Transition pathways to a flexible and carbon-neutral energy system in the Nordic-Baltic region

Coupling techno-economic modelling and socio-technical analyses with a focus on social acceptance of renewable energy technologies

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Social acceptance of renewable energy technologies and infrastructures

- Social acceptance (or not) occur at different **levels** or dimensions
  - **market** acceptance - of project developers, energy producers, utilities, grid owners, consumers
  - **Socio-political** acceptance - opinion in society, media, national institutions, politics
  - **Community** acceptance - of people living near energy projects

- Social acceptance of renewables at socio-political and community levels can significantly affect if and how countries or regions reach clean energy targets.

- Social acceptance is influenced not only by 'objective' financial and physical impacts, which may be managed through **economic and engineering approaches** … perception, knowledge and learning, equity and procedural justice may be equally important, calling for **socio-technical and political approaches** to renewable energy deployment and integration.

- The **physical properties** of the energy technology clearly matters for social acceptance, as it means impacts on landscapes, environment, human health, smell, noise, property value

- Instrinsic **economic properties** of technologies can also affect acceptance, for example regarding options for job creation (e.g. biogas), local ownership, effects on domestic power prices (transmission lines).

- Associated **supply chains or infrastructures** can cause low acceptance in some cases, e.g. sustainability impacts along biomass supply chains, power lines connecting offshore wind parks to the grid on land.

- The **geographical context** in which the technology is deployed is important for acceptance, e.g. regarding settlement patterns, current density of energy infrastructure, environmental conditions, tourism, local political culture, level of unemployment, etc.

- Geographical factors interact with intrinsic properties of the technologies to produce **case-by-case outcomes**.

Research aim and questions

Aim

To assess the influence of socio-technical factors on transition pathways to a carbon-neutral energy system in the Nordic-Baltic region in 2050.

Research questions

1) How does social acceptance of energy technologies affect key energy system attributes in a carbon-neutral 2050 scenario?

   Attributes: Investments in generation capacity, storage capacity,
   Consumer costs, system costs, power price, producer revenues

2) What are the distributional welfare effects of transition pathways for different types and levels of social acceptance?

   Indicators: Changes in consumer costs versus in producer revenues

Methods

- **Review of literature on social acceptance** of renewable energy technologies and infrastructures
  - Wind power
  - High-voltage transmission lines (interconnectors), transmission capacity
  - Solar photovoltaics
  - Biomass
  - Demand response technologies (smart homes, smart devices, smart meters etc.
  - Direct 'planning and permitting costs' of renewables in the EU

