Energy modeling with PANTA RHEI

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Integrated model: economic core module INFORGE

- Basic dataset: input-output tables and national accounts
- Bottom-up structure
  - ⇨ 59 sectors determine macro-economic aggregates
- Total integration
  - ⇨ interdependences between sectors and macro-economic development
  - ⇨ Accounting consistency is guaranteed („closed system“)
  - ⇨ Iterative solution (simultaneous solution of non-linear functions)

- Econometric estimation of parameters
  - ⇨ Limited rationality of economic agents
  - ⇨ Imperfect market forms
  - ⇨ Prices are partially sticky
- Main features:
  - ⇨ Demand and supply side are equally considered
    - Production is determined via the Leontief-equation
    - Demand depends among others on relative prices
  - ⇨ Variable input coefficients determine technological change
- Detailed additions like energy balances, energy prices per carrier and consumer
  - ⇨ Variables in IO sectors determined by aggregation

Recent applications:

- **Energy scenarios for the German energy concept (2010)**
  http://www.bmu.de/english/energy_efficiency/doc/47548.php
  http://www.bmu.de/files/english/pdf/application/pdf/energiekonzept_bundesregierung_en.pdf

- **Short and long-term impacts of the expansion of renewable energy on the German labour market (ongoing)**
  http://www.bmu.de/english/renewable_energy/downloads/doc/46910.php

- **Energy efficiency:**
  Study on „Economic impacts of the National Climate Initiative“
  http://www.bmu.de/english/climate_initiative/general_information/doc/42000.php

Policy background of the energy scenarios

Policy background

- **German government decided in late 2009 to develop a new energy concept on the basis of scenarios within 1 year**
- **objectives**
  - ⇨ Reach climate mitigation targets
  - ⇨ Shape the way towards a renewable future
  - ⇨ Clarify the role of different energy carriers

  with a focus on nuclear:
  - ⇨ Building of new power stations no option
  - ⇨ 2/3 of the population and all opposition parties against nuclear
  - ⇨ Sell it as a “bridge” technology towards renewables

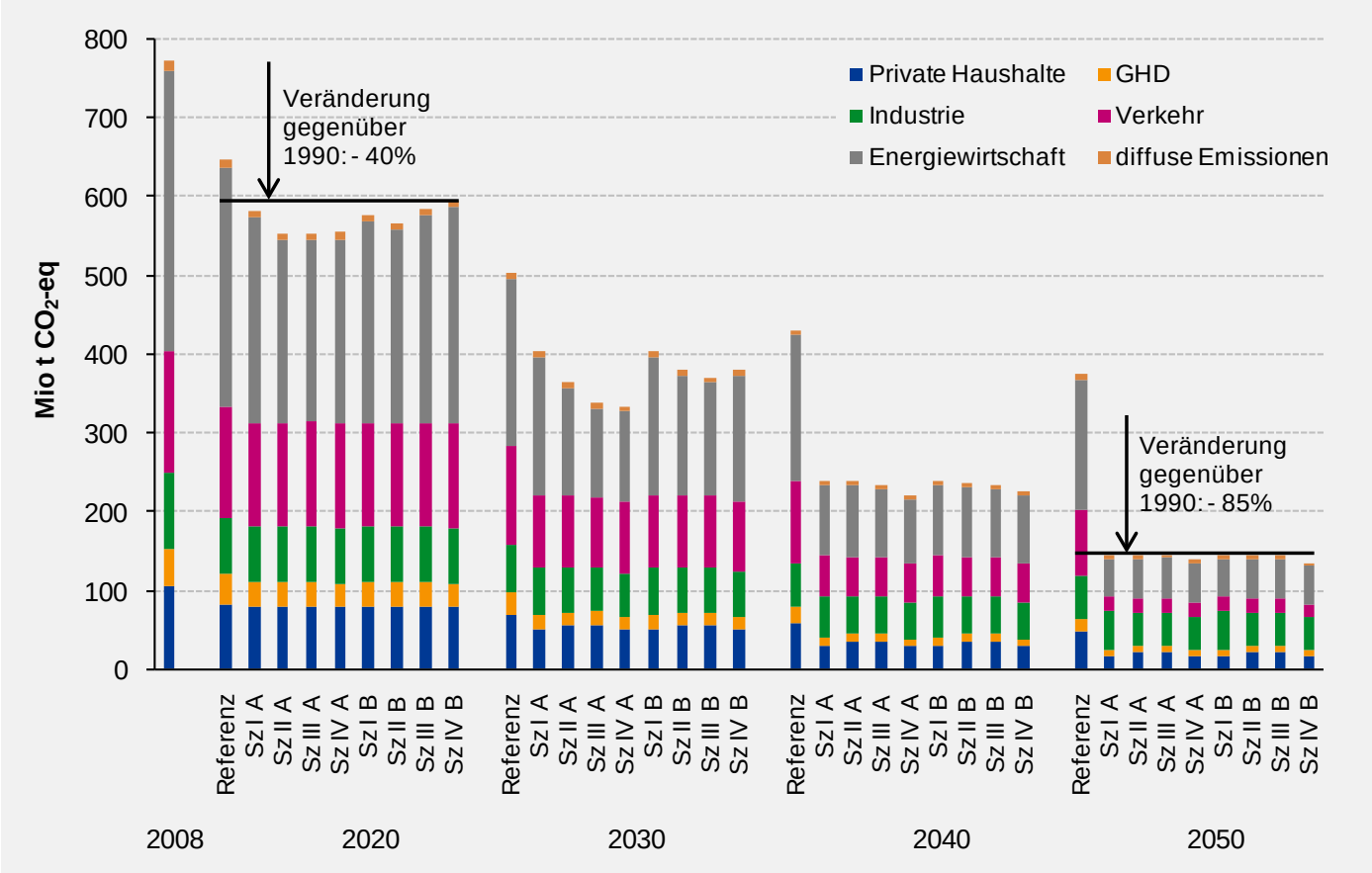
- **Study started in April 2010, commissioned by Ministries of Economy and Environment (Office of the chancellor involved)**
- **As German government started very badly after 2009 elections, energy policy was in the focus of media**

