Kick-off CEDREN
The future needs of large-scale balancing and energy storage in Europe

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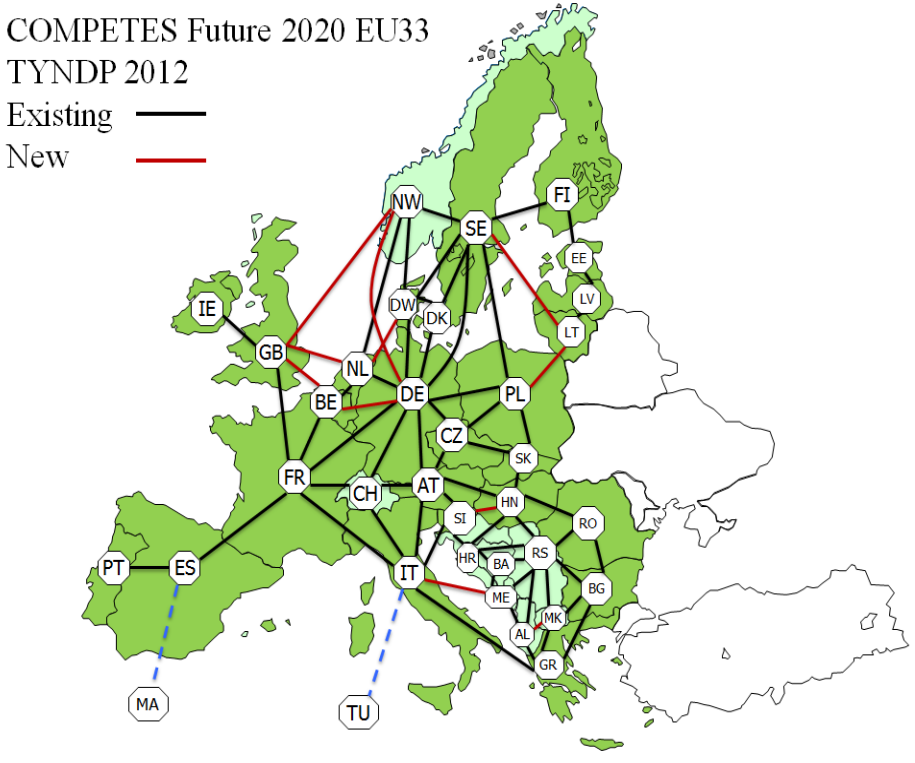
ECN Policy Studies

- Main themes
  - Renewables, national policy advise, energy markets, energy demand and consumers, international climate policy
- Relevant expertise
  - Market knowledge: new and closing plants, fuel prices, renewables capacity and profiles, regulation, policies and structure of energy markets
  - Technical information: supply technologies, demand side response, smart grids, transmission
  - Various modeling tools
- Relevant modeling tools
  - COMPETES-electricity market model for Europe
  - OPERA-integrated energy system model for the Netherlands

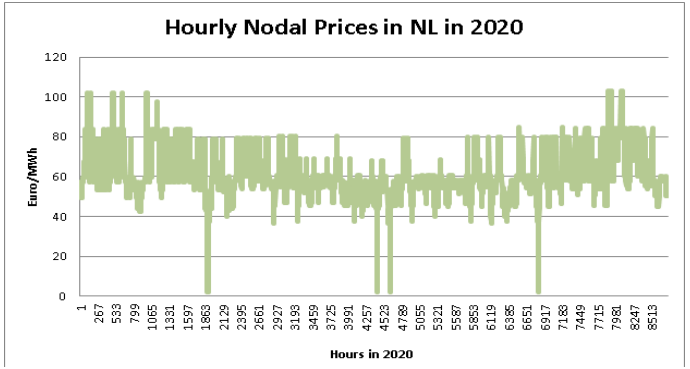
Modeling Tools (1)-COMPETES

- European electricity market model
  - Minimization of operation costs
  - Hourly dispatch
    - *Power balance constraints*
    - *generation availability constraints*
    - *cross-border transmission constraints*
- Endogenous investment in generation capacity
  - Two-period model
  - Optimal generation capacity portfolio under perfect competition