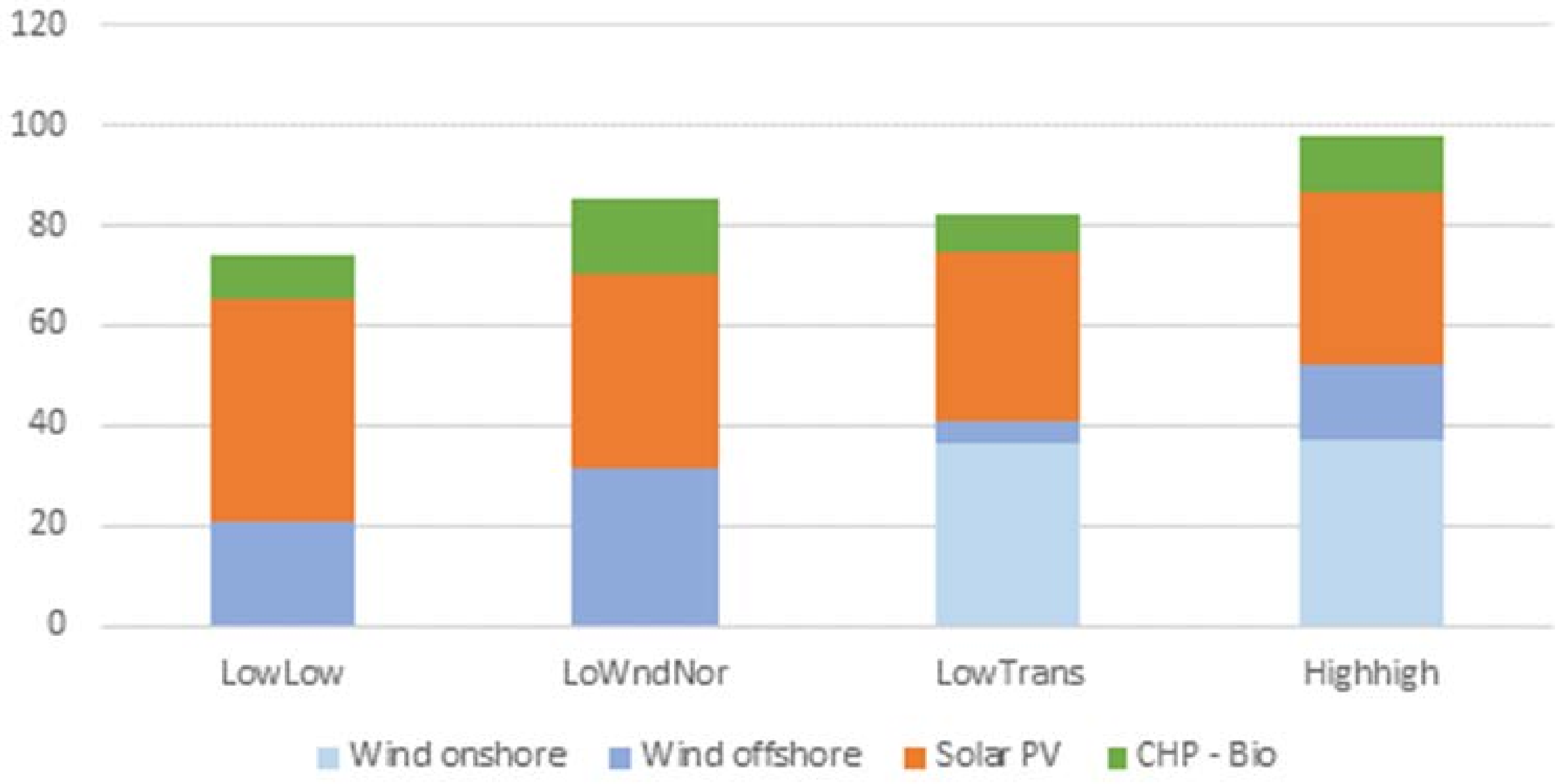
- **Model runs of scenarios** representing different levels of social acceptance, 2020-2050
  - Balmorel energy-economic optimisation model for North-West Europe, i.e. Nord Pool
    - Least cost solutions meeting energy supply and demand balance
    - Baltic and Nordic countries
    - Rest of NW Europe - UK, Netherlands, Belgium, Germany, Poland

