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Perspectives on Nordic energy system development

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Nordic Energy Perspectives
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Scenario approach to Nordic energy market development

- The future system is formed by
  - Market forces
  - Policy measures
  - Expectations of the future:

  ➔ *Today's investments shape tomorrow's system*

- Models capture market dynamics and policy implementation
- Analysts capture policy dynamics and expectations

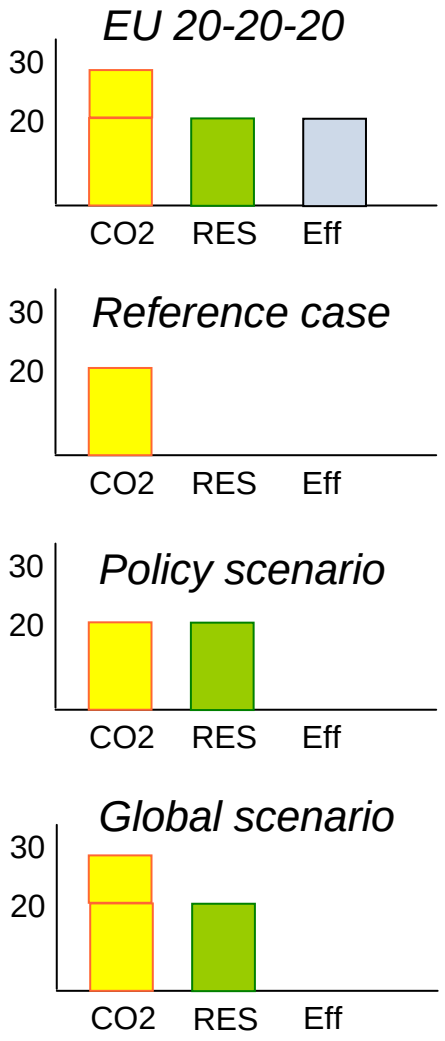
- The NEP policy scenarios are built to analyze the uncertainties pertaining future global and EU climate policies
  - And policy implementation in the Nordic area

- The NEP models are used to analyze the market impact and dynamics
  - No model captures it all
  - Using a suit of models enhance insights into important market features

Overview of NEP climate policy scenarios

- Basis for scenario formulation: EU 20-20-20 targets to 2020
  - 20% reduction in GHG emissions compared to 1990 levels (30% if global agreement)
  - 20% share of final energy consumption should be renewable energy
  - 20% increase in energy efficiency
- Reference case: 20-0-0
  - EU emission reduction policy, renewables according to national targets and policies
- Policy scenario: 20-20-0
  - EU emission reduction policy, renewables according to EU RES target
- Global scenario: 30-20-0
  - Global emission reduction agreement, renewables according to EU RES target

- **Focus of the analysis**
  - **Impact on Nordic generation and prices**
  - **Impact on Nordic CO2 emissions**



Main conclusions

- *Qualitative results are fairly robust across models:*
  - Nordic electricity market balance: Increasing electricity surplus
    - Even with national policy targets and measures
    - EU policies imply even greater surplus
  - Prices stay below long run marginal costs in the Nordic area
  - No new investments in condensing power profitable
  - Climate and renewable policies have limited effects on electricity consumption
  - CO2 emissions: Reduction to 2020 and 2030 even in the Reference case

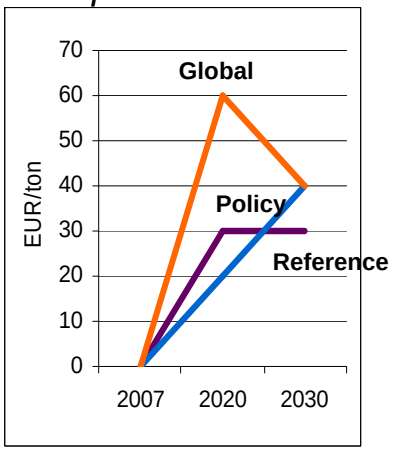
- *(Some) quantitative results differ significantly*
  - All models have limitations: Employing a portfolio of models increases insights
  - It is not possible to harmonize all model inputs: Results are not always comparable
  - The most important differences are
    - Demand representation
    - Modelling of trade
    - Coverage
      - Only electricity or inclusion of heat
      - Geographical scope
    - Price structure

General scenario assumptions – policy and market

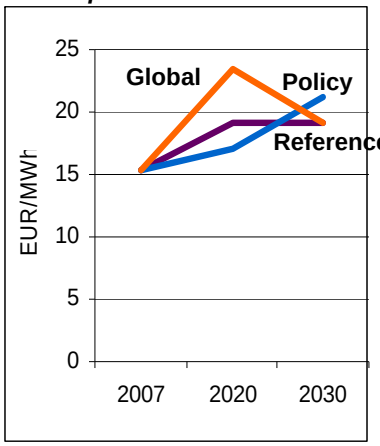
- CO2 prices
  - ***Reference:*** *30 Euro/ton throughout*
    - Continuation of 20% reduction cap in EU ETS to 2020 and beyond
    - Moderate RES expansion
  - ***Policy scenario:*** *20 – 40 Euro/ton*
    - 20% reduction cap, increased RES
    - Long-term: CCS price setting
  - ***Global scenario:*** *60 – 40 Euro/ton*
    - 30% reduction cap 2020
    - Long-term: CCS price setting

- Fuel prices
  - ***Coal*** prices lower in global scenario due to reduced global demand
  - ***Gas*** prices at the European level reflect gas competitiveness towards coal