Energy scenarios for the German energy concept

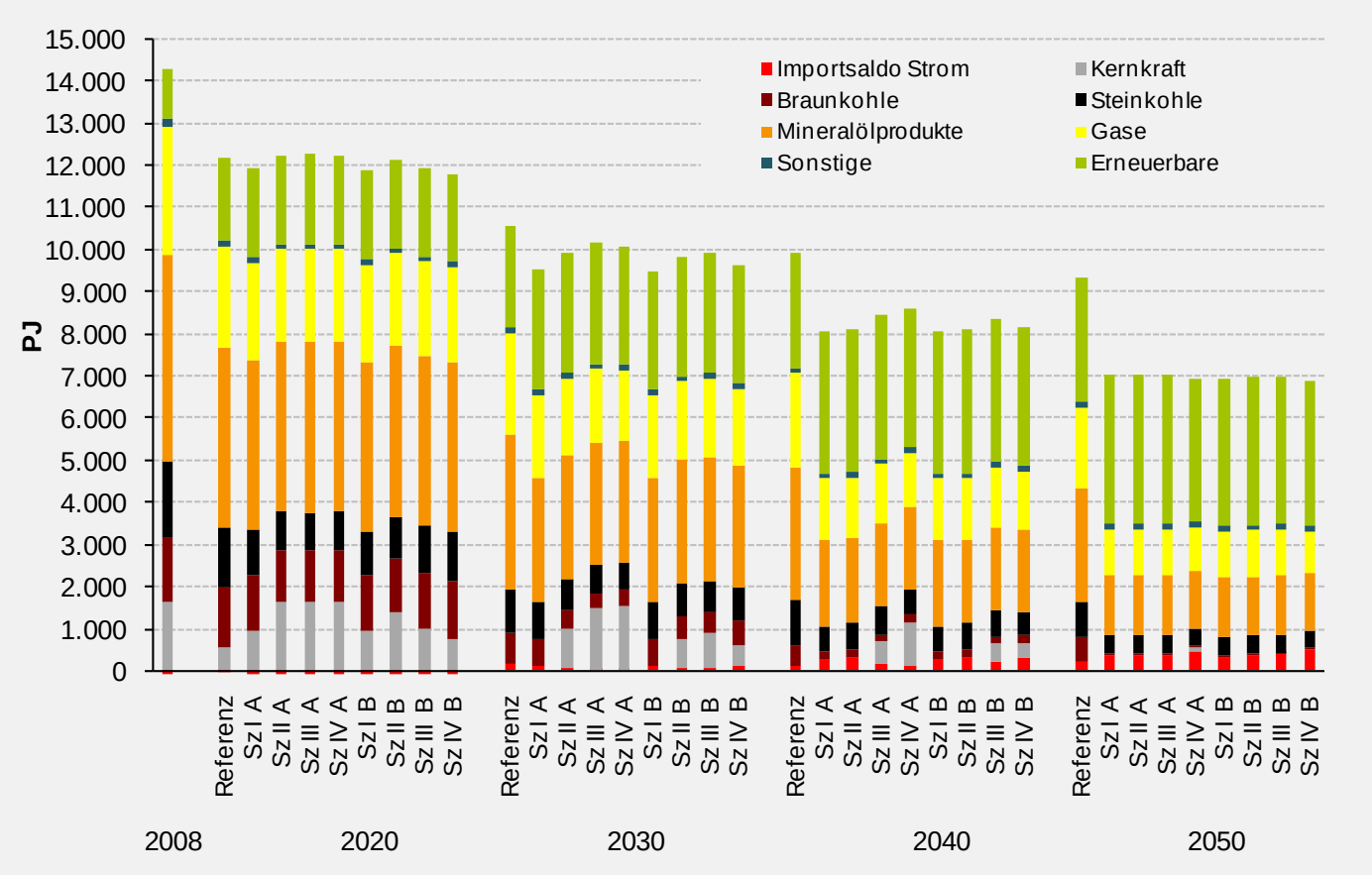
- **1 reference**
  - ⇨ Past trends continue
  - ⇨ Additional assumptions for long-term GDP growth (1%), international energy prices, international climate agreement until 2020, carbon tax
- **8 target scenarios (targets are reached):**
  - ⇨ GHG emission reduction: 40 % until 2020, 85% in 2050 (against 1990)
  - ⇨ Renewable Energy: 18% in gross final energy consumption in 2020; more than 50% in primary energy supply in 2050
  - ⇨ Energy efficiency increase (ambitious)
  - ⇨ Longer lifetime of nuclear power plants:
    - 4 – 12 – 20 – 28 years more than decided in 2002 (2022-2025)
    - 2 different sets of investment costs (security standards)
- **Consortium:**
  - ⇨ Prognos, Basel: final energy demand
  - ⇨ EWI, University of Cologne: electricity market
  - ⇨ GWS, Osnabrück: economic impacts

