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Gas Crisis Analysis

Short-term analysis of power prices in Sweden
10th April 2022

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Agenda

1. Introduction
2. Methodology
3. Fuel price assumptions
4. Main results
   - Key results
5. Sensitivity results
   - Key results
6. Uncertainties

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INTRODUCTION

Objective

- How will the Ukraine crisis affect the Nordic power market in the coming years?
- How may the crisis be mitigated?

- Three fuel price scenarios:
  1. **BAU**: Pre-crisis prices
  2. **High prices**: Current forwards
  3. **Gas crisis**: Extremely high gas price prices

- Three mitigation scenarios based on the Gas Crisis scenario:
  1. **Demand reduction** – *5% reduction of classic demand*
  2. **Fast-tracking renewables** – *increasing buildout of solar and onshore wind*
  3. **Thermal power plant extension**

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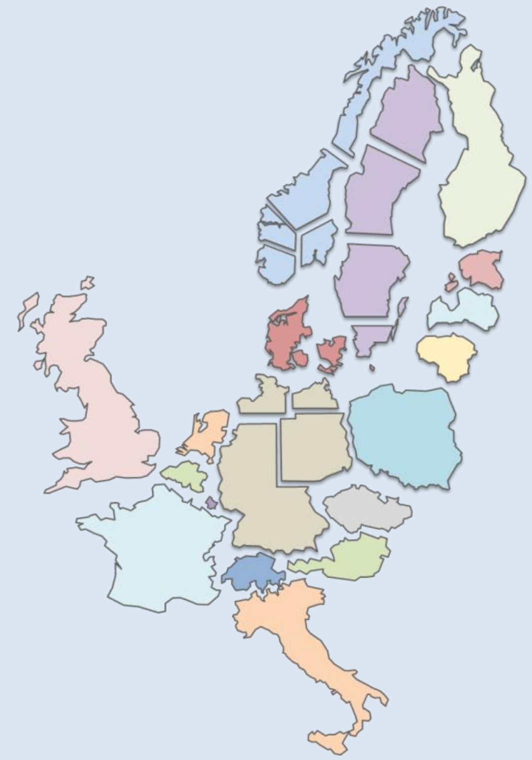
Methodology

- Balmorel power market model, covering the Nordic countries, and 14 other European countries, including Germany, the UK and the Baltic countries (see map). 2700 TWh
- Power plant and transmission capacities according to
  - ENTSO-E' Transparency Platform
  - ENTSO-E National Trends scenario
  - Nordic TSO
  - Recent government plans (Germany 80%RE in 2030)
- Key model specifications
  - We do not allow the model to invest in new capacities
  - Least cost dispatch
  - No limitations on the availability of natural gas, coal or oil
  - Fuel price are inflexible
  - Normal weather year



Geographic scope of the model

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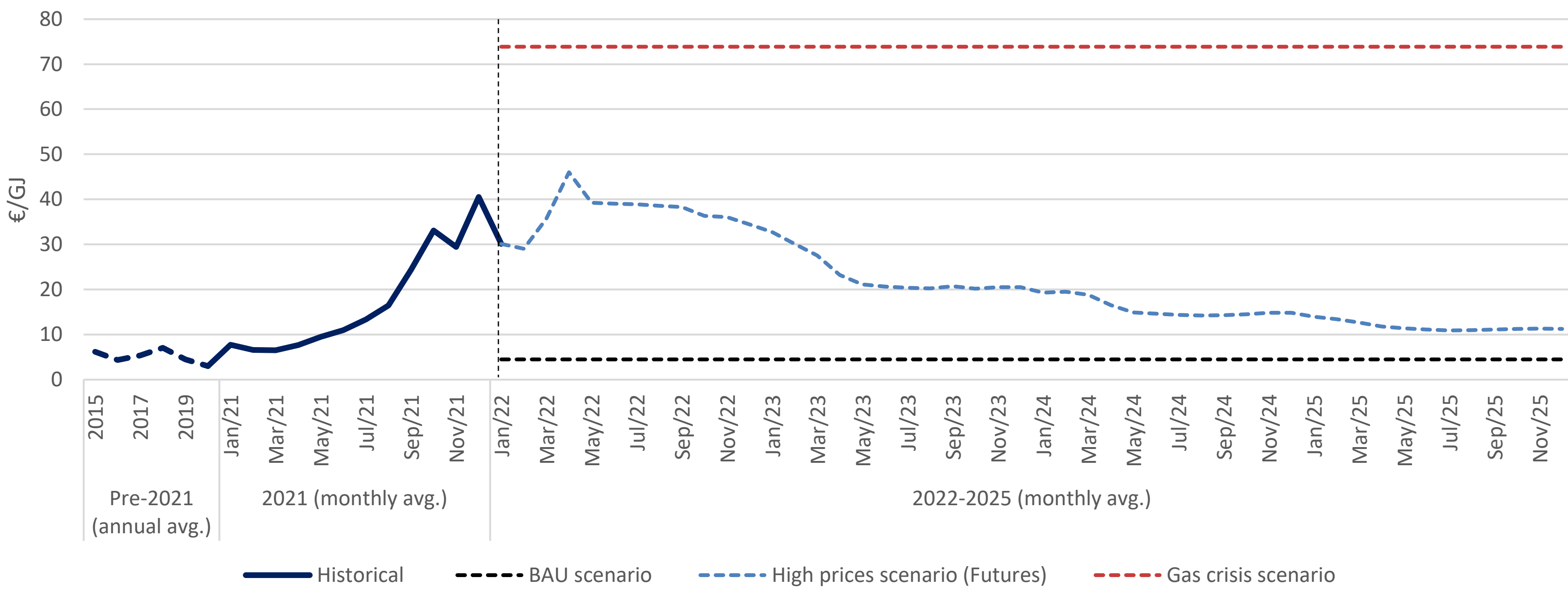
FUEL PRICE ASSUMPTIONS

