Efficiency matters.

43rd LCA Discussion Forum
LIFE CYCLE ASSESSMENT OF ELECTROMOBILITY
ANSWERS AND CHALLENGES

Methological approaches for determining marginal electricity mixes

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TECHNOLOGY ECONOMICS POLICY – RESEARCH AND ADVICE

The role of marginal effects

- Economics: marginal effects are the key element that drive decisions of individuals, firms and (ideally) policy makers
- Supply side: Invest/expand supply capacity as long as marginal benefits (revenues) exceed marginal costs
- Demand side: buy as long as (marginal) cost exceeds marginal benefit (utility)
- Usually:
  - Increasing marginal costs of supply
  - Decreasing marginal benefit (utility) of additional units (Law of Diminishing Marginal Utility)
- Marginal cost = marginal benefit

The role of marginal effects in decision making

- Marginal effects are important decisions elements in economics
- The role of decisions in LCA approaches?
- Descriptive: average “performance” of all decisions
- Decision-oriented
  - Decisional model: how would my decision options perform in the future?
  - Consequential model: what would be the impact of decisions if taken on a large scale?

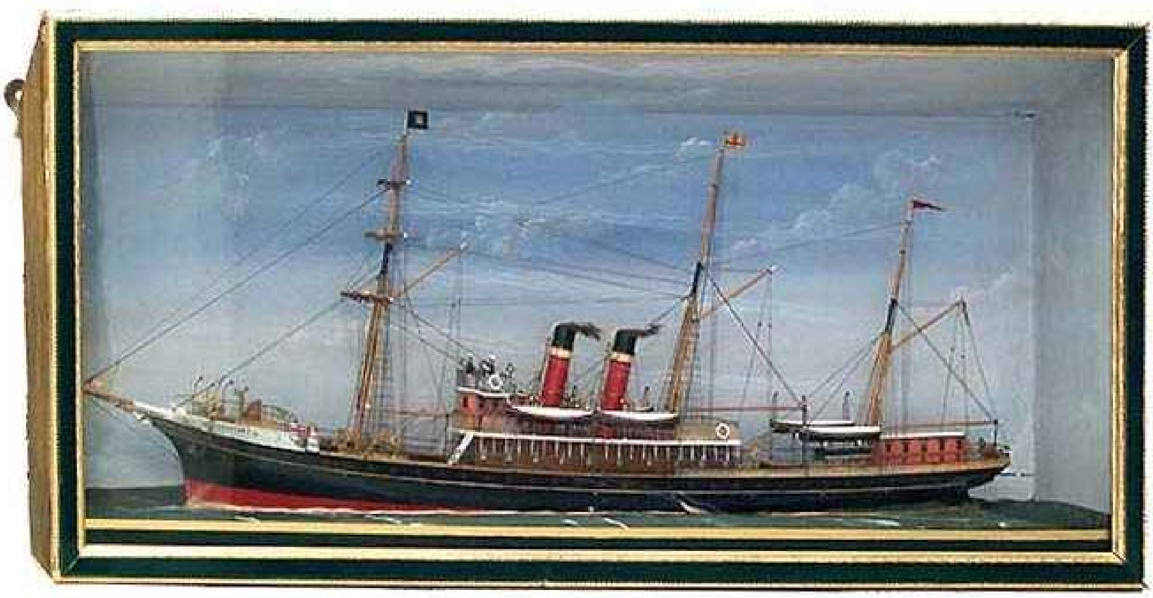
The potential role of electro-mobility in climate policy (1)

- Electro mobility is a new technology in the market place
- Still more expensive than well established ICE vehicles
- Policy intervention needed?
- Justified if cost-benefit analysis is positive from a societal and environmental perspective
- What is the ex-ante impact and the contribution of electro mobility?
  - By itself
  - As compared to other policy options
  - In a portfolio of policy options (implemented simultaneously)

The potential role of electro-mobility in climate policy (2)