Main results for the energy part

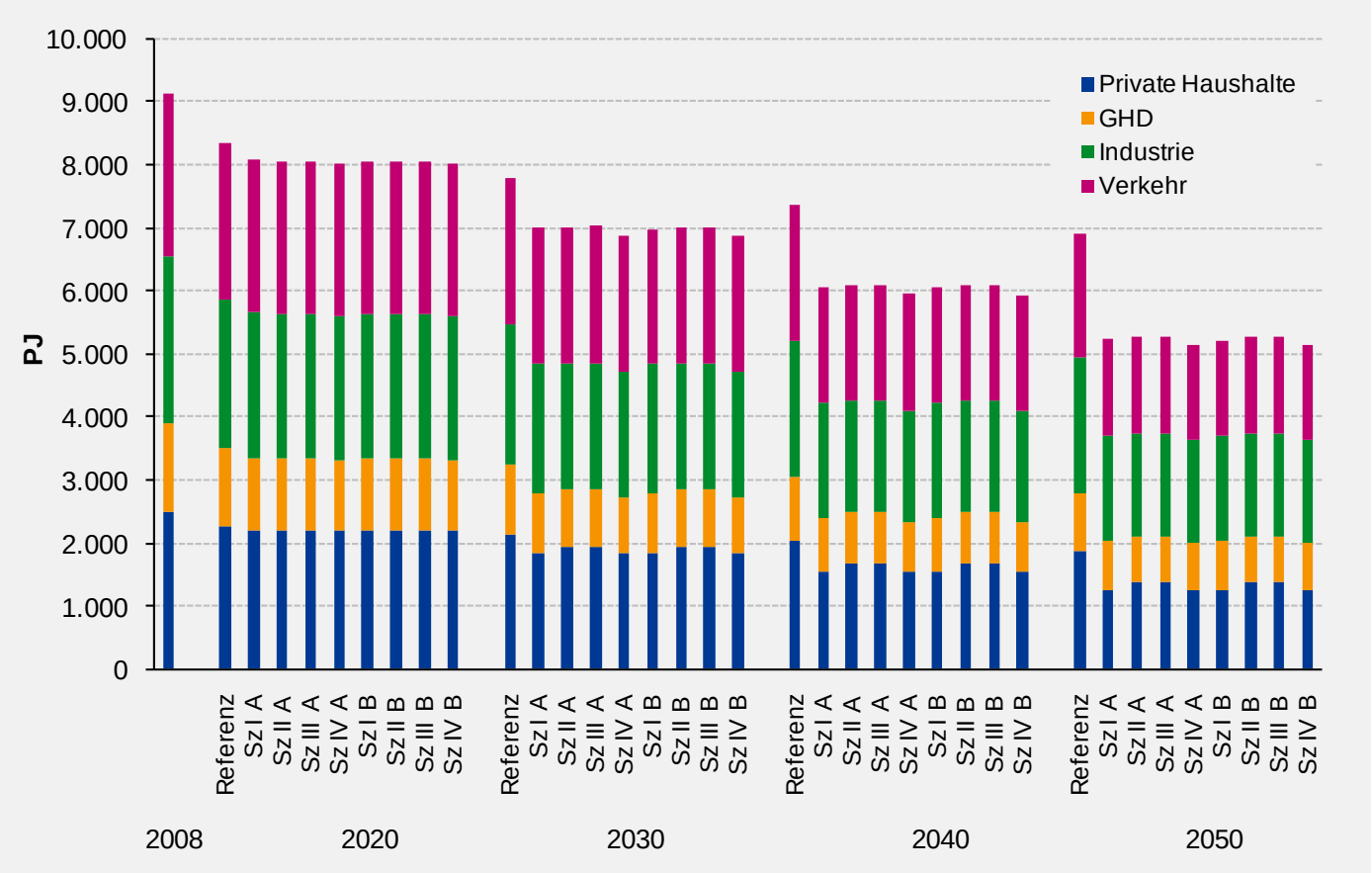
Results: Energy-related GHG emissions



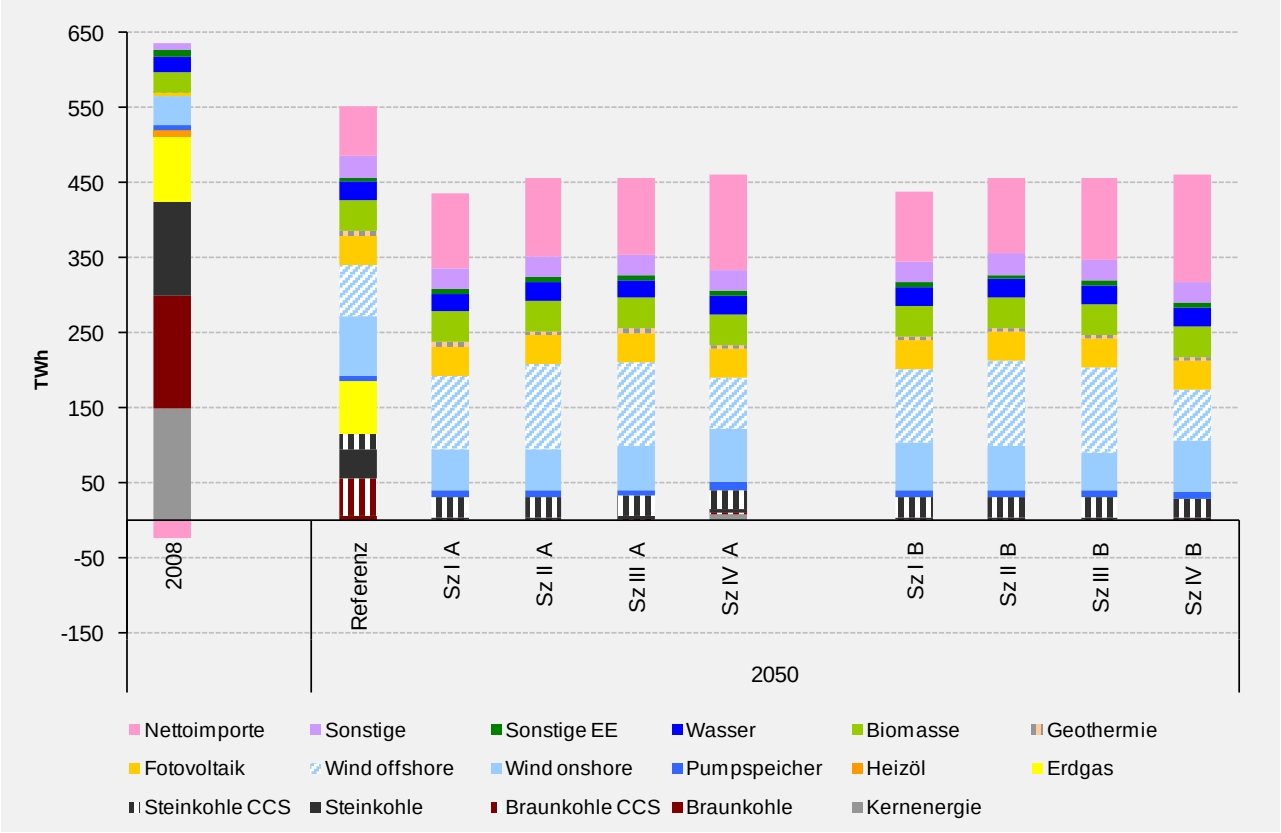
Results: Primary energy supply



Results: Final energy demand



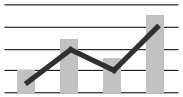
Results: Electricity production



How could the electricity market based on renewables look like?

- Today: Large coal and fossil power plants deliver base load, controlled by 4 large utility companies
- In the future: fluctuating energy sources like wind and sun will have to be stored
- Capacity markets?
- Electro mobility also needed to reach the emission targets
- Many questions remain!

- 3 basic concepts:
  1. Create an international market according to specific production factors: sun in Southern Europe and Africa, wind in the North Sea, storage in mountain areas (AT, CH, NO)
  2. Germany should still produce the electricity it needs, but can use the international dimension partly
  3. Regionalize electricity production