Gas price in scenarios

- Three different gas price scenarios (see graph)
  - Reference: Business-as-usual (BAU) – 'normal' fuel price scenario (2019) and current CO_2 price
  - High prices: Projected – Energy Futures price scenario
  - Gas crisis: Gas cut-off – manifested in higher gas price
- CO_2 price of approx. 80 €/ton



**Price is plotted at low heat value*

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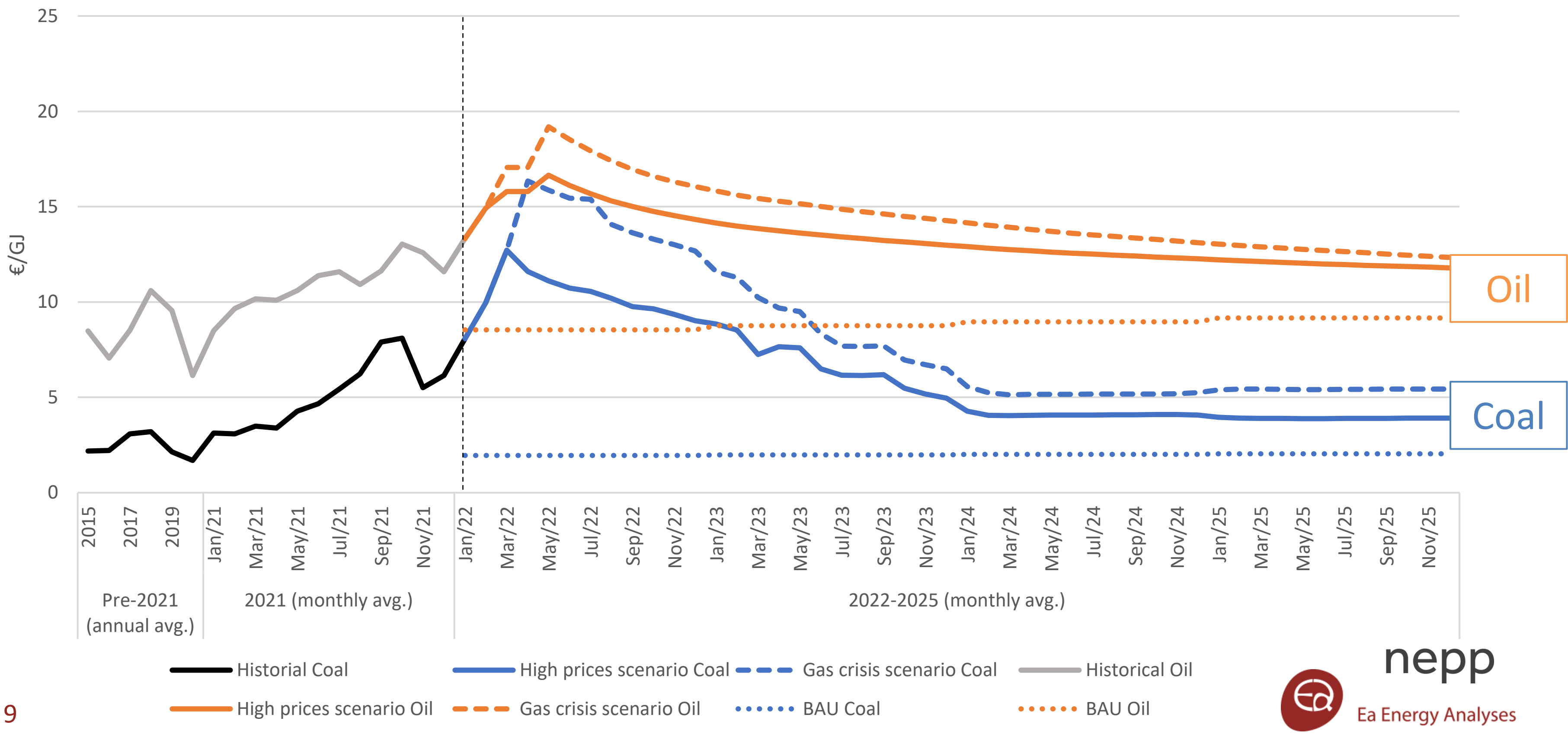
Coal, oil prices

- Three different fuel price scenarios (see graph)
  - Reference: Business-as-usual (BAU) – 'normal' fuel price scenario (2019)
  - High prices: Projected – Energy Futures price scenario
  - Gas crisis: Gas cut-off – highest observed futures