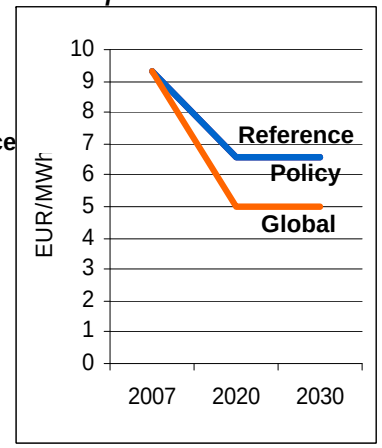
CO2 prices



Gas prices

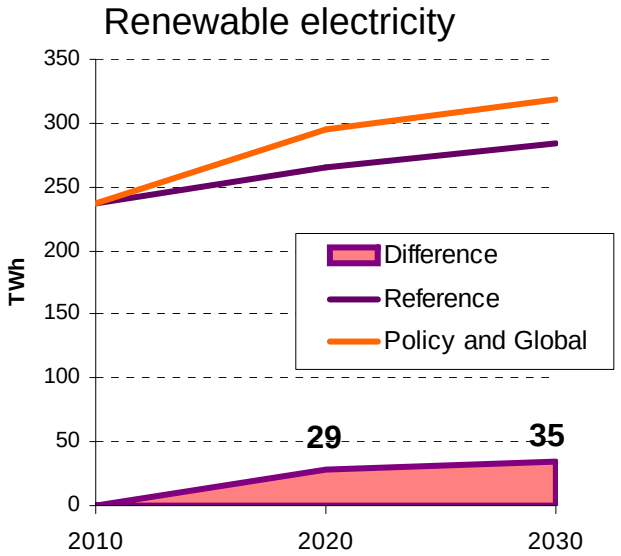


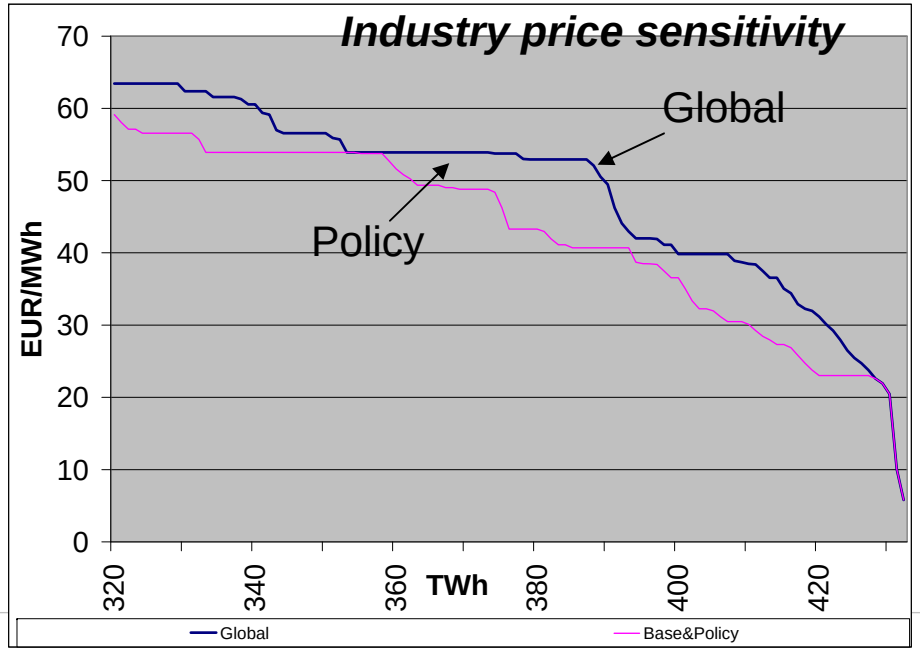
Coal prices

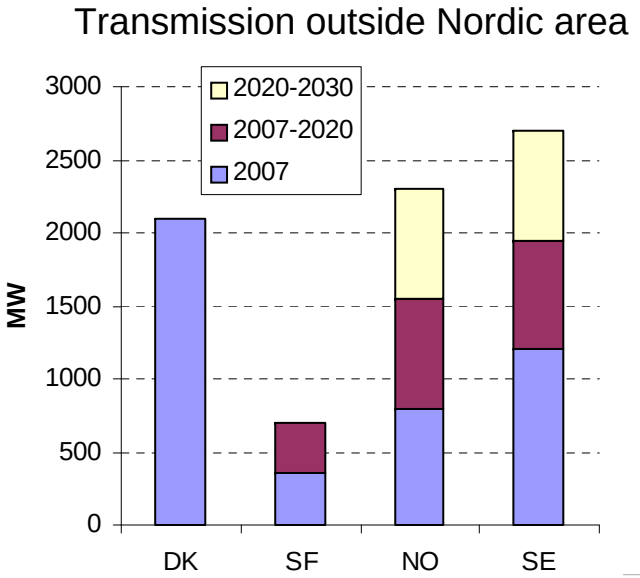


Nordic scenario assumptions – policy and market

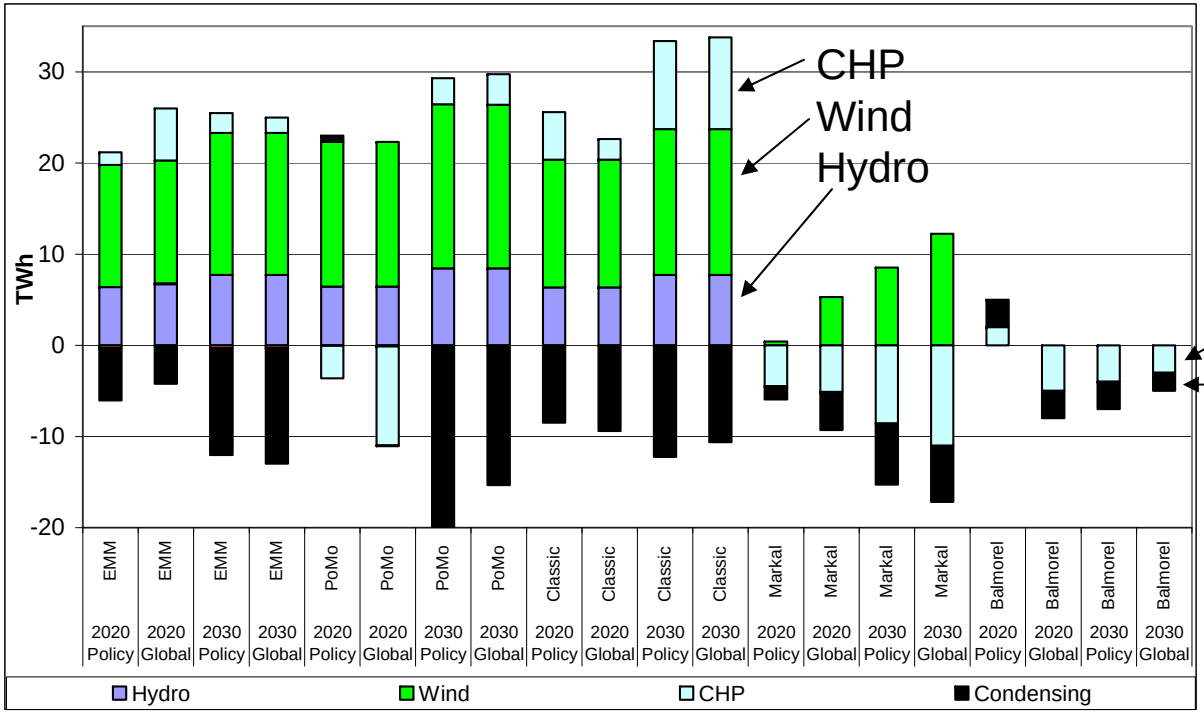
- Ambitious national targets even in reference scenario
  - Significant increase in climate policy scenarios
  - Large share of increase is wind power
- Moderate increase in conventional capacity
  - Increase in nuclear
  - Decommissioning of coal
- Moderate increase in electricity demand
  - Before price sensitivity is taken into account
  - Industry price sensitivity greater in the Policy scenario
- Moderate increase in transmission capacity in all scenarios
  - Reduction in SF import from Russia
  - Higher prices on the Continent