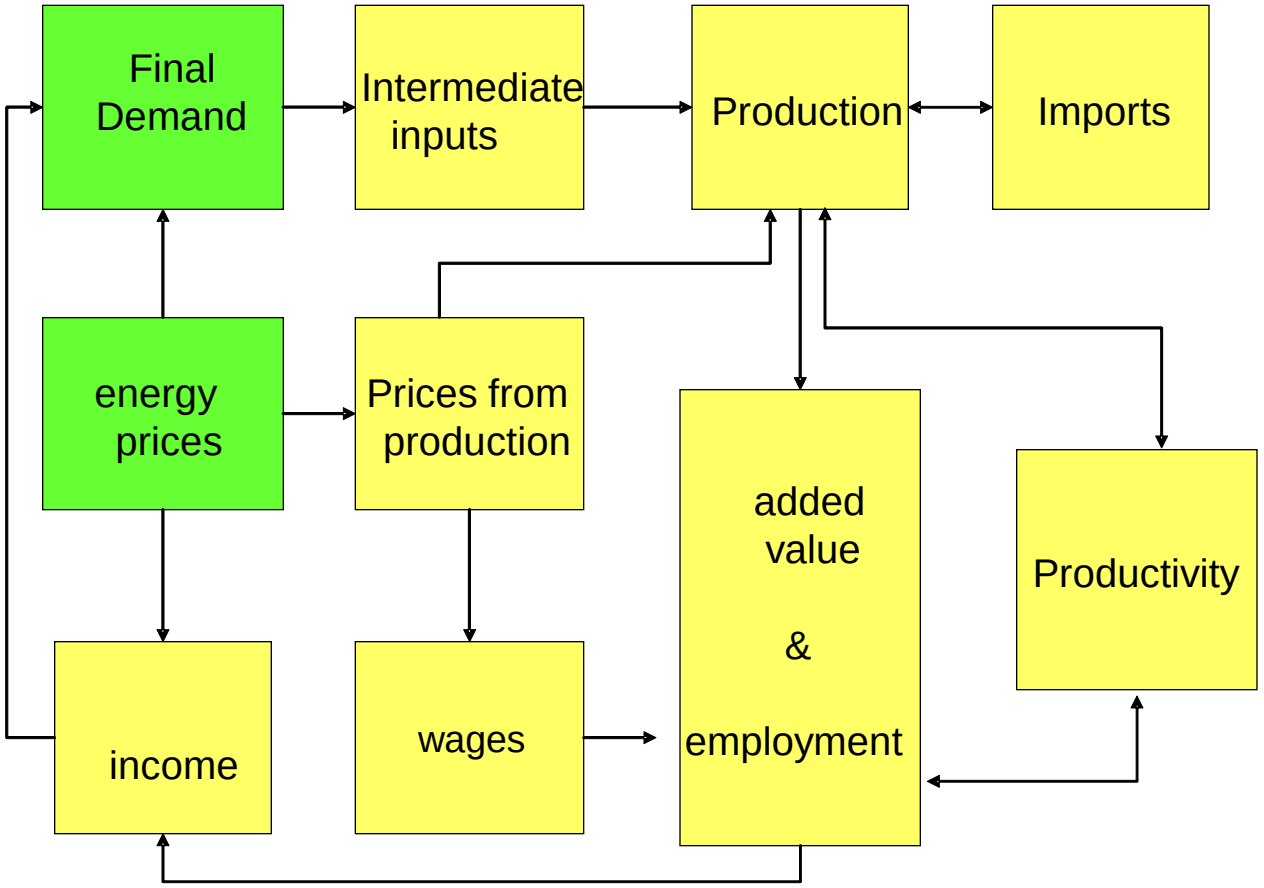


The economic part

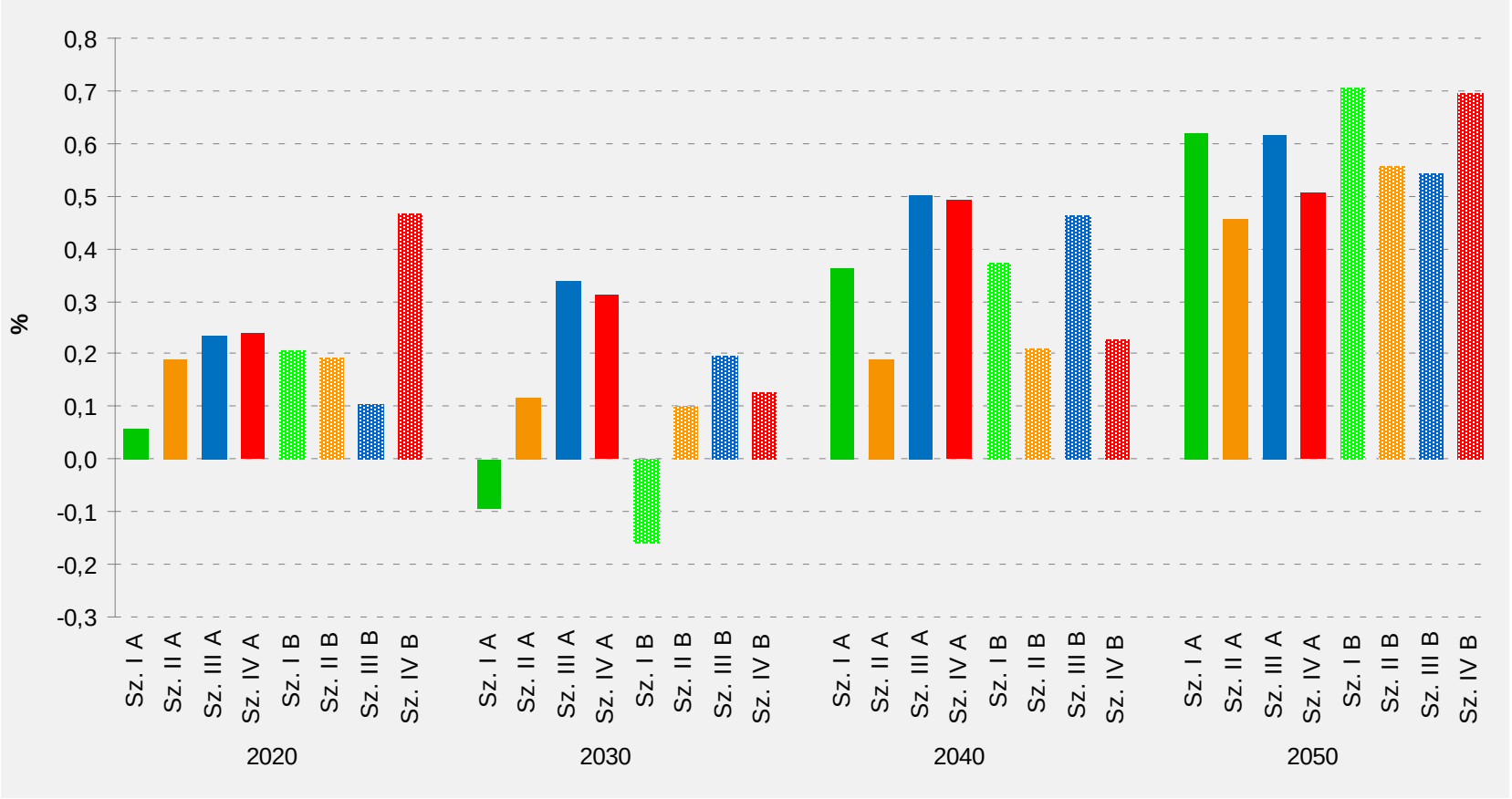
How to determine economic impacts

- Energy part (Prognos & ewi):
  - ⇨ Bottom-up models for energy demand
  - ⇨ EU electricity market optimization model
  - ⇨ Energy volumes and prices and related cost/investment differences
- Economic impacts (GWS):
  - ⇨ Primary impulses (as fixes) have different direct and indirect impacts on the economy:
    - Electricity: Prices (up to 1 Cent /kWh), investment, input mix, net imports
    - Final energy demand: Investment differences (up to 15 Bill. Euro p.a.), prices, energy consumption
  - ⇨ Scenario comparison delivers macroeconomic differences
  - ⇨ Shortcomings
    - no structural change wanted (to be shown)
    - no really integrated results in PANTA RHEI