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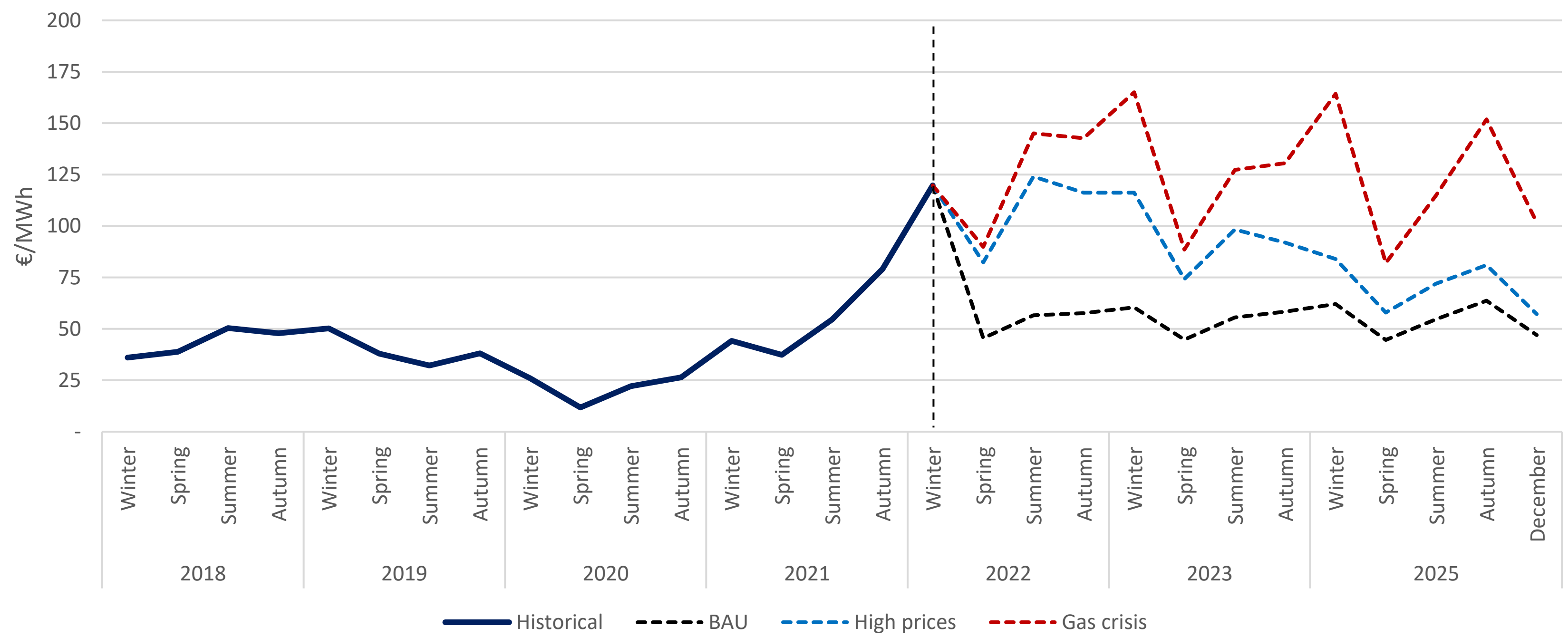
MAIN RESULTS

SE3 price projection

- Three different projections of SE3 prices.
- The gas futures show that next winter will result in just as high prices as 2021/2022 winter, in the high price scenario.
- Next winter can see even higher prices, if a gas crisis occurs.



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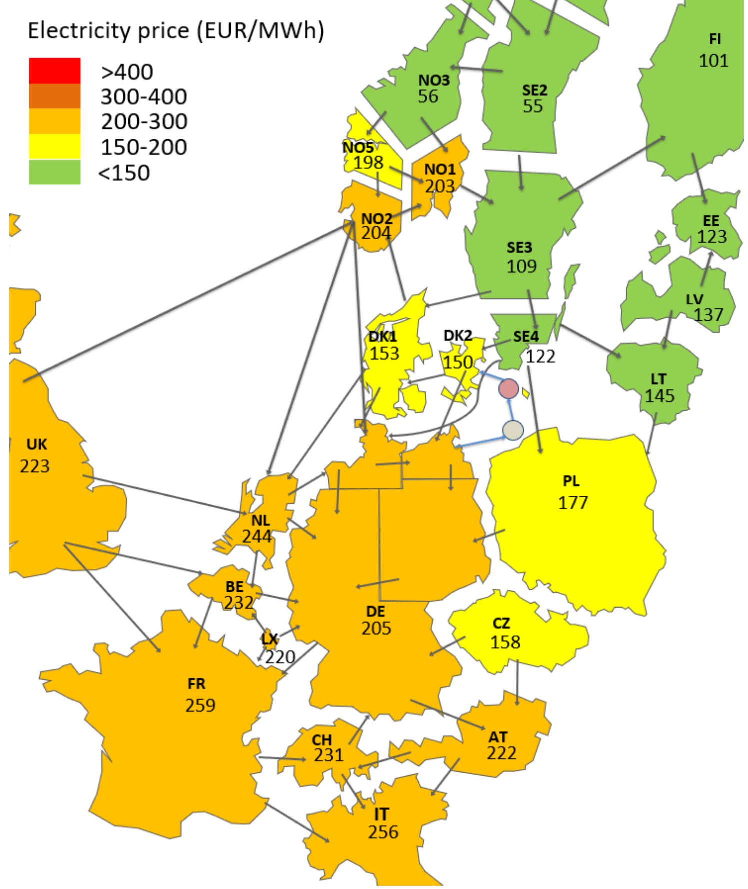
Average electricity prices

- There is a bottleneck from Northern Norway and Sweden (*Snitt 2*) to the southern national regions.