Policy scenarios: RES replace fossil capacity

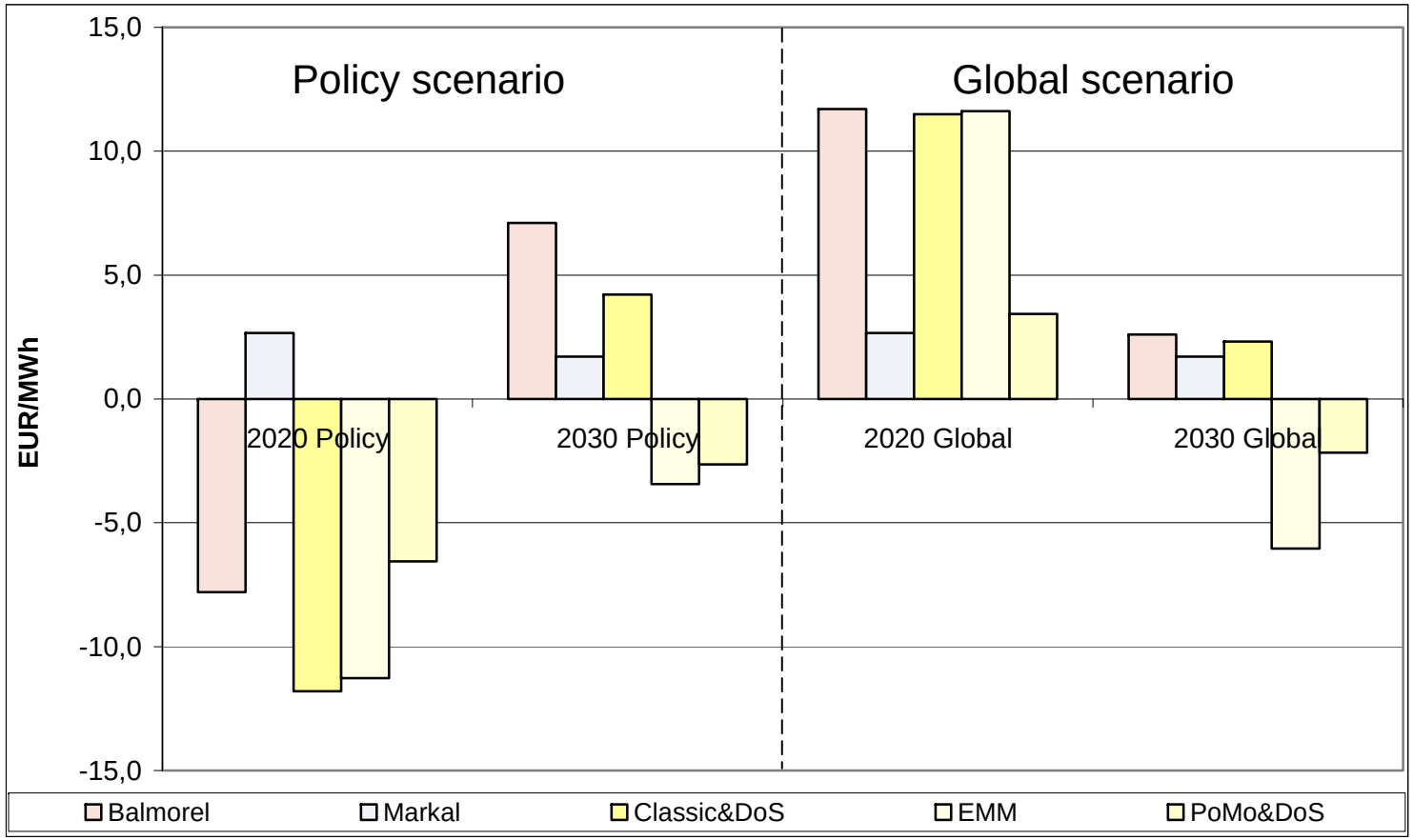


... compared with Reference:
- Fossil fuel generation marginal
- ... but only a small share of total generation

CHP
Condensing

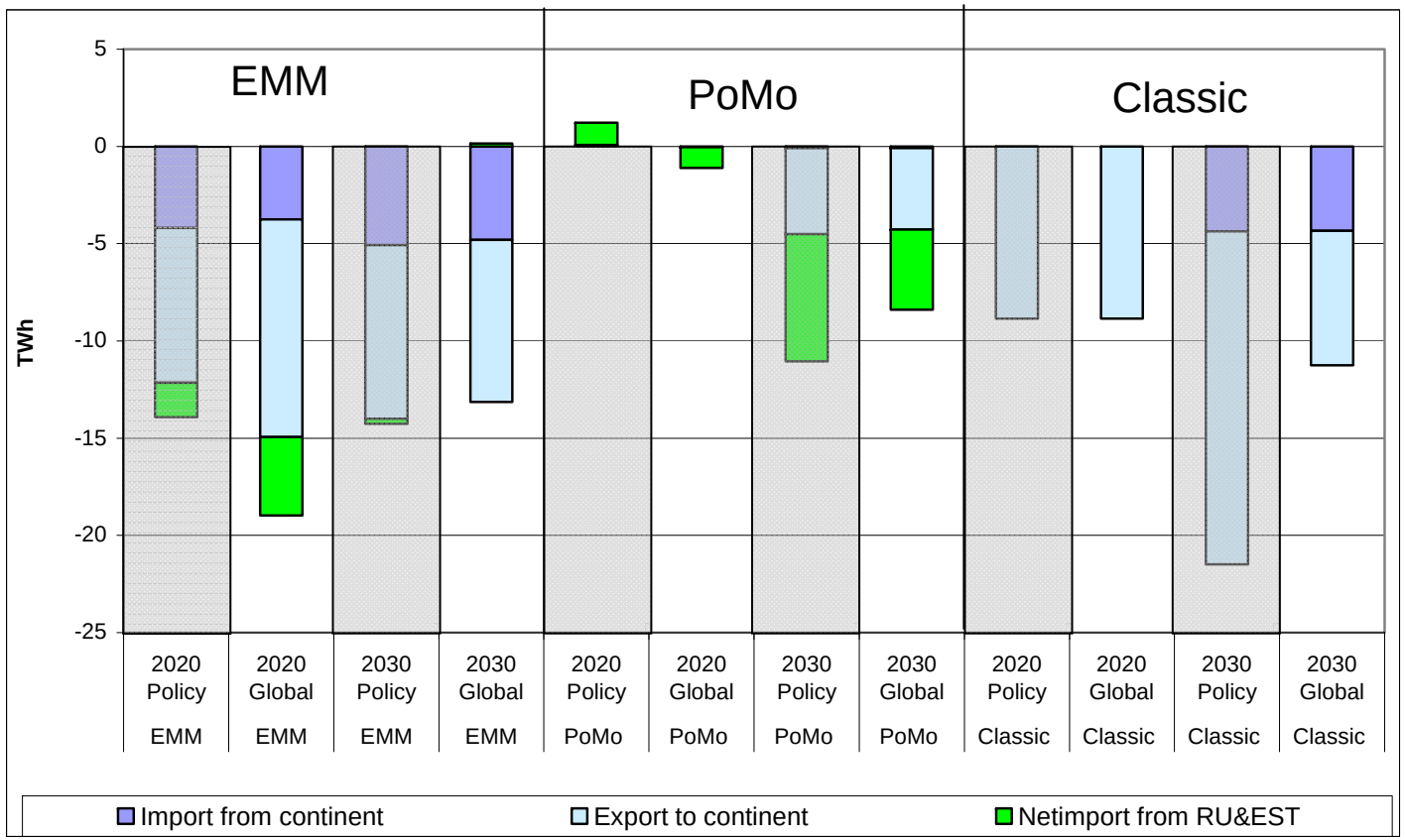
- Increase almost exclusively in renewable generation from hydro, wind and biomass CHP
- Reduction in fossil fuel based condensing generation
- Increase in overall generatin in almost all models
  - Results depend on demand sensitivity and trade opportunities
  - ... and to what extent models include the heat sector