'Social acceptance' scenarios

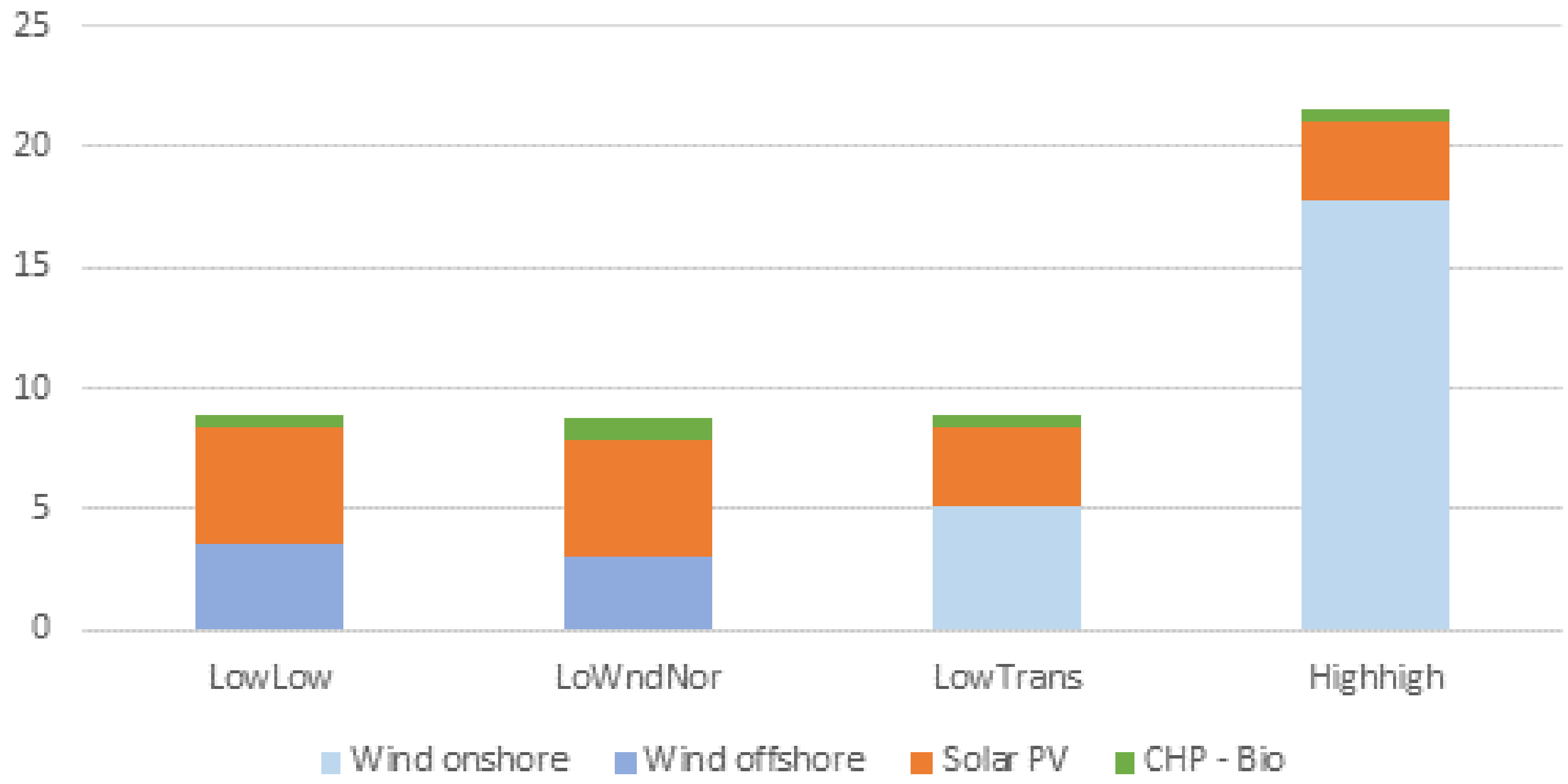
Differences in **assumptions on investments** in on/nearshore wind power and high-voltage electricity transmission lines between countries, in the Nordic-Baltic region:

1. **LowLow:** No more onshore or nearshore wind power will be built in the Nordic-Baltic countries, except for the already planned projects. We make the same assumption for transmission between countries.
2. **LowWind:** Same as in the "LowLow" scenario, but new investments in transmission are possible from 2030.
3. **LowTransmission:** Same as "LowLow", but new investments in wind power are possible.
4. **HighHigh:** New investments in both on/nearshore wind power and transmission are possible.

