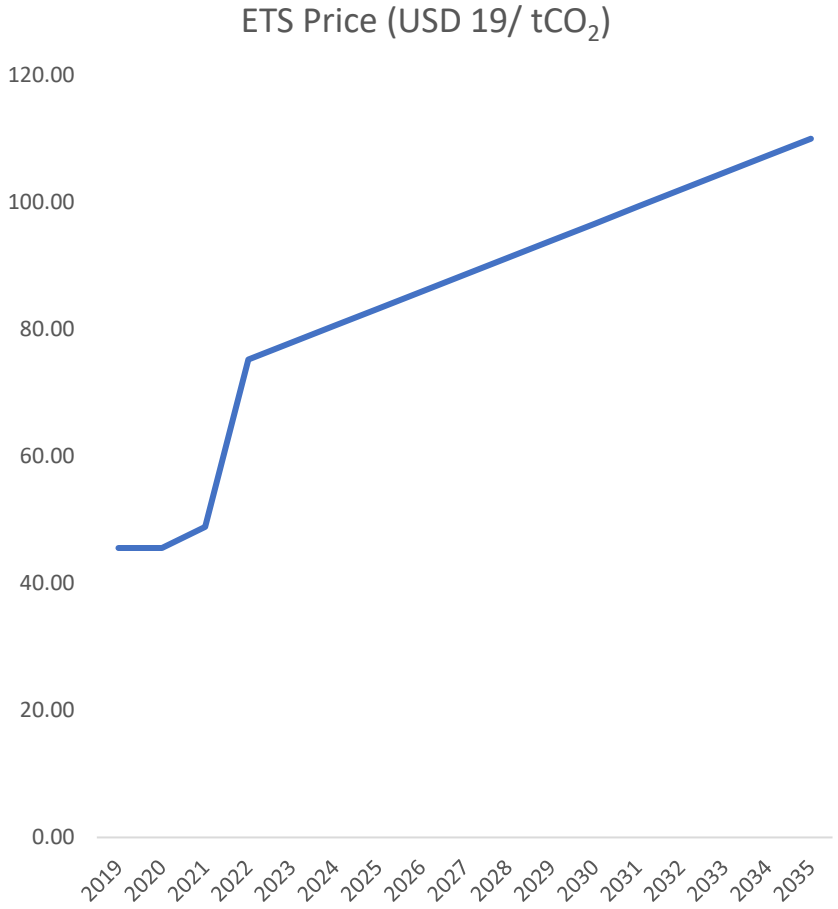
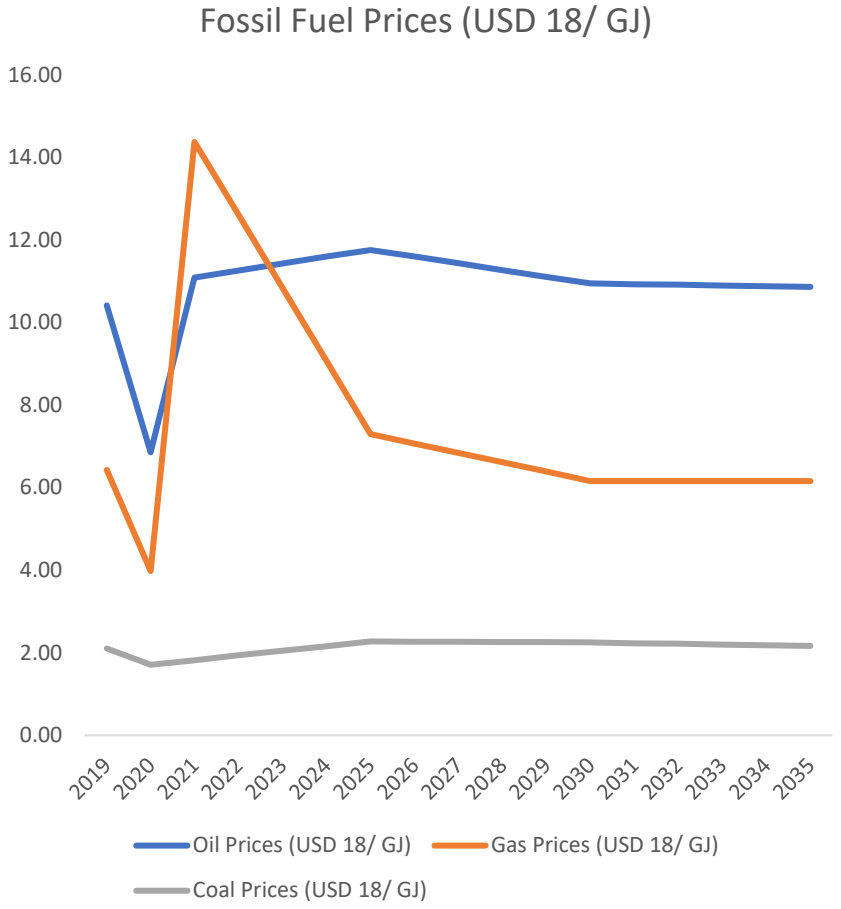
Annex – ETS and Fossil Fuel Prices





Sources: EU ETS price (real data to 20222; onwards from EU Ref scenario, 2020); Fossil fuel prices (IEA World Energy Outlook, 2021)

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