Modeling Tools (2)-COMPETES

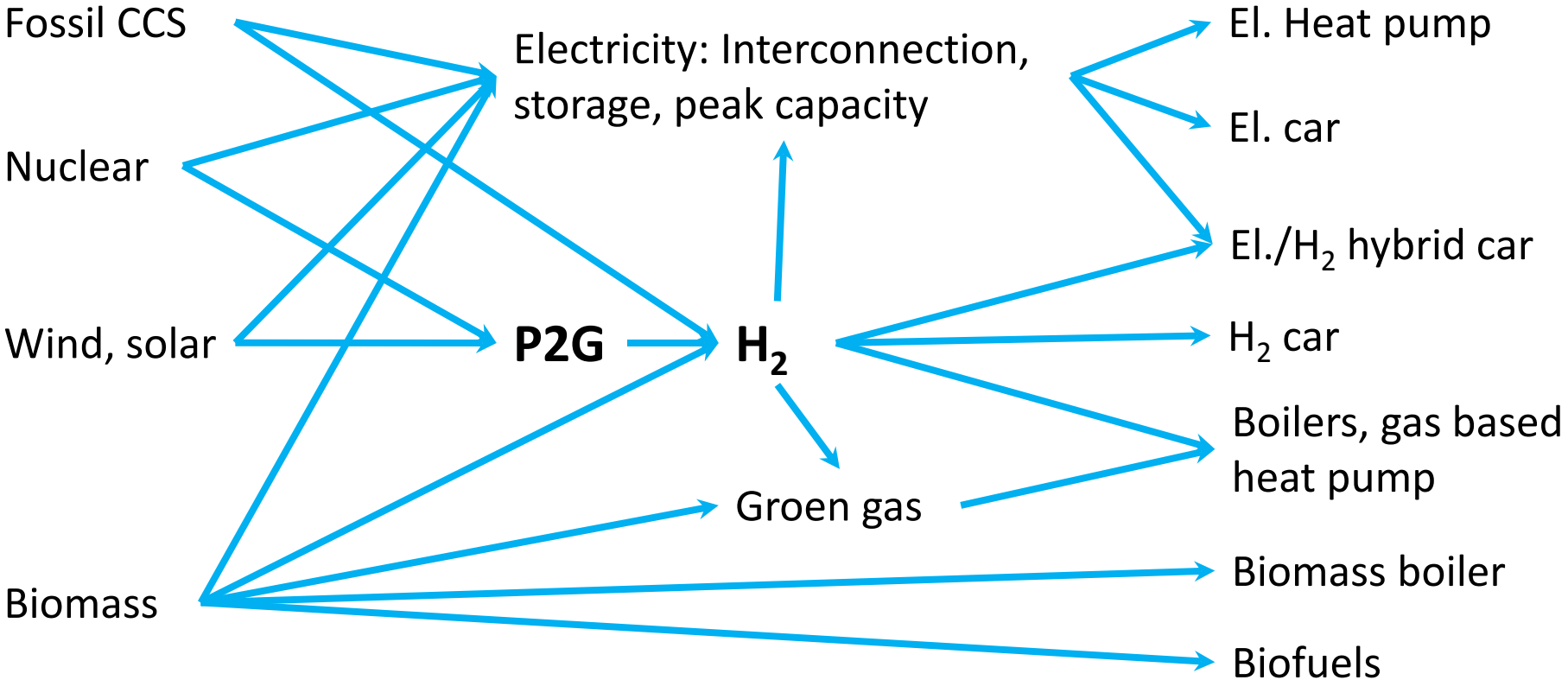
- Wide-range of RES and conventional generation technologies
- Wind and solar intermittency
- Cross-border transmission limitations (e.g., NTC values)
- Perfect competition equilibrium: Dispatch minimizing total generation and load-shedding costs subject to electricity market constraints
- Main Outputs
  - The allocation of generation and transmission capacity.
  - Hourly perfectly competitive prices per country
  - Hourly commercial flows and congestion pattern per interconnection
  - Yearly generation mix in each country
  - CO_2 Emissions
  - ***Dyn:*** Optimal generation capacity investments under energy-only or capacity markets



Modeling Tools (3)-OPERA

- Integrated energy system model of the Netherlands
- Top-down approach to evaluate the potentials of flexibility options in the Netherlands
  - Renewables, nuclear, fossil, biomass
  - Wind, Solar-PV, CHP, CCS, P2G
  - Gas grid, electricity grid, H_2-grid
  - Electricity, hydrogen, heat, feedstocks, transport fuel, energy savings
- Scoring possible options on:
  - Potential, emissions, cost effectiveness , flexibility/intermittency/storage, capacity & costs infrastructure, required increase infrastructure, growth limitations, (chain)efficiency, investments, dependency on foreign supplies etc.