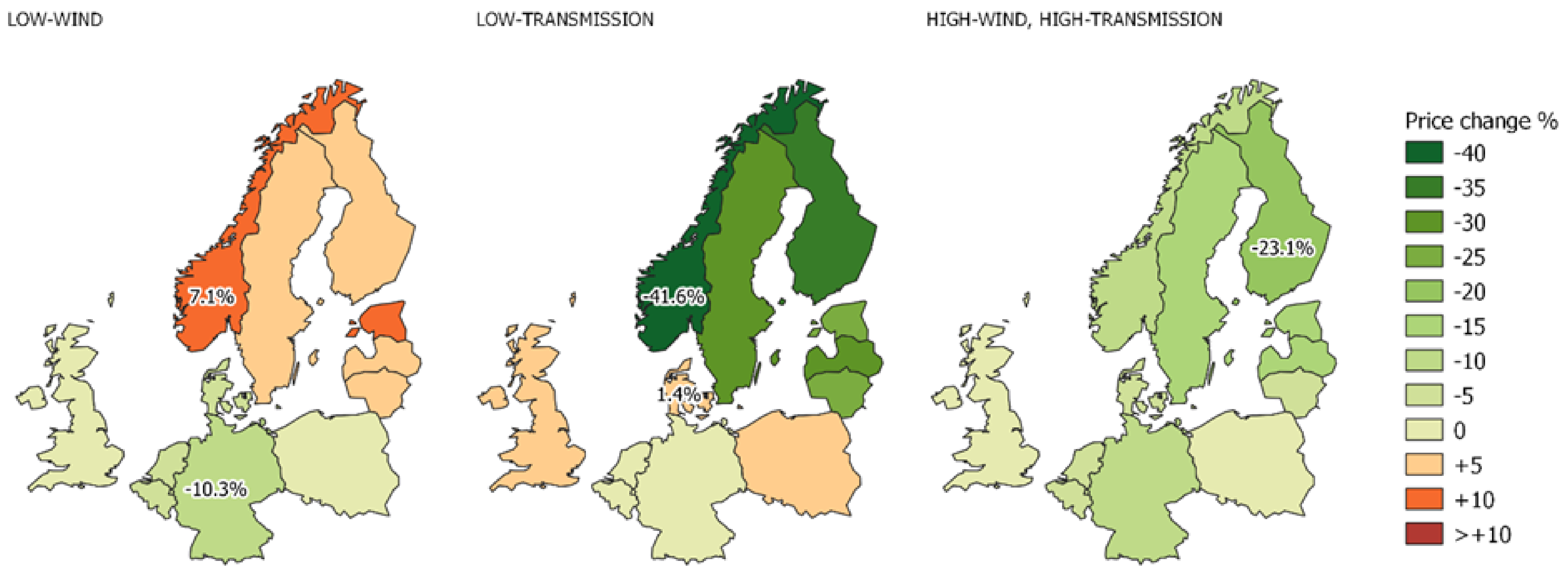
Generation capacity investments (GW), 2030-2050, Nordic countries