Price effects very uncertain – predictions are sensitive



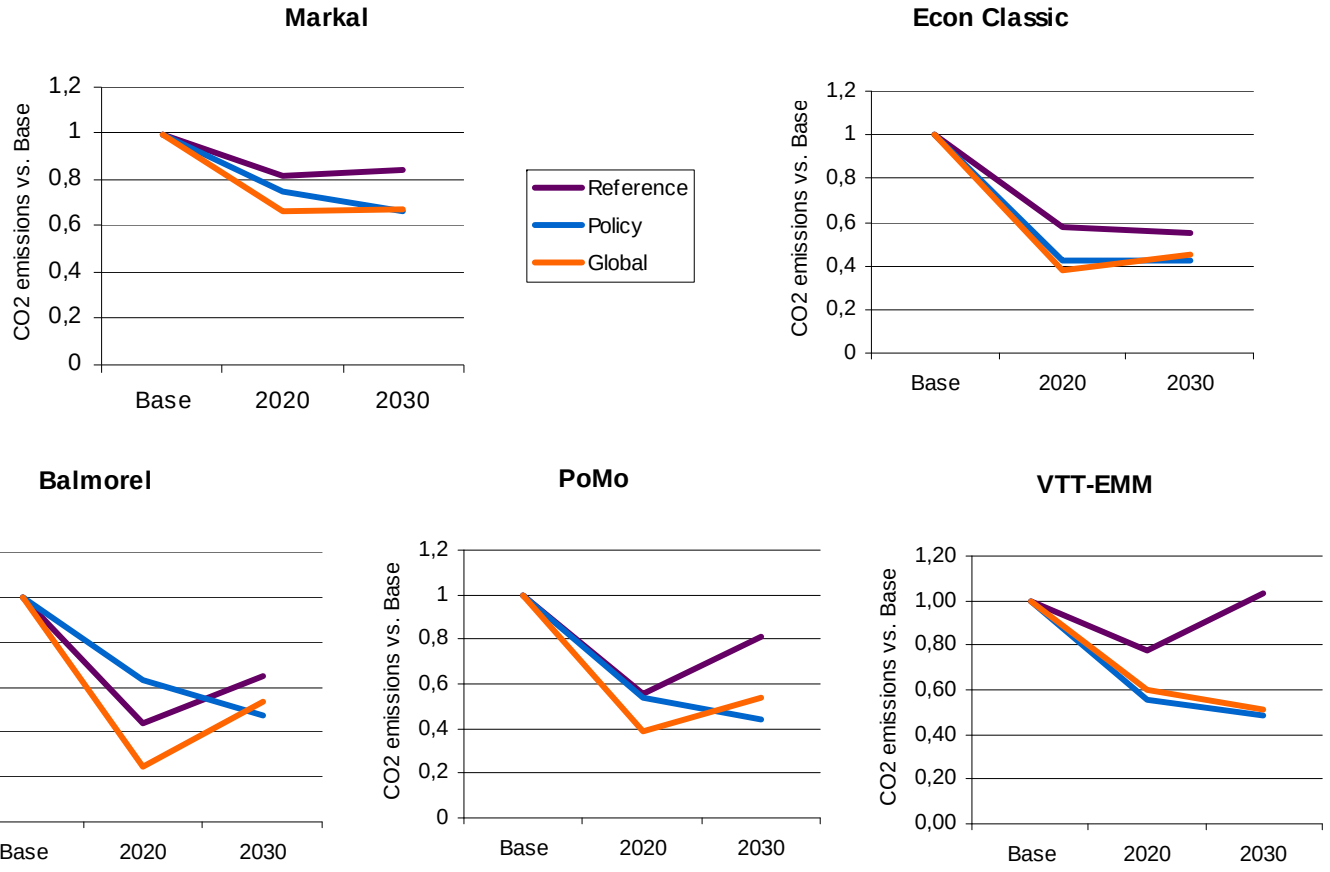
- Some patterns can be identified
  - Price impact larger in 2020 in both scenarios – reduction in Policy, increase in Global
  - Long-term price impacts less clear
- NB! Price results are very sensitive to model configurations and assumptions – especially as markets are not in long-term equilibirium

Policy scenarios: Increased exports to the Continent



- Significant increase in exports to the Continent in all models
- Increases in exogenous capacities replace generation in condensing and CHP
- Only small changes in electricity consumption
- No robust *pattern*
  - Several inputs change – counteracting effects – uncertain total result

CO2 emissions from Nordic energy reduced significantly



- Reduction in all scenarios – including Reference
- Largest reduction in Global scenario in 2020: High CO2 price!
- Largest long-term reduction in Policy scenario: Higher coal price
- Some rebound effect in 2030 in Global scenario
- Fairly consistent results across models

Crucial drivers: The ones to watch …

- Different results from different models: No model captures it all!

- Demand vs. consumption:
  - How do growth rates, industry structure and prices affect demand?

- The drivers behind capacity development
  - Are investments profitable based on market developments and support schemes?
  - And consistent with long-term expectations and market threats?

- Interaction between markets:
  - Substitution of electrical heating with other fuels
  - New electricity uses, e.g. transportation
  - Renewable electricity vs. renewable energy

- Electricity exchange and imports/exports
  - Market coupling
  - Increases in trade capacities

- Price structure according to time resolution
  - Do we capture all relevant effects? (Depends on the question)
  - Affect profitability, trade, investments, networks, bottlenecks
  - Impact of increased wind generation

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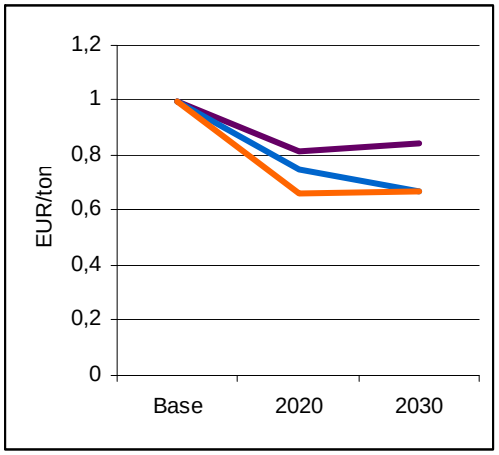
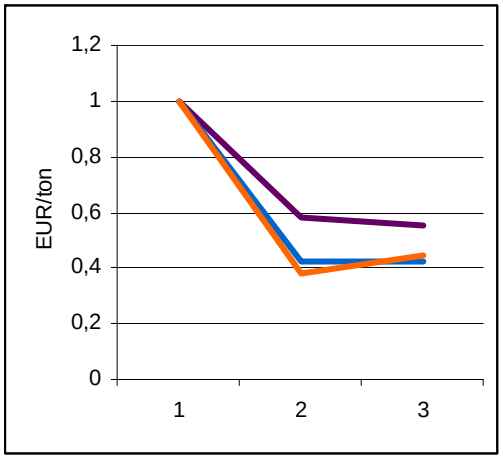
Scenarios: CO2 emissions