- Southern Norwegian prices are increased as they are directly connected to the three of the highest priced bidding zones -> Netherlands, Germany and UK.
  - Sensitive to availability on interconnectors

High prices scenario 2022



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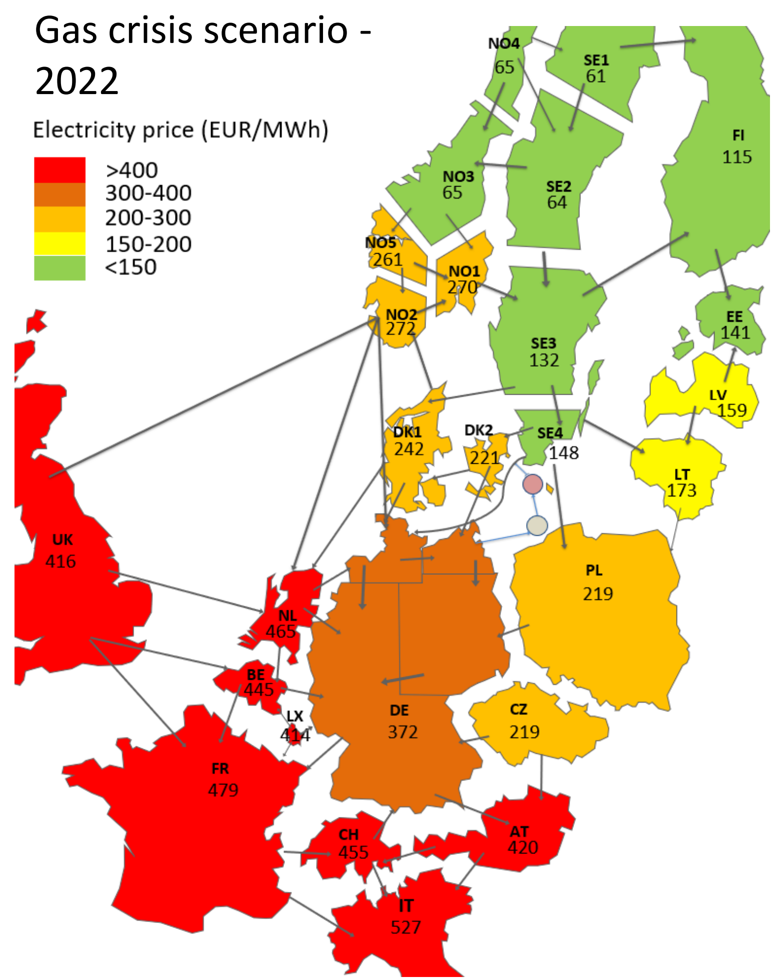
Average electricity prices

- The bottlenecks in Scandinavia are more in contrast to the rest of the continent in the gas crisis scenario.
- Continental European countries are highly affected by the extreme gas price in this scenario.
- Italy, Netherlands, France and the UK will have particularly high prices since natural gas units are more frequently marginal producers in these countries. This will be illustrated in our demand sensitivity.



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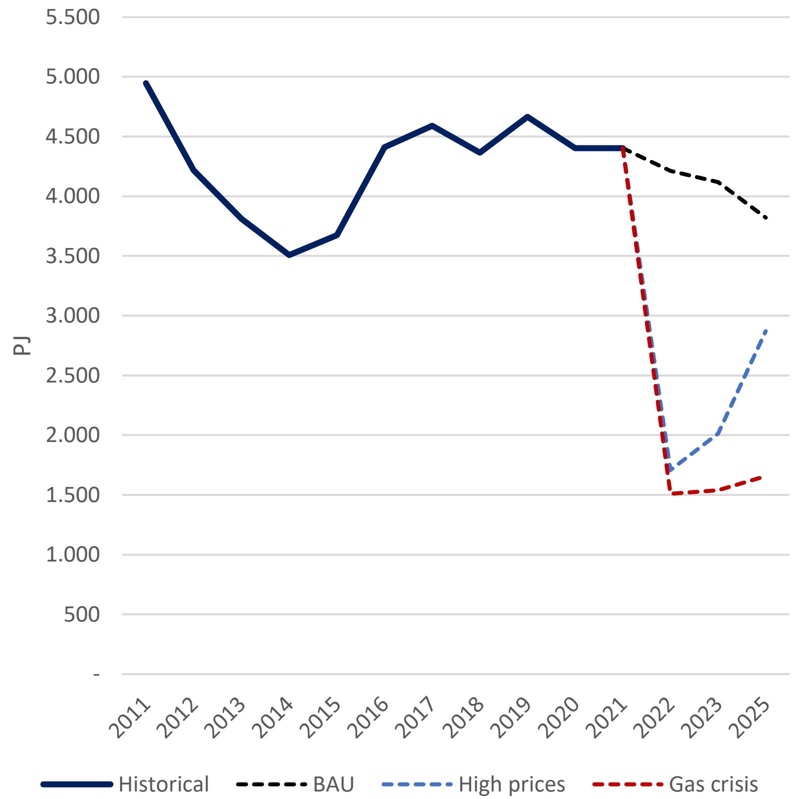
Natural gas consumption projection