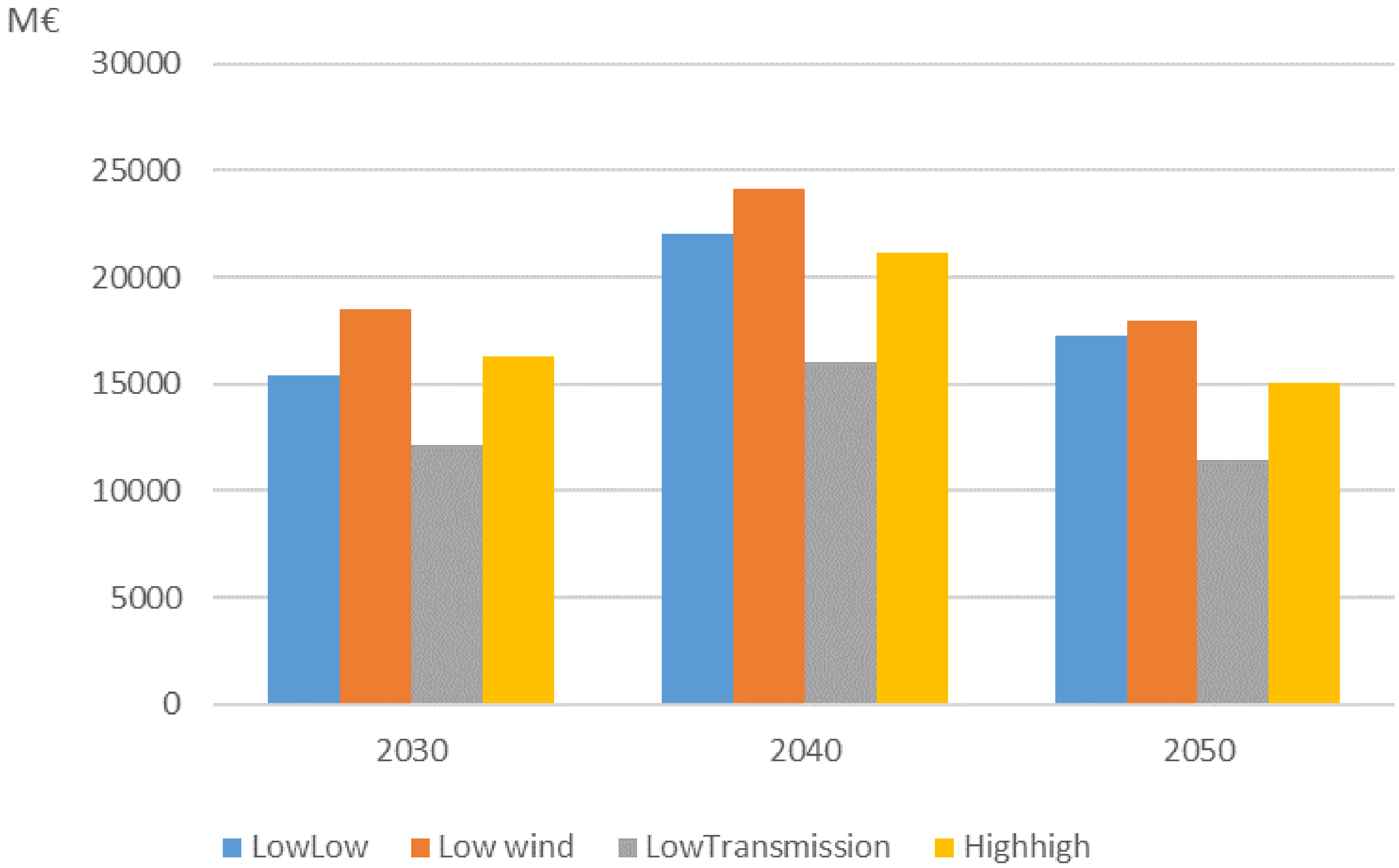
Generation capacity investments (GW), 2030-2050, Baltic countries