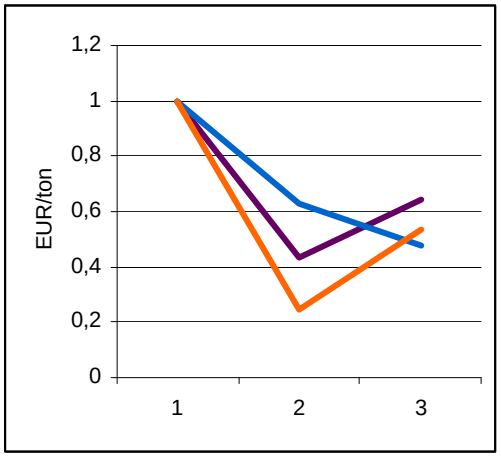
Markal

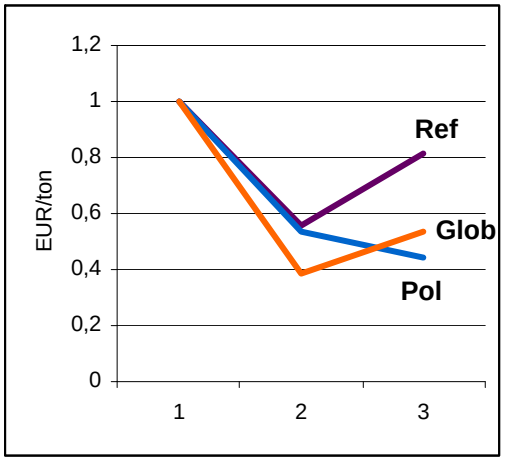




Classic

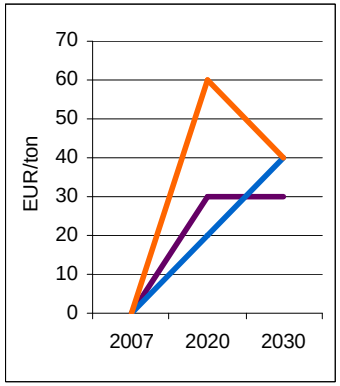
Balmorel





PoMo

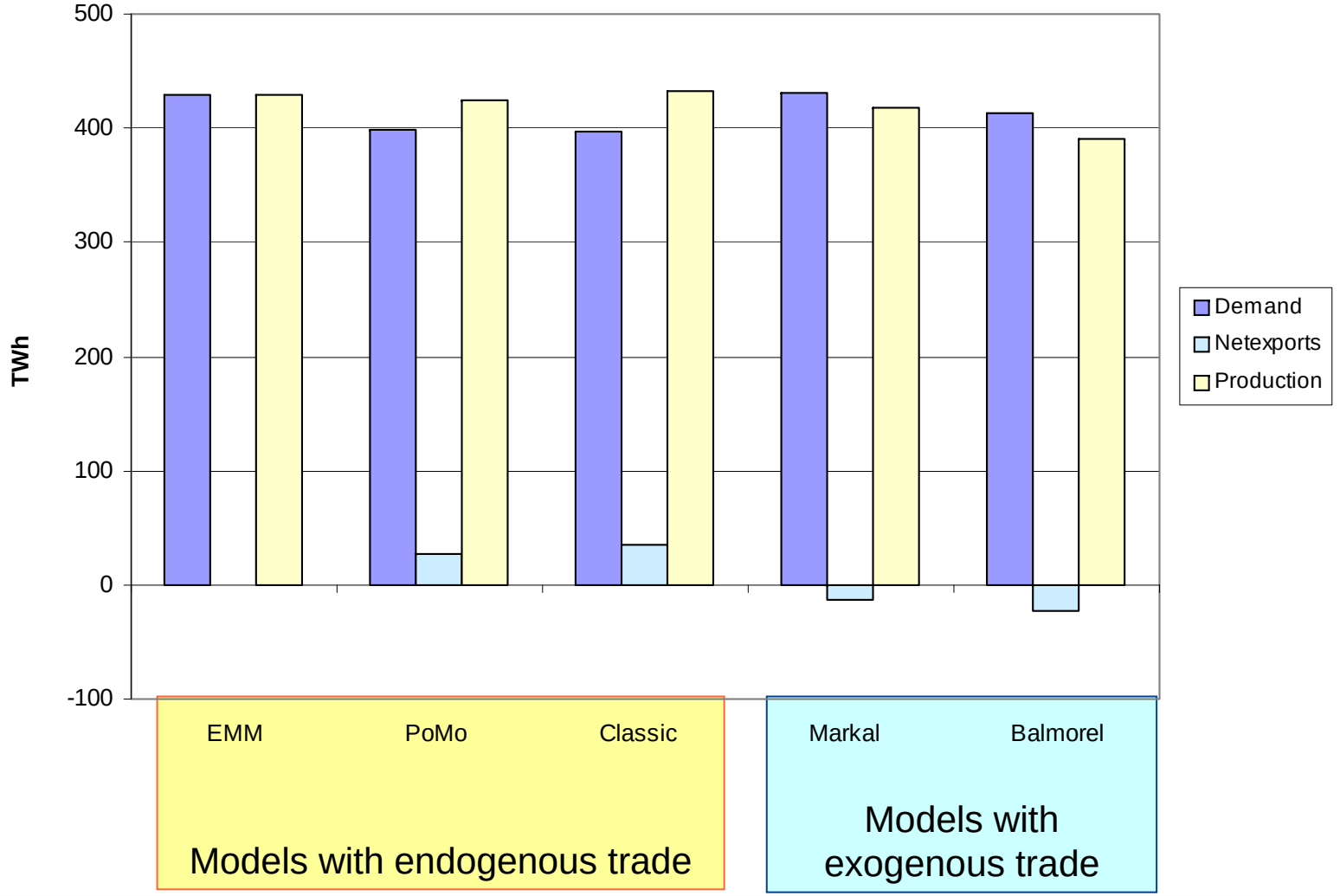
Assumed CO2 prices



- Generally CO2 emissions tend to be lower in the policy scenarios
  - Policy scenario has stonger effect on emissions than Global scenario in the long run
  - To be expected given the CO2 price assumptions