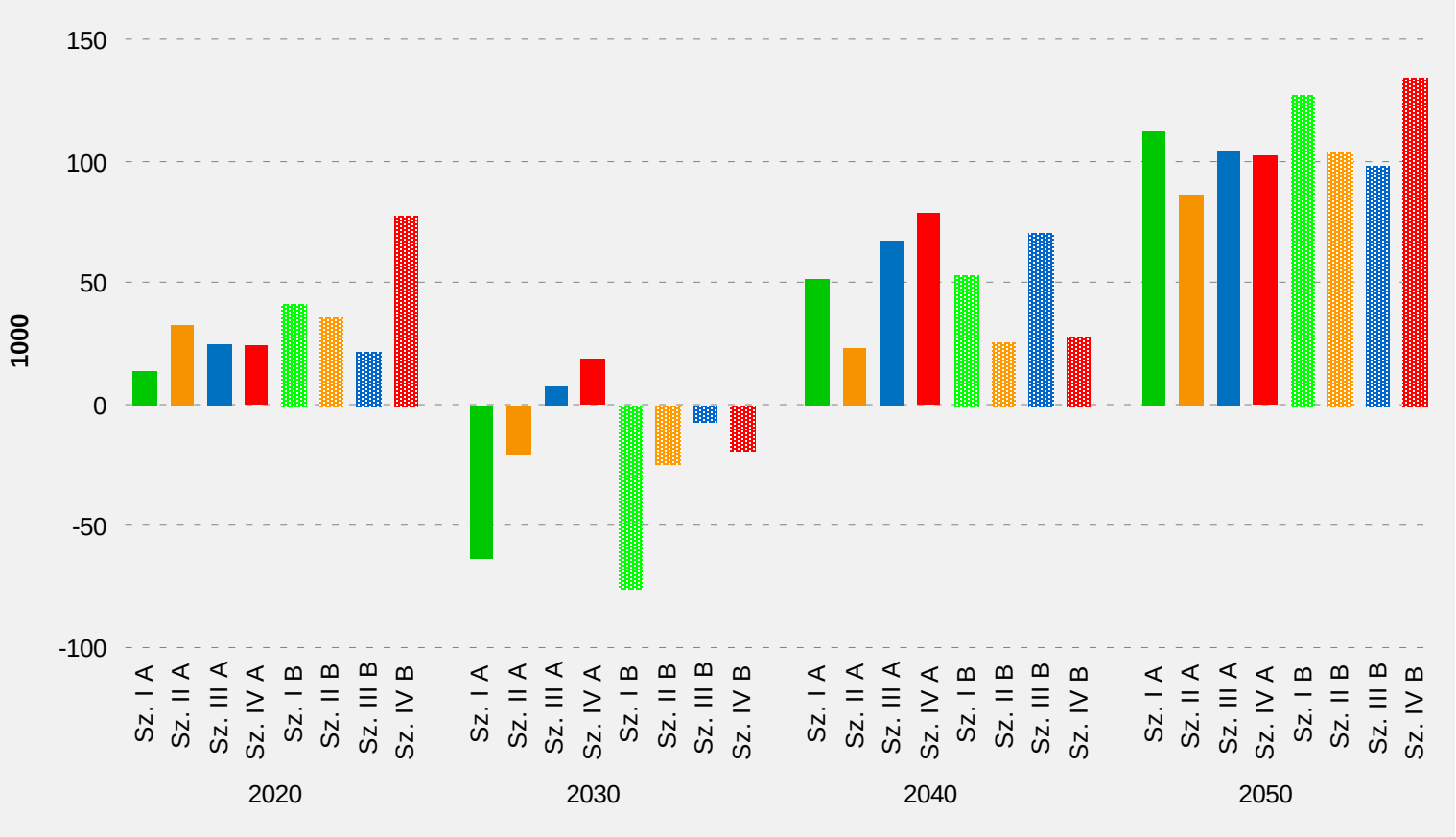
PANTA RHEI – macro-econometric model



GDP – percentage deviation from reference



Employment in 1000 – deviation from reference



Interpretation of results

- GHG reduction has only small negative impacts in the medium term, even positive in the long term
  - ⇨ Main driver in 2050 are reduced imports of fossil fuels due to higher efficiency and more renewables
- Depending on the additional investment costs prolongation of lifetime of nuclear power plants is positive in the medium term
  - ⇨ Reduction of electricity price
  - ⇨ Shift of new investment in power plants over time

Sector results not published, as losers will complain

- ⇨ Biggest winner is construction
- ⇨ Electricity intensive industries may lose without an international climate agreement
- ⇨ Market instruments could push structural change

Energy concept

Energy concept of fall 2010:

- Additional lifetime of nuclear power plants of 8 to 14 years
- Feed-in tariffs for renewables remain at least until 2020
- New market design for electricity needed
- Insulation of houses most important on energy demand side
- Fostering offshore wind, emobility and biofuels
- More research
- Parts remain vague (instruments, time plan,…)

Adaptation after the disaster in Japan (summer 2011):

- Germany decided to phase out nuclear energy until 2022
- 8 of 17 nuclear plants have been shut down in March
- Additional coal and gas power needed?
- Some other parts of the concept have been further elaborated

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