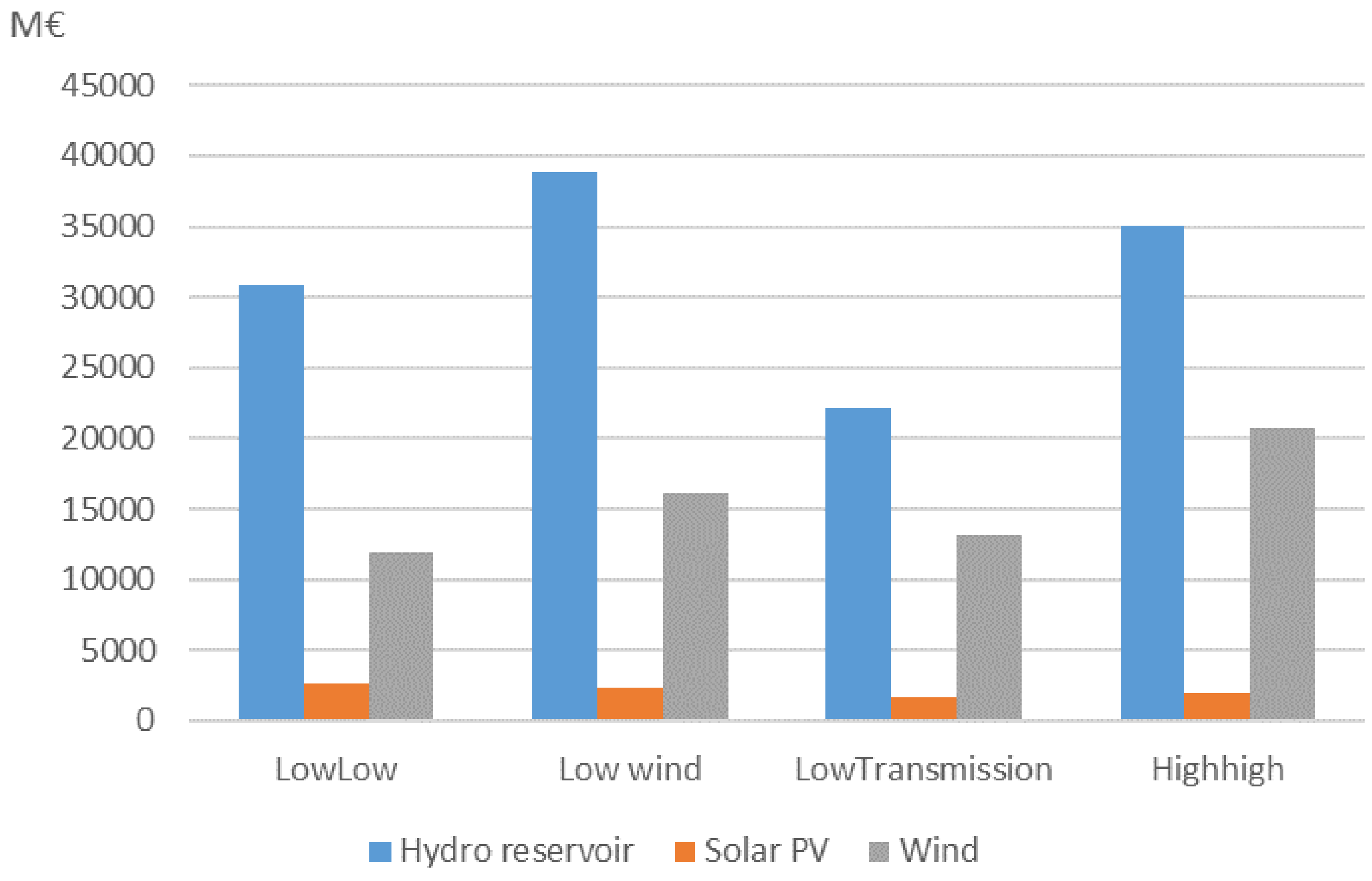
Changes in power prices in 2050 compared to the LowLow scenario (%)