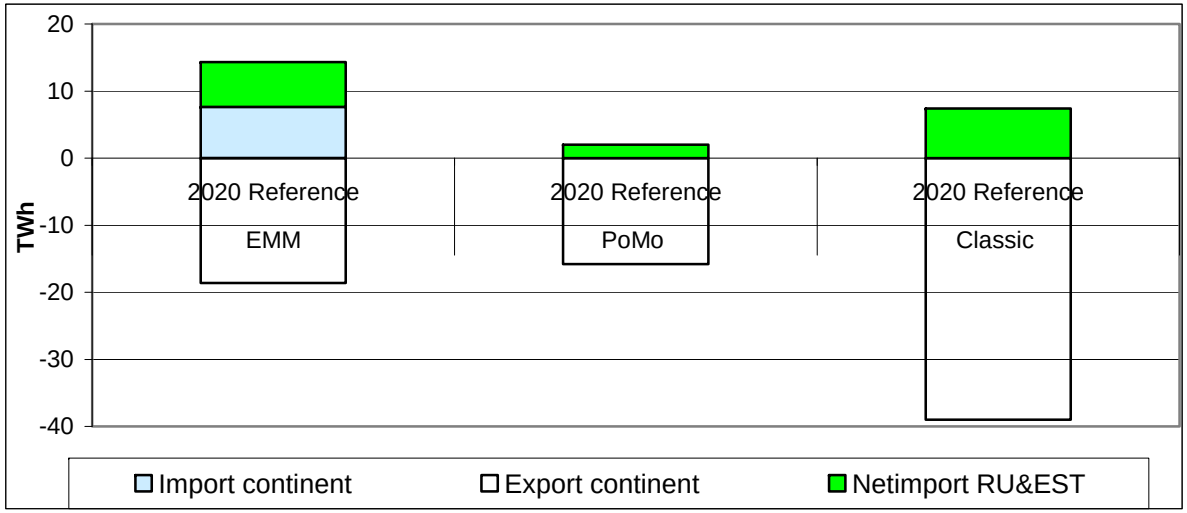
Reference case: Electricity market balances 2020

- Consumption differs according to modelling
- Trade against Continental prices yield net exports



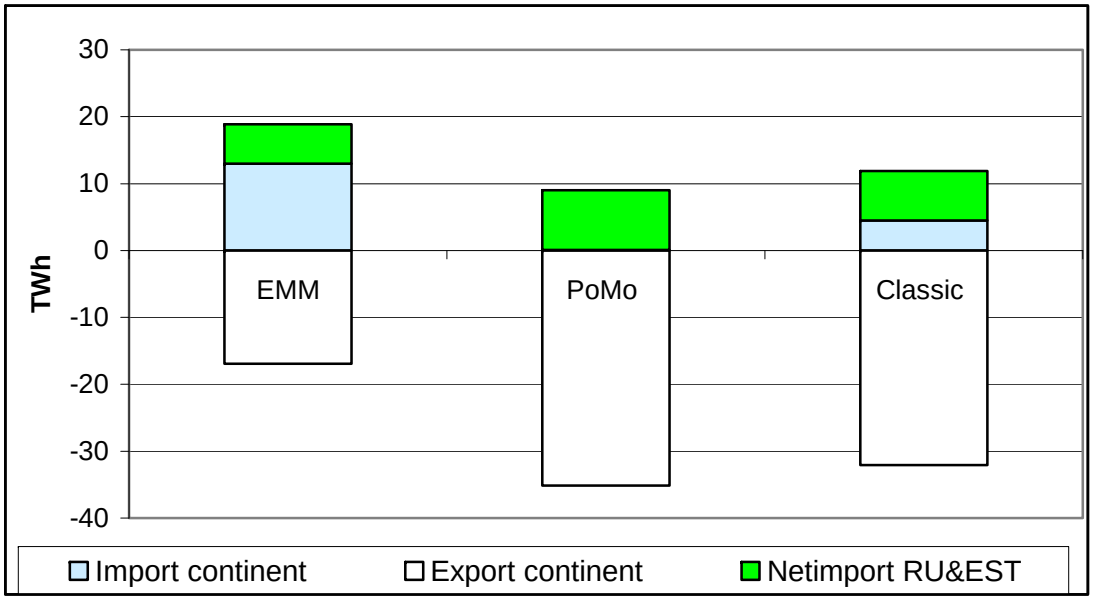
Reference case: Imports and exports

2020



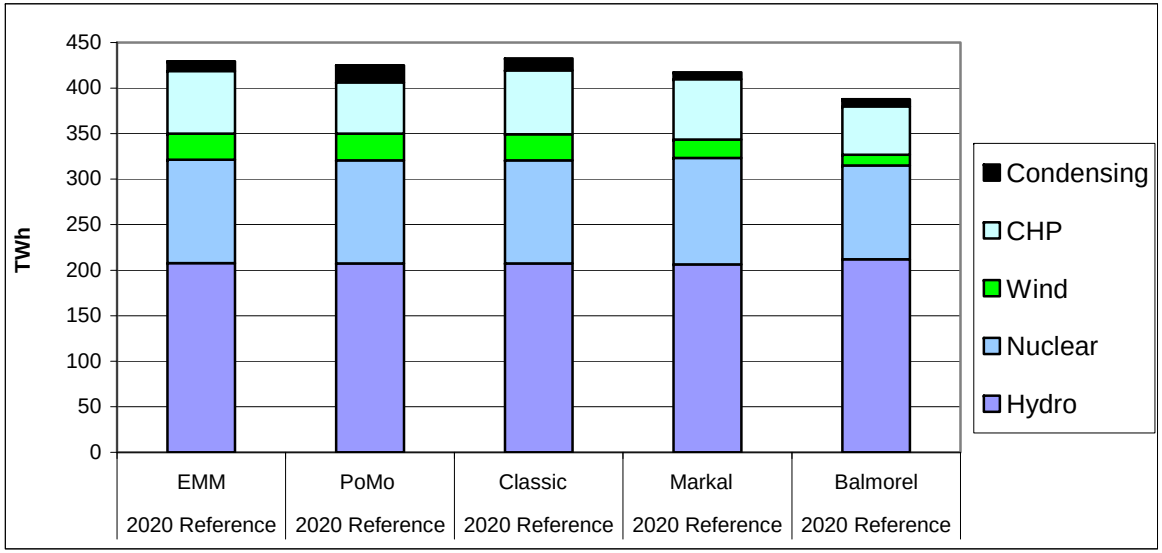
- Adjustments of trade flows:
  - EMM: Price structures and levels
  - PoMo: Weekly availability
  - Classic: Observed maximum flows

