Insights from the European electricity sector transition to 2035: technologies, co-benefits, and models

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27 September 2023
UNCTAD expert meeting
For today

• European electricity sector transition to 2035 and the parallels to other countries
• Certain, optional, and declining technologies
• Co-benefits for policies across sectors
• The need for spatially-explicit energy models
Long-term carbon neutrality

Net-zero carbon emission targets

European Green Deal

Projected electricity generation (%)

Source: Net Zero Tracker, Energy and Climate Intelligence Unit, Data-Driven EnviroLab, NewClimate Institute, Oxford Net Zero, OurWorldInData.org/co2-and-greenhouse-gas-emissions - CC BY

Technologies for 70% emissions reduction in electricity sector by 2035 (1)

Source: Sasse & Trutnevyte (2023) Nature Communications
Technologies for 70% emissions reduction in electricity sector by 2035 (1)

Frozen generation and storage capacity (continuation of today)

Minimum system costs (70% emissions reduction)

Source: Sasse & Trutnevyte (2023) Nature Communications
Technologies for 70% emissions reduction in electricity sector by 2035 (2)

Source: Sasse & Trutnevite (2023) Nature Communications

*MGA – Modeling to Generate Scenarios
Technologies for 70% emissions reduction in electricity sector by 2035 (2)

Certain technologies
Cost competitiveness, growing markets, decreasing risk, modular and hence easier projects etc.

Source: Sasse & Trutnevyte (2023) Nature Communications

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Technologies for 70% emissions reduction in electricity sector by 2035 (2)

Certain technologies
Cost competitiveness, growing markets, decreasing risk, modular and hence easier projects etc.

Declining technologies
Declining markets and supply chains, ever increasing transition risk, high complexity of nuclear projects etc.

Source: Sasse & Trutnevye (2023) Nature Communications

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Technologies for 70% emissions reduction in electricity sector by 2035 (2)

- Wind (onshore)
- Wind (offshore)
- Solar (roof)
- Solar (open)
- Geothermal
- Biogas
- Woody biomass
- Waste
- Hydro dams
- Hydro run-of-river
- Small hydropower
- Nuclear
- Gas
- Oil
- Hard coal
- Lignite
- Pumped hydro
- Battery
- Hydrogen

**Certain technologies**
Cost competitiveness, growing markets, decreasing risk, modular and hence easier projects etc.

**Optional technologies**
Good low-carbon technologies with limited market potential (e.g. geothermal) or some risk/uncertainty (hydrogen)

**Declining technologies**
Declining markets and supply chains, ever increasing transition risk, high complexity of nuclear projects etc.

Source: Sasse & Trutnevyte (2023) Nature Communications
Co-benefits of carbon emissions reduction in Europe

Synergies with other policy goals

New investment and hence regional growth

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Co-benefits of carbon emissions reduction in Europe

Synergies with other policy goals

New investment and hence regional growth

New direct employment locally, but the workforce needs to be ready to avoid bottlenecks

Source: Sasse & Trutnevyte (2023) Nature Communications
Co-benefits of carbon emissions reduction in Europe

Synergies with other policy goals

- New investment and hence regional growth
- New direct employment locally, but the workforce needs to be ready to avoid bottlenecks
- Air pollution, improved health, reduced mortality, healthcare savings

Source: Sasse & Trutnevyte (2023) Nature Communications
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**Synergies with other policy goals**

- New investment and hence regional growth
- New direct employment locally, but the workforce needs to be ready to avoid bottle necks
- Air pollution, improved health, reduced mortality, healthcare savings
- Lower electricity prices are more likely than not (depends on the scenario)

Source: Sasse & Trutnevyte (2023) Nature Communications
Building up capacity for spatially-explicit energy modeling

Benefits of such models:
- Long-term planning and short-term operation of generation and grids
- Help for siting projects
- Especially suitable for decentralized generation, like PV and wind

Prerequisites:
- Open data and code
- Open-source modeling tools
- Open documentation
- Training and building own modeling capacity

Minimum system costs

Sasse & Trutnevyte (2023) *Nature Communications*

Joshi et al. (2021) *Nature Communications*

Kenya

Müller et al. (2023) *Applied Energy*

China

Chen et al. (2021) *Joule*
For today

- European electricity sector transition to 2035 and the parallels to other countries
  Fundamental and rapid transformation of the electricity sector is a priority

- Certain, optional, and declining technologies
  Solar PV and wind power are wise choices. Fossil fuels and nuclear power are declining technologies. Other low-carbon electricity technologies are also needed, but are unlikely to become key players (e.g. geothermal) or are still risky today (e.g. hydrogen)

- Co-benefits for policies across sectors
  Climate mitigation offers co-benefits of attracting investment, creating jobs, reducing air pollution, improving health, and likely reducing electricity price

- The need for spatially-explicit energy models
  It is time to set up open-access spatially-explicit models and build up own capacity to develop and use such model
Thank you very much for your attention!

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