- The High Price scenario shows a reduction in gas consumption of 59% in 2022 and 2023
- This increases to 64% in the Gas Crisis scenario
- For every unit of gas reduced
  - coal consumption is increased 1.0
  - oil consumption is increased 0.3
  - biomass consumption is increased 0.1

  1.4 in total because electrical efficiency of these units are lower than gas units

Oil units and older coal units are not necessarily fit for operation in the spot market at intermediate or base load



Note that historical data for 2021 is not yet available on Eurostat. 2021 consumption is therefore assumed equal to 2020.

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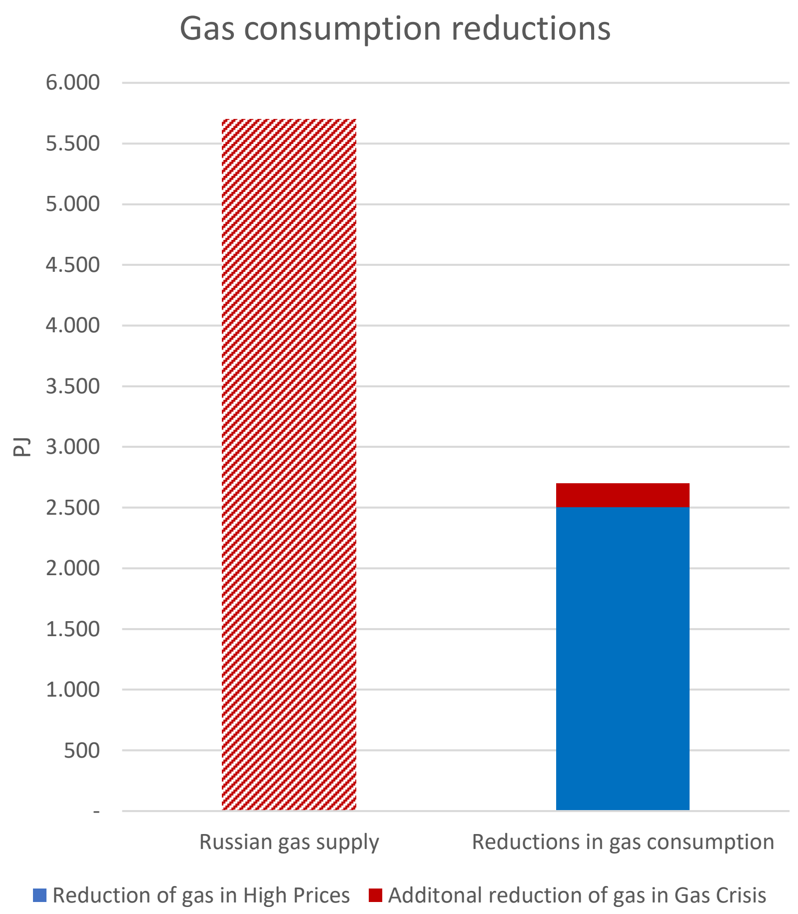
Natural gas consumption with Russian perspective

- The Russian share of the gas supply is assumed to be 40% of the total gas consumption of the model area, calculated as 5,700 PJ.
- Gas for electricity and district heating is calculated to be around 4,400 PJ for the model area.
- The High Price scenario shows a significant reduction of gas consumption from power and district heating of around 2,500 PJ.
- The Gas Crisis scenario shows an additional reduction in gas consumption for electricity and district heating of around 200 PJ.
- The total reduction is equal to 48% of the total Russian gas supply to the model area.