Modeling Tools (4)-OPERA



- Explore alternative transition paths via model simulations
- Search for best solutions from public perspective

Integrating large scale intermittent renewables in future EU electricity markets

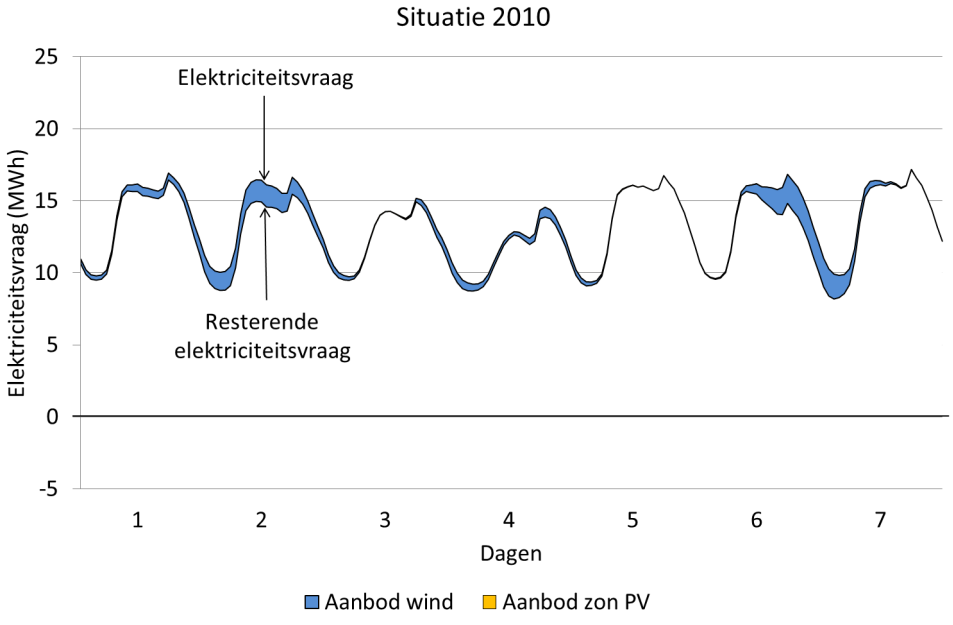
- EU transition to a low carbon energy system by 2050

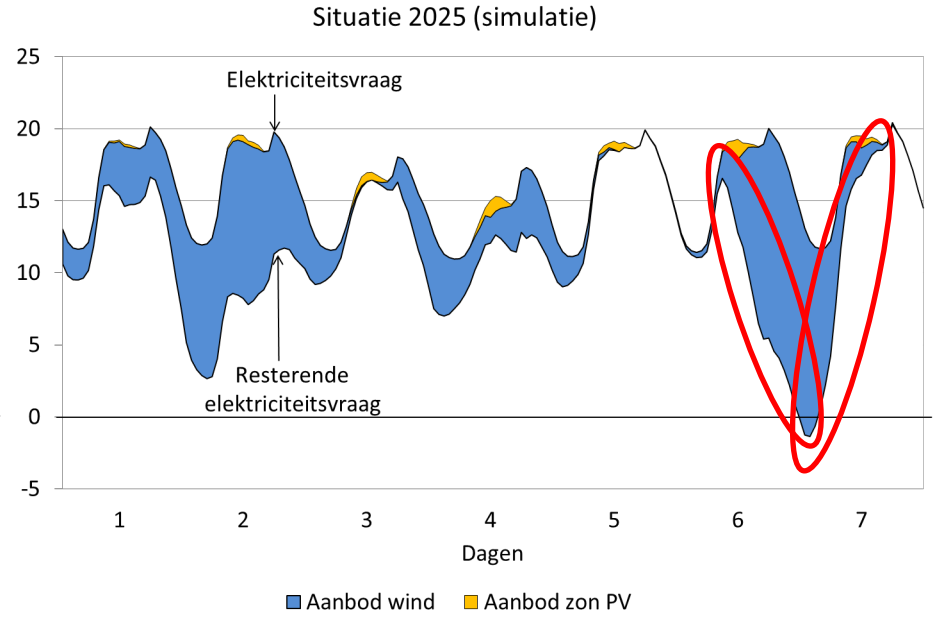
- Much higher shares of wind power generation in electricity sector
  - Increase in variability of generation from intermittent renewables
  - Uncertainty in wind generation (forecast-errors)