- Electro mobility: a substitutes for fossil driven vehicles?
- Or bike trips, public transport or bike/pedestrian trips?
- Electro mobility
  - Will be established in the future over a period of several decades
  - Increases electricity demand
    (or decreases less in an ambitious climate policy scenario)
  - Potentially changes electricity production mix
    (as some technologies and energy sources have limited potentials)
  - Replaces technologies that still will be developing (improving)
    For example, in the 50 years after the introduction of the steam ship, sailing ships made more improvements than they had in the previous 300 years. Ward, **"The Sailing ship effect".**

The potential role of electro-mobility in climate policy (2)



How to estimate the potential impact and
contribution of electro-mobility

- Long-term horizon
- Systemic and dynamic approach needed
- Include also marginal effects on transport side
- Marginal electricity mix with changing demand
  - Long term: What investment decisions will be taken: replacement and expansion capacities
  - Short term: Which power plants and technologies will be dispatched in a given power plant and technology supply mix

=> Dynamic energy system model

Energy system models

- Bottom-up, might include all sectors
- Process and technology oriented
  - Supply side of energy
  - Demand as input parameter, might include efficiency options
- Technical and economic characteristics
- Long-term and short-term load (demand) profiles
- Boundary conditions and potentials
  - Techno-economic potentials of conventional techn. and renewables
  - Marginal cost of grid utilization (e.g. auctioning at country boarders)
  - Policy constraints
- Coherent scenario definitions

Case study: heat pumps

Impact of demand increase, heating profile?

- Increase of demand in Switzerland, e.g. 1.5 TWh
- Heating demand profile (winter, intermediate seasons)
- Low additional hydro potentials available
- Assumptions: no change of load profile of other users
- New capacities (if needed) in Switzerland or abroad

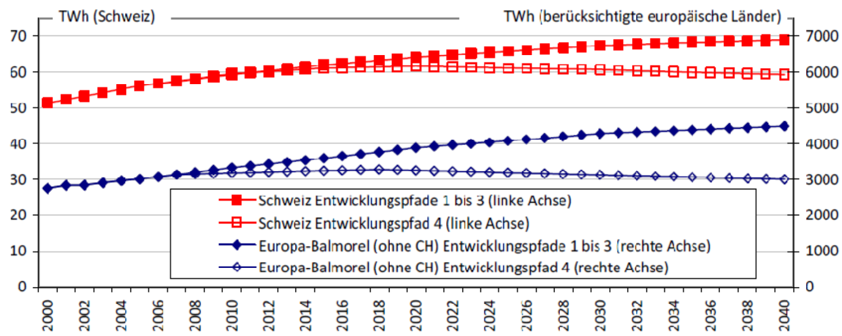
Approach

- Use of a European power plant model (TEP-Balmorel)
- Optimisation (minimizing costs: captial, operation, energy)
- Investment and dispatching determined by the model