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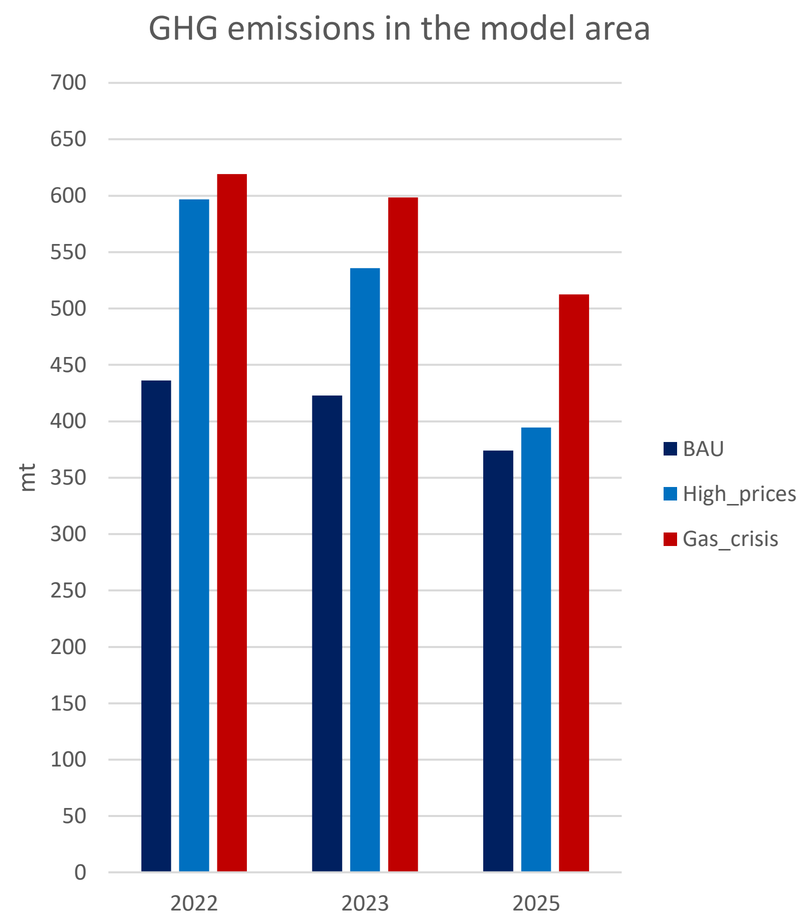
GHG emissions in each scenario

- The gas consumption reduction comes at a significant cost in terms of GHG emissions, because coal, lignite and oil consumption is increased.

- <u>42% increase in GHG emissions</u> from power and district heating in the Gas Crisis scenario in 2022 in the model area



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Key messages

- Electricity prices in SE3 will be higher next winter, if either the High Price or Gas Crisis scenario is realized.
  - Bottlenecks in the Swedish transmission lines will to a certain degree protect the Swedish bidding zones from extreme electricity prices on the continent.

- The natural gas consumption for electricity and district heating is significantly decreased in both the High Price (59%) and Gas Crisis(64%) scenarios
  - The Gas Crisis gas consumption reduction is equal to 48% of the total Russian gas supply to the modelled area.
  - For every unit of gas reduced, 1.0 unit of coal/lignite and 0.3 unit of oil is increased in 2022. This puts pressure on the current supply of coal/lignite and oil.
  - There is a risk that price levels of coal and oil, which are already high, will increase further if the consumption of these commodities increases for the electricity sector. This is not represented in our modelling.

SENSITIVITY SCENARIOS

THERMAL POWER EXTENSION, FAST-TRACKING RES, 5% DEMAND REDUCTION

Assumptions in sensitivities

Thermal power extension

- Effect of maintaining or re-commissioning coal and nuclear capacities (mainly relevant in central European countries)
- Only nuclear capacity that is phased out in 2024 - is extended[1]. 7 GW in total.
  - 4 GW in Belgium, 2.4 GW in UK, 0.5 GW in France
- Approximately. 18 GW of coal capacity is extended from 2023-2025.
  - 6 GW in UK, 4 GW in Germany, 4 GW in Italy, 3 GW in France, 0.5 GW in Poland, 0.7 GW in Denmark

Fast-track renewable energy sources deployment

- Effect of ***tripling*** buildout of RE capacity towards 2025 compared to TSO's BAU projections.
  - 46 additional GW of RE capacity in 2023, on top of expected buildout.
  - 131 additional GW of RE capacity in 2025, on top of expected buildout.
  - Germany is not included in these assumptions, as they have some very ambitious planned buildouts already, as a reference.