- Significant increase in demand for flexibility
  - Short-term flexibility: Balancing of wind generation due to forecast errors
  - Long-term flexibility: Flexible demand and supply options to deal with variability of wind power generation

Increasing need for flexibility in the electricity system

- Increase in installed generation from wind & solar PV
- Increase in variability of generation from intermittent renewables





Source: ECN

Main sources of flexibility

Supply-side flexibility

Demand response (via smart grids)

Flexibel production

Interconnection capacity

Energy storage (e.g., hydro storage)

Economic and market challenges

- Intermittent Renewables (wind, solar)
  - Low or zero marginal costs
  - Intermittent supply
- Consequences
  - Increasing need for supply-side flexibility
  - Missing money problem increases
    - Lower electricity prices when renewable energy sources produce electricity
    - Less operating hours for supply-side flexibility
  - Alternative market designs to incorporate demand for flexibility

Recent/on-going projects addressing integration of intermittent renewables

Ministerie van Economische Zaken, Landbouw en Innovatie

Financing investments in new generation capacity

Study on the incentives for investments in new generation capacity with an increasing share of renewable energy in the generation mix and the effects of introducing a national capacity market in Germany on the electricity markets in neighboring countries including the Netherlands. This has been examined with the European electricity model COMPETES.

ECN 2012

Ministerie van Economische Zaken/ Ministerie van Milieu

Reference projections and additional policies 2010-2020

A national baseline scenario was developed for energy, greenhouse gases and air pollutants. The aim of the project was also to evaluate the Clean and Efficient programme of the Dutch Government. Three variants op the projections include without policies, with implemented policies and with proposed policies. On top of this, over 40 additional policy options were separately analyzed. In 2012, an update was done up to 2030.

ECN 2009-2012

Agentschap NL
Ministerie van Economische Zaken

North Sea Translational Grid

The impact of wind offshore generation on the benefits of the major players in the electricity sector are analyzed from a social welfare perspective within a set of North Sea Transnational Grid scenarios. ECN uses COMPETES model for the economic analysis.

ECN 2012-2013

Ministerie van Economische Zaken, Landbouw en Innovatie

A Social Cost Benefit Analysis of interconnection capacity to the Netherlands

This study developed a A Social Cost Benefit Analysis (SCBA) was developed to secure optimal contribution of the investments in interconnection to the social welfare of the involved countries. With COMPETES a case study was conducted of a 'fictitious but realistic' investment project in interconnection to illustrate how certain social effects from the developed SCBA framework can be practically and concretely established.

ECN 2012

New Energy World

Power to Gas

Assessment of the potential, actors, and relevant business cases for hydrogen underground storage to support large scale integration of intermittent renewable energy in Europe. 6 case studies (France, Germany, Netherlands, Romania, Spain, UK), supported by a wide range of affiliated parties. ECN is conducting the case study for the Netherlands

ECN 2012-2014

Relevant research topics on Hydro balancing in the North-West Europe

- The potential and cost of hydro balancing compared to other flexibility options
  - Increase in exports from Norway to main land EU
  - Costs for hydro and transmission capacity expansion
- Business cases for hydro capacity expansion
  - Price volatility and financial risks in current energy-only market designs
  - Additional market mechanisms to incorporate demand for flexibility
  - Minimum price for flexibility to attract hydro capacity investments

Thank you for your attention!

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