2030



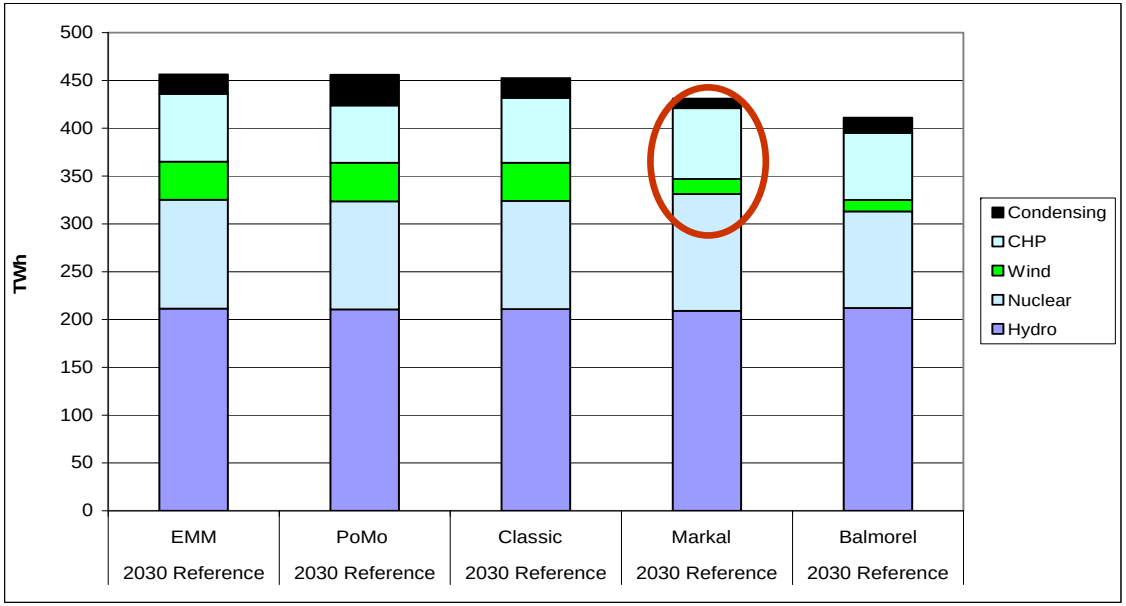
- Significant differences in trade results from different models
- None of the models capture trade accurately
  - Price structures
  - Prices in adjacent markets
  - Capacity utilization

Reference case: Electricity generation

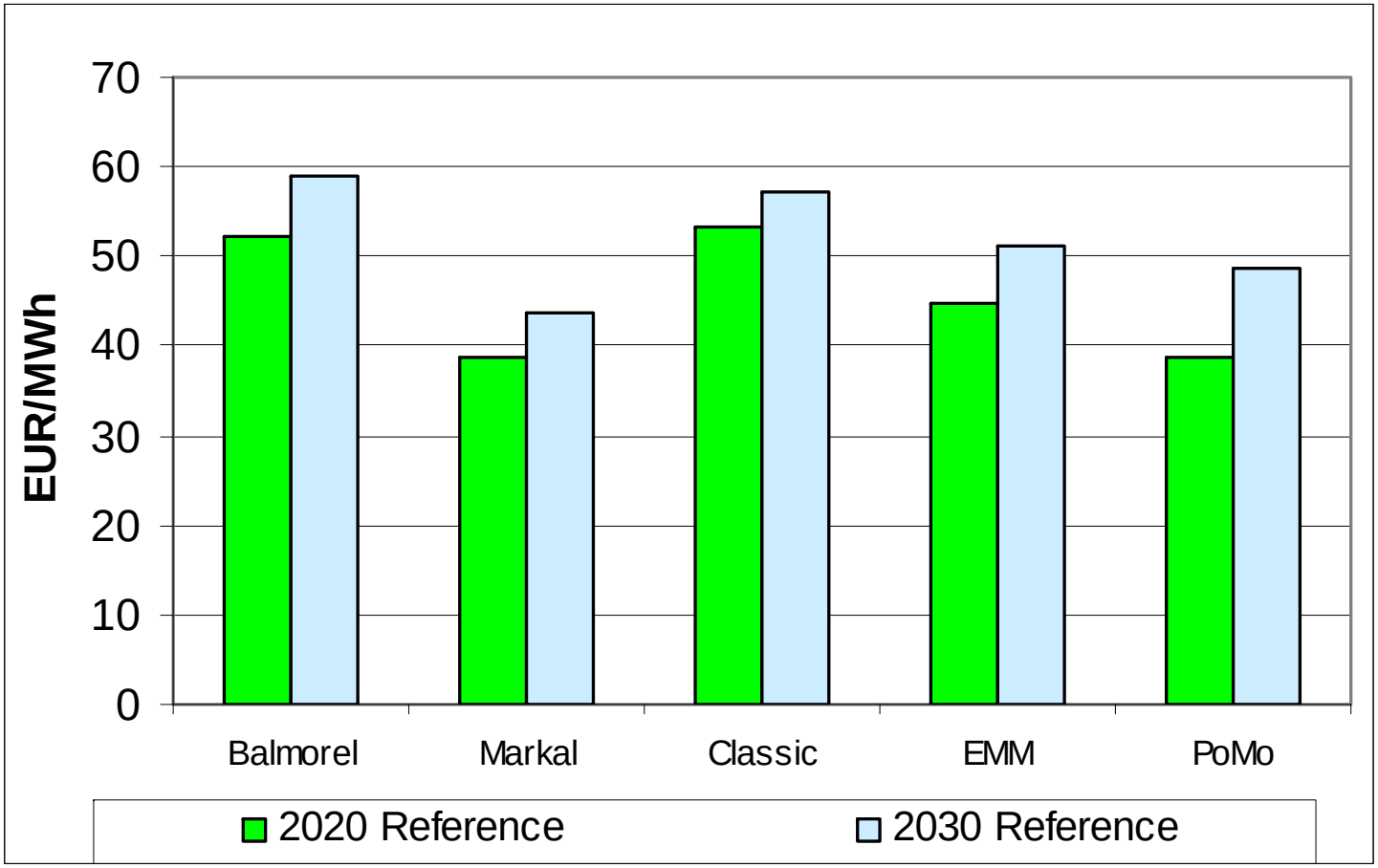


- Strong harmonization:
  - EMM: Price structures
  - PoMo: Weekly availability
  - Classic: Observed maximum flows

- Condensing fossil fuel generation marginal in the Nordic market
- … but only a small share of total generation