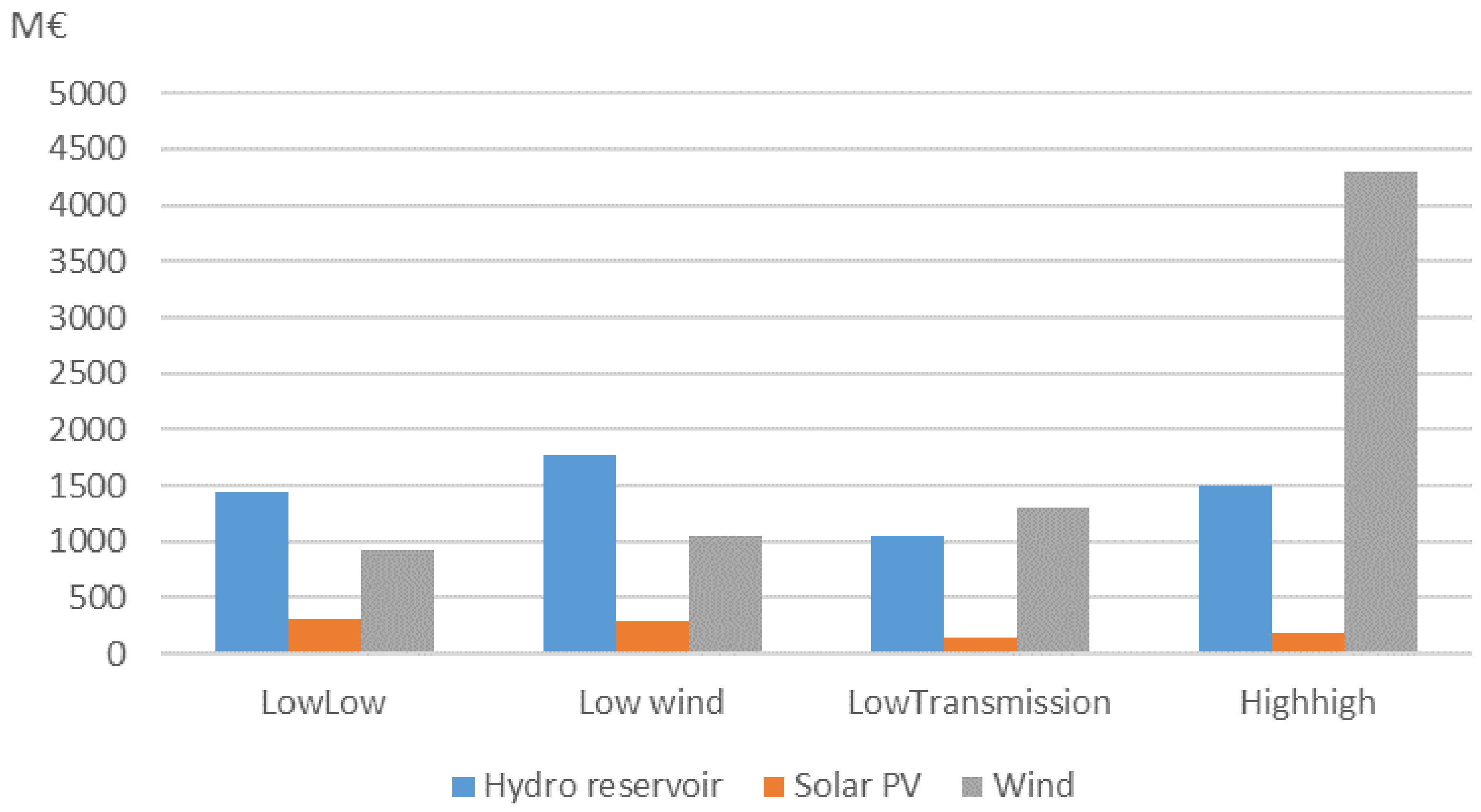
Consumer costs of electricity, Nordic countries