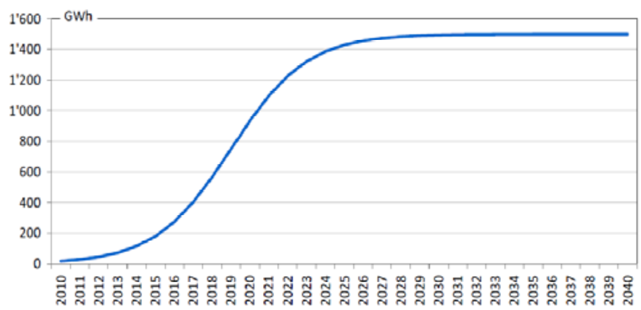
Different scenarios

Assumptions regarding demand

Switzerland (red, left axes) and Europe



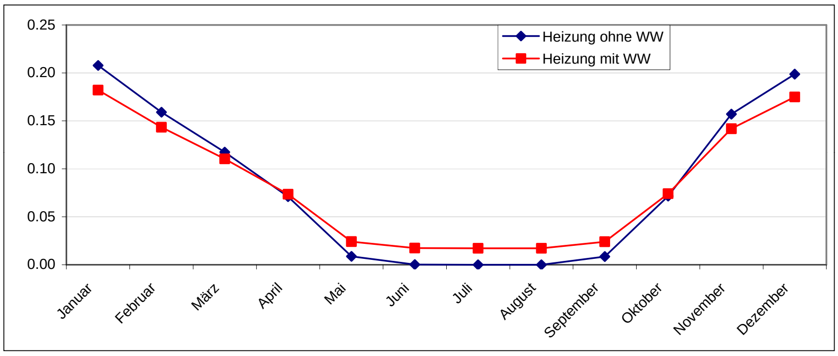
Demand scenarios without heat pumps



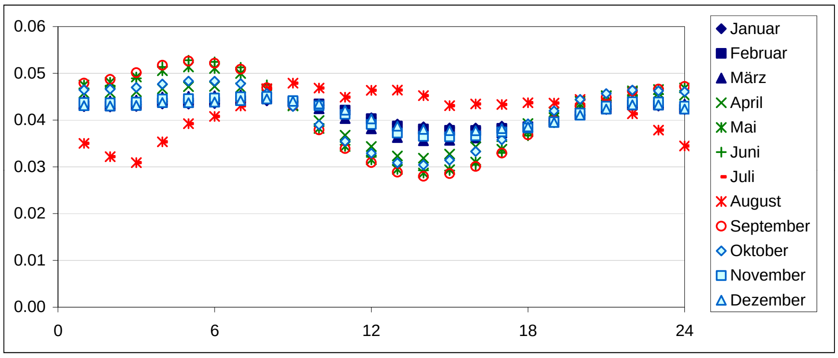
Additional demand heat pumps

Marginal demand of heat pumps

Saisonal and daily load profile



Seasonal demand load profile



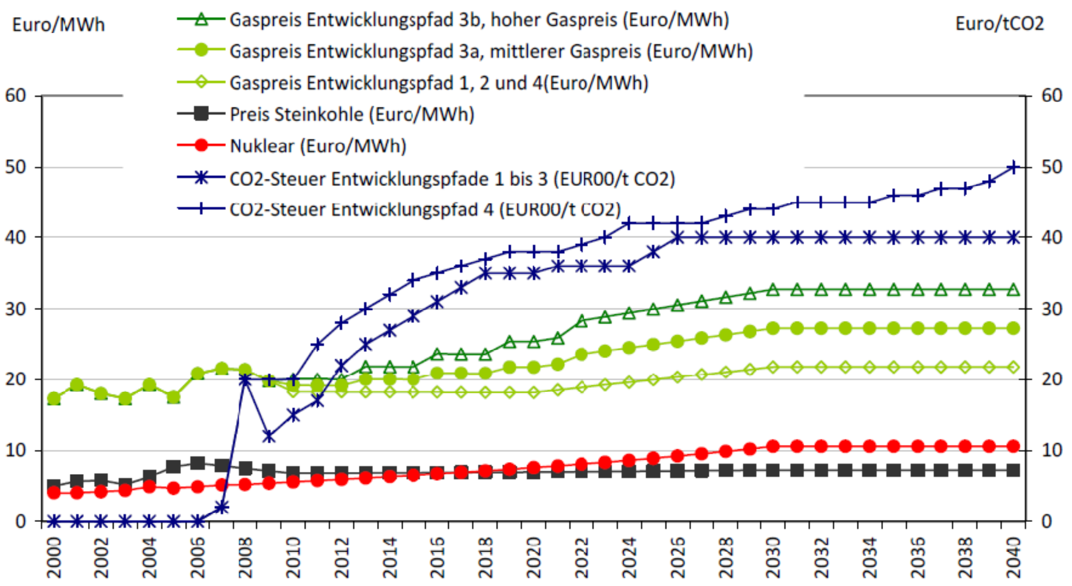
Daily demand load profile, depending on the season