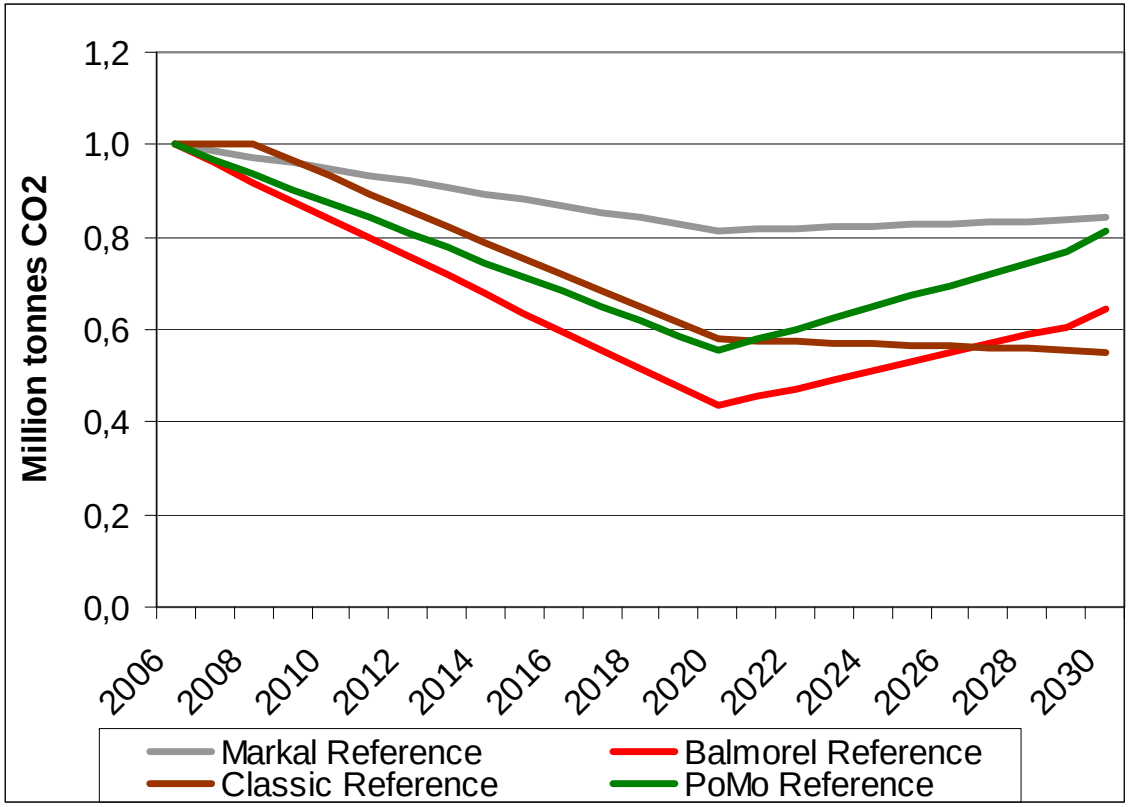


Reference case: Wholesale prices vary significantly!



- Prices increase from 2020 to 2030 in all models
- With one exception, markets are not in long-term equilibrium
- Trade and demand modelling explains a great deal, plus investments

Reference case: CO2 emissions



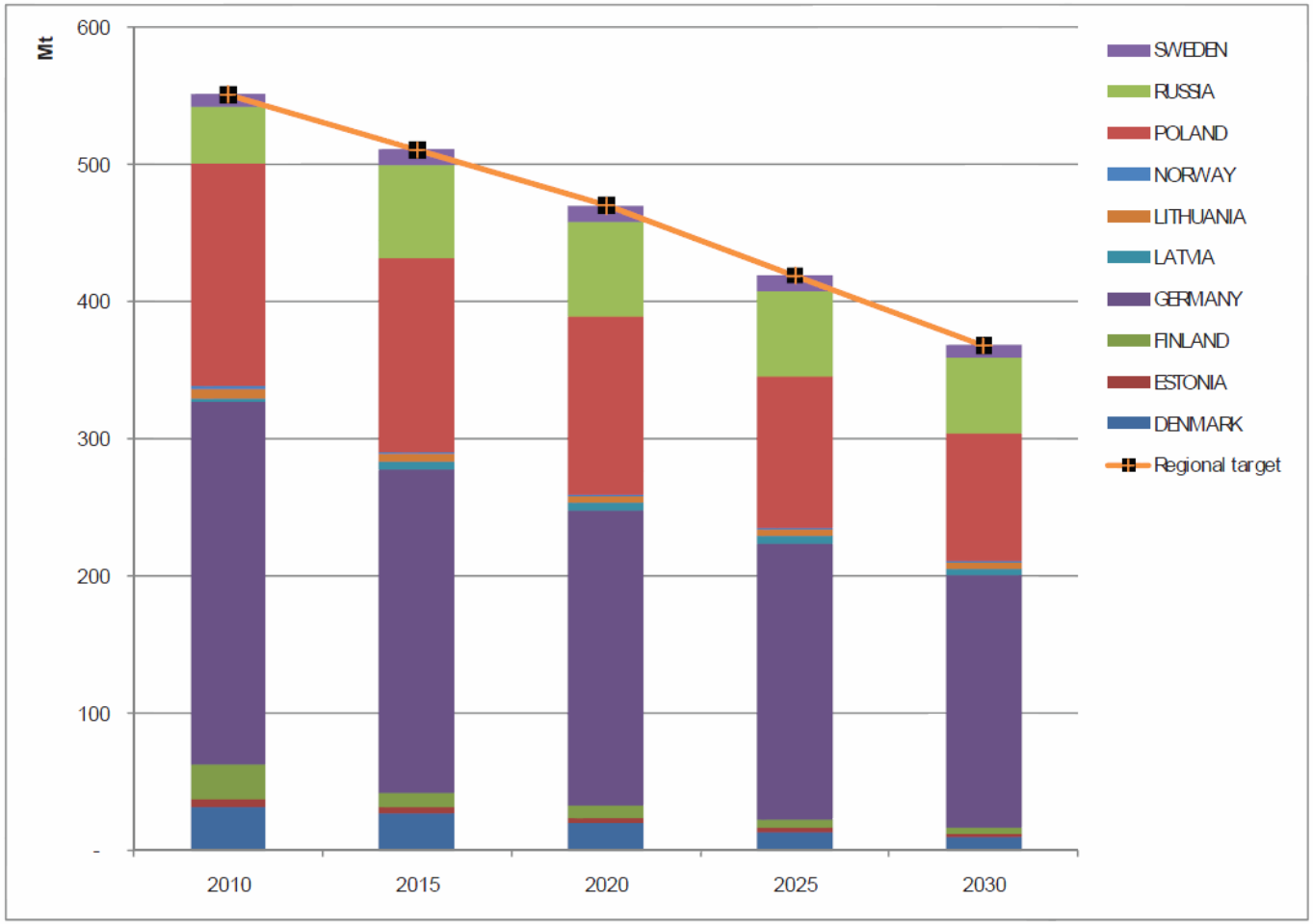
- All models yield reductions
- CO2 emission levels are not directly comparable – differences in coverage

Different model attributes and coverage affect results

- Demand representation
  - Fixed consumption: Assessments made outside the model
  - Demand elasticities: Demand responds to changes in prices and economic growth
  - Bottom-up consumption model – generates demand curve
  - Trade-offs in heat market
- Investments in new capacity
  - Exogenous input: Assessments made outside the model
  - Endogenous: According to profitability
    - Conventional capacities: Full costs vs. market price level
    - Renewables: Full costs vs. market price level and/or support level
      - Electricity only or electricity/heat/energy efficiency trade-off
    - Full investment horizon
- Trade with surrounding market areas
  - Exogenous input: Assessments made outside the model
  - Endogenous: According to price differences
    - May be adjusted to take account of simplifications in time resolution
      - Adjustment of availability (capacities)
      - Adjustment of prices in other areas
- Price structure according to time resolution
  - Seasonal prices
  - Weekly average prices
  - Load blocks
  - Hourly resolution

CO2 emissions: Baseline with 50% reduction target in the Baltic region

- Marginal CO2-price
  - 7 €/ton in 2020
  - 52 €/ton in 2030



Marginal cost of increasing RE generation

0 – 30 €/MWh in 2020

0 - 11 €/MWh in 2030

Lessons learned

- *It is not possible or desirable to harmonize all input assumptions*
- *Important results are similar in different models*
- *Important results differ between models*
- *… but we can explain why*
- *Using different models increases insights*