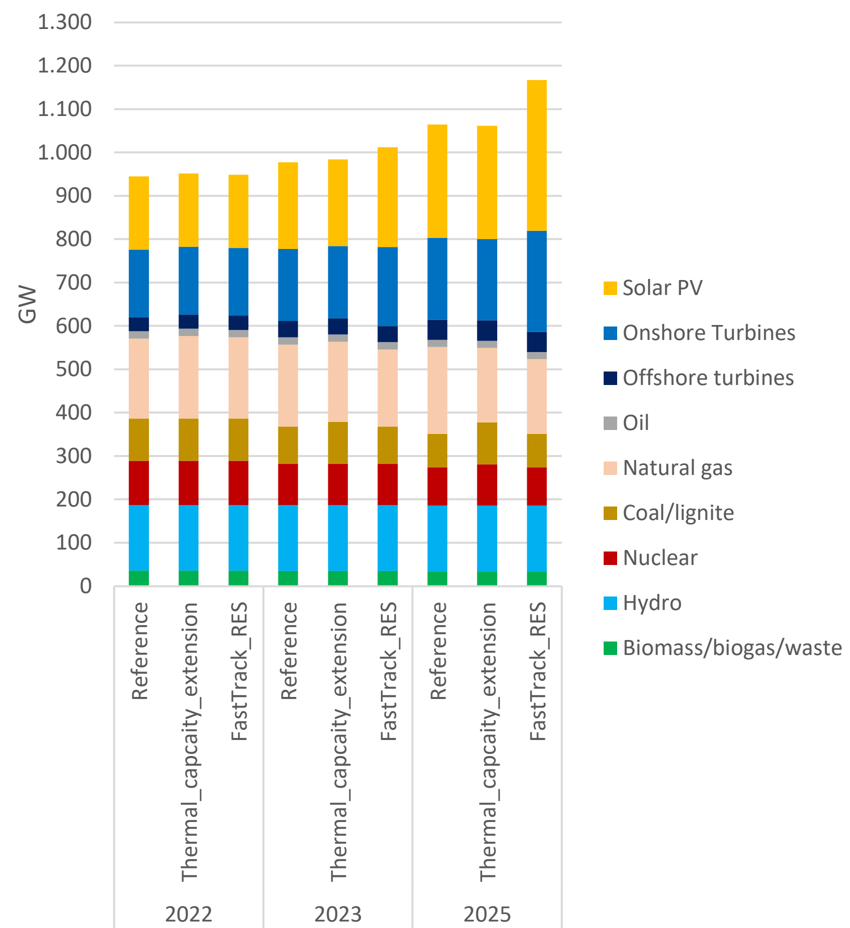
Electricity demand sensitivity

- Exploring how a reduction in power demand among European consumers, most obvious high intensity power consumers, will affect power prices and natural gas demand (will also give insights as to how an accelerated effort towards electrification will affect EU natural gas demand)
  - Approximately 118 TWh demand reduction for the model area.

[1] Based on statements by German and Belgian officials it is assessed that it is too late to extend nuclear reactors phasing out earlier than 2024.

Power capacities in the sensitivity scenarios

- The *reference scenario* shows the power capacity of three central cases (BAU, High Prices and Gas Crisis).
- The *Thermal Capacity Extension scenario* have a higher nuclear and coal/lignite capacity.
- The *FastTrack RES scenario* have three times as high buildout of renewables, except for Germany which is already quite ambitious.



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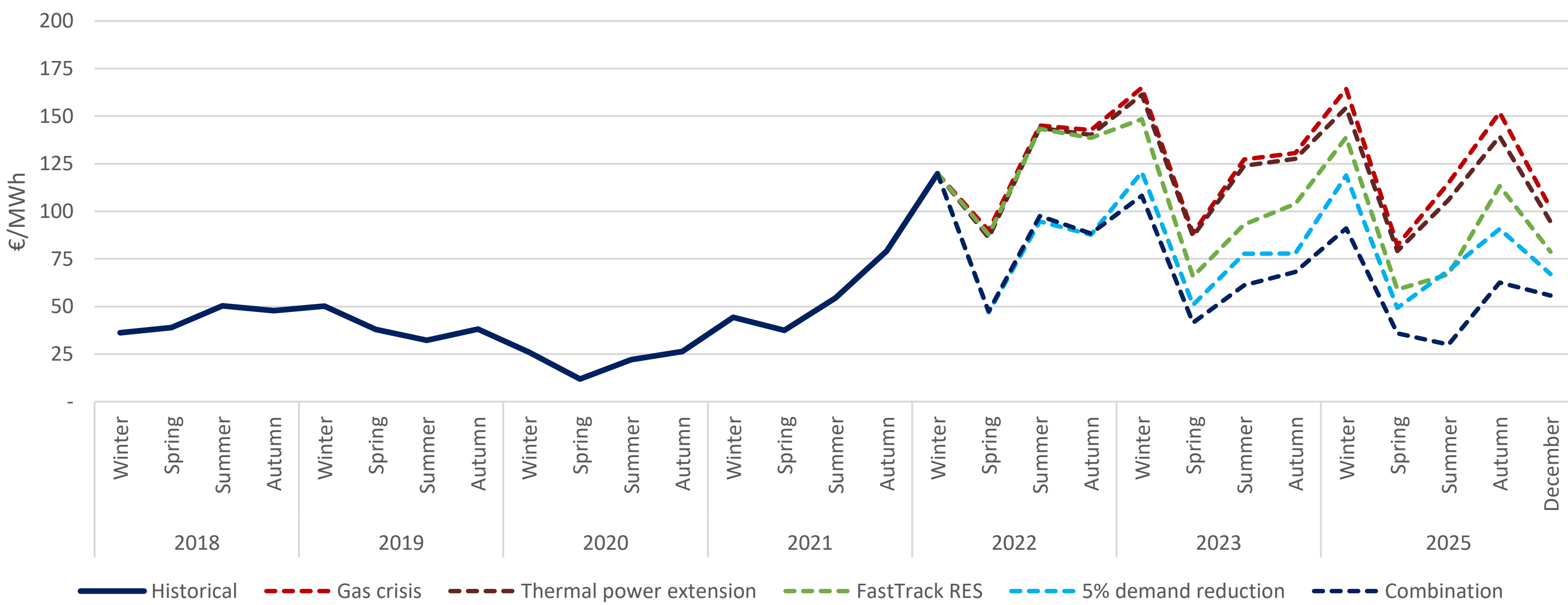
Price projections in SE3
- of sensitivities

- *Thermal power extension* in continental Europe have only marginal effect on the average price level in SE3.
- *Fast-tracking renewables* have a significant impact on the prices in 2023 and 2025, 30% decrease in 2025.
- *5% demand reduction* have the most significant impact of all sensitivities in all years, 29% price reduction in 2022 and 39% in 2025
- *Combining* all scenarios will decrease the average price to a pre-crisis level of 46 €/MWh in 2025, mostly due to 5% demand reduction and fast-tracking renewables.