Case study: heat pumps

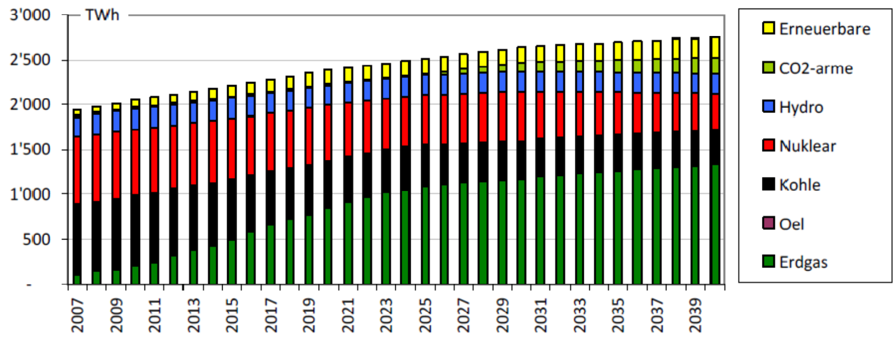
Impact of demand increase, heating profile?

- Scenario 1 („Reference“): Demand increase of Switzerland according to Scenario I of SFOE Europa gemäss PRIMES.
- Scenario 2 („nuclear power possible“): as Scenario 1, but with nuclear power plant of 1.6 GWe, available from 2025.
- Scenario 3a and 3b („increased gas price“): as Scenario 1, but increase of gas price by 25% (etwa 13 CHF/MWh) and 50% up to 2030.
- Scenario 4 („efficient and renewable“): only moderate increase of electricity demand in Switzerland (SFOE Scenario III). In Europa, promotion of renewable electricity generation.

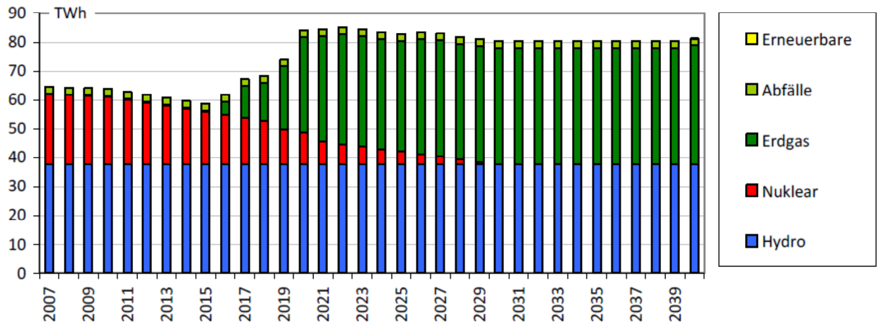
Different scenarios
Input energy price assumptions



Resulting generation mix of scenario 1
European countries and Switzerland



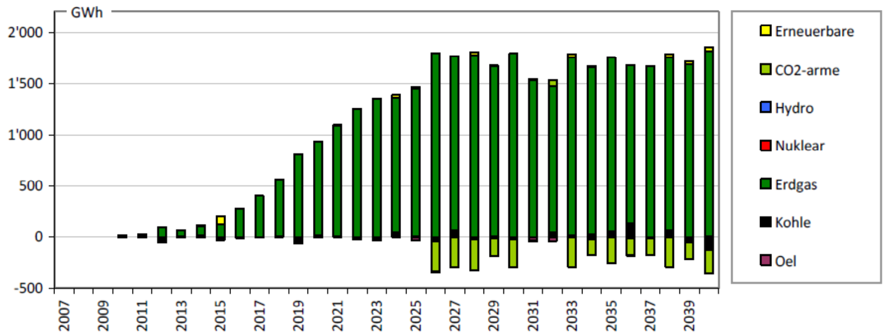
European countries (selection Balmorel)



Switzerland

Resulting marginal generation mix