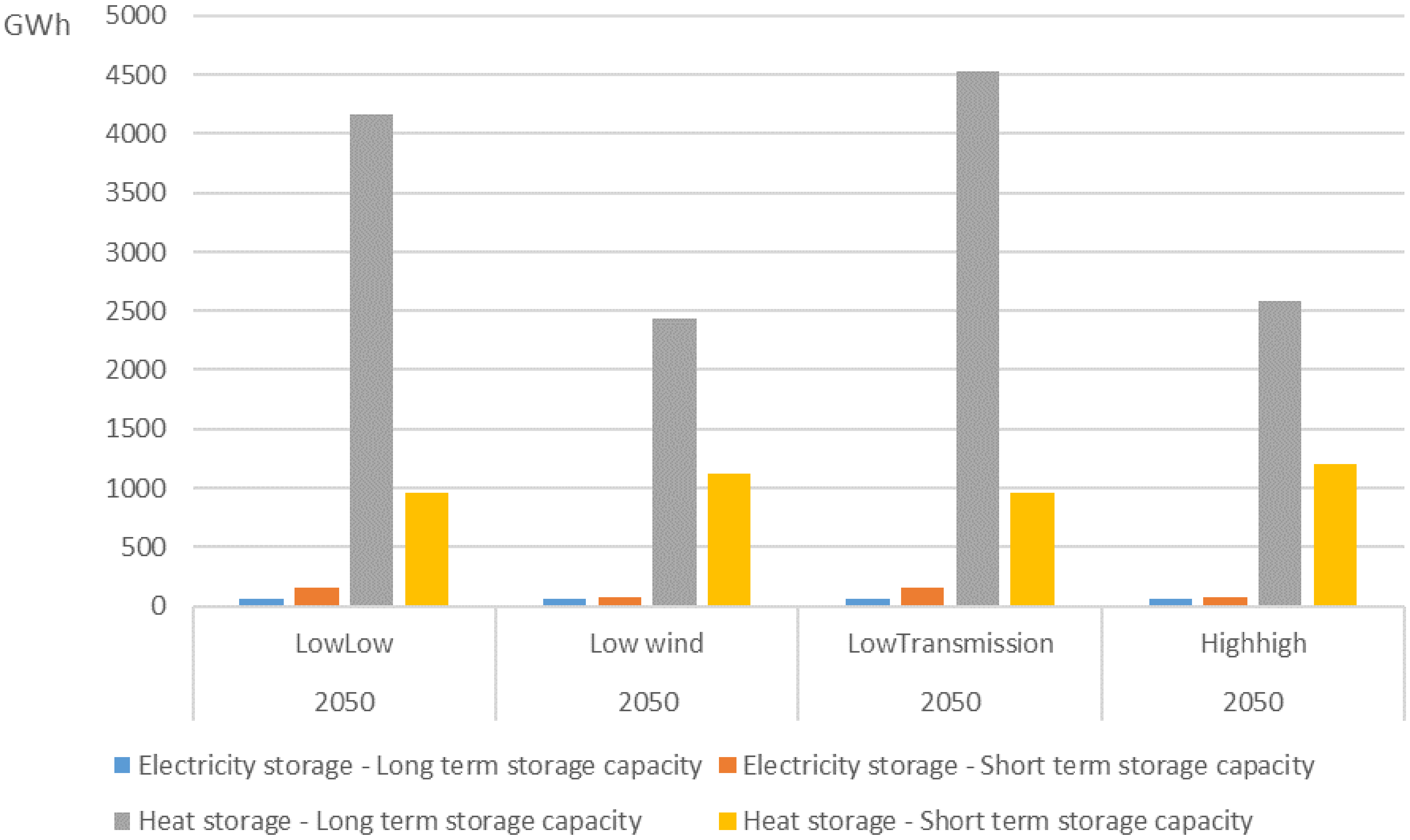
Producer revenues in 2050, Nordic countries



Producer revenues in 2050, Baltic countries



Storage capacity for all model countries in 2050



Preliminary conclusions

- Nordic-Baltic has **onshore wind resources that can contribute significantly to a cost-efficient decarbonisation of the North-West European energy system.** With no restriction in investments, 40 GW (Nordics) and 20 GW (Baltics) of new onshore wind power would enter the market in 2030-2050.

- **Producers** of onshore wind and reservoir hydropower in Nordic-Baltic would **benefit** from few or no restrictions to investments in wind power and transmission lines

- **Consumers** in Nordic-Baltic would **suffer** from higher costs of electricity.

- If **low social acceptance** restricts onshore wind power, investments, **solar PV** and **offshore wind** would replace the onshore wind investments (**high carbon prices**).
- With **low carbon prices**, **gas power** would take a large share of the investments.

- Trade-off between:
  - investments in onshore wind and transmission lines, and
  - more expensive alternative of de-centralized solar PV and storage technologies

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- #flex4RES

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