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Key messages: sensitivities

- Next winter will result in just as high prices in Sweden as 2021/2022 winter, in the high price scenario.
  - And even higher prices, if a gas crisis occurs
- Significant potential for fuel shift in the European power system - <u>interpretation with caution</u>
- Demand reduction and fast-track RE deployment will have strong downward effect on Swedish prices

Uncertainties (1/2)

- **No limits for import of coal and oil**
  - The study is based on a least-cost dispatch of the modelled system which is unconstrainted of any practical challenges related to sourcing fuel commodities – with the exception of bioenergy and waste which have been limited to known potentials and statistics. Any supply bottlenecks that would prevent meeting the resulting demand coal and oil in the model will in most cases result in increases in natural gas consumption and electricity prices than identified in this study.

- **Deterministic fuel and EU ETS price modelling**
  - In the high gas price scenarios the merit-order of thermal power plants shifts and result in an increased demand for hard-coal, lignite and oil compared to recent years and a Business-as-usual scenario. The fuel and EU ETS prices are modelled deterministically and does not include any supply/demand feedback on the prices in the model. In the case of insufficient margin in global coal and oil supply to meet the additional demand identified in the model, a price increase could be expected beyond what is captured in the forward prices that have been applied in the model. In addition to increased demand, a political decision of e.g. a ban of energy imports from Russian will further test the global supply. Similar for EU ETS, a large increase of coal and oil based electricity generation that is currently unaccounted for in the EU ETS market will push the allowance price upwards. Any marginal coal and oil consumption in the scenarios not accounted for in the energy futures prices and not easily covered by supply margins; as well as for marginal emissions in the EU ETS not accounted for in the prices applied in the study – will likely translate into higher marginal costs and thus higher electricity prices.

- **Demand elasticity**
  - A conservative approach to modeling demand elasticity has been applied. The model is forced to satisfy all demand at all times, with limited options for demand shifting. Demand elasticity could play a significant role when electricity prices reaches a certain threshold. Demand sensitive consumers will eventually disconnect above specific price levels, and this is not account for in the model. Price adaptive demand-side dynamics (energy efficiency, demand destruction, higher shares of load shifting, consumer awareness etc.) not represented in the model will have an alleviating effect on the electricity prices.

- **Normal climate year**
  - The demand and RES quantities in the model are based on a normal climate year. Hydro reservoir levels, wind and solar availability and heat and cooling demands etc. are sensitive to changing weather conditions. For example, 2021 experienced a cold winter and low wind availability that resulted in a higher reliance on thermal power to cover the gap. In case that the need for thermal power grows due to weather conditions it may cause stress on the system and result in higher gas reliance and electricity prices than found in this study.

Uncertainties (2/2)

- **Existing fuel contracts not taken into account**
  - In reality, many fuels are traded on long-term contracts and some plants operate with storages/reserves as well. Thus only the short-term marginal consumption is purchased at the recently amplified prices. This could affect how plants bid on the power market to an extend that is not captured in the model – as the hard-coal, lignite, oil and natural gas prices etc. in the model in most cases are modelled with a universal price respectively for each type of fuel.
    <u>To the extend that existing fuel contracts can have an effect on bidding strategies in the light of recent price-hikes, this could have an alleviating effect on the electricity prices.</u>

- **Representation of units in the model**
  - Modelling of large and highly complex systems as the European power and district heating systems relies on availability of data and knowledge on many levels. While a calibration exercise have been carried out based on available statistics, as even the statistics come at a high level of uncertainty and often at an aggregated level. For example, data on the capacity of coal power plants is available, but not on the operational state or condition of each plant. While e.g. coal units have been derated to represent assumed physical/regulatory constraints, it may be that some plants operate in the model at quantities that is not physically possible to maintain. Likewise, oil units may be limited by regulatory and other constraints not captured in the model. Strategic reserves and other reserves are for example always needed in the power system. The model only accounts for some reserve capacity in each country. These cannot participate in the spot market.
    <u>To the extend that the modelled units – mainly coal and oil units – for any given reason are not capable of running at the capacity factors achieved in the model, the marginal in most cases is natural gas and would lead to increased gas reliance and electricity prices.</u>

- **Availability factor of transmission lines**
  - The Balmorel model approximates a flow-based market coupling for the exchange on interconnectors between bidding zones in the model. With a few exceptions[1] most of the NTC is available for power flows between bidding zones in the model. Furthermore the model has perfect foresight and has no need to reserve available capacity for unexpected variabilities. In reality the available transmissions capacity is often not equal actual NTC of a line, as they are limited by physical constraints and operated with a margin.
    <u>The model may overestimate the flows in the system compared to a real life setting. If flows are further restricted from e.g. marginal German coal-fired power plants to Italian consumers, the marginal will instead be e.g. an Italian natural gas plant. In that case it would lead to higher marginal cost which translate into a higher electricity price in Italy, but potentially greater price differences between bidding zones. It will also lead to a higher reliance on gas to meet demand than found in this study.</u>

[1] The Nordic transmissions lines have been derated with a profile based on historical data of the past three years. The transmission lines of continental Europe are modelled with a relatively conservative derate and not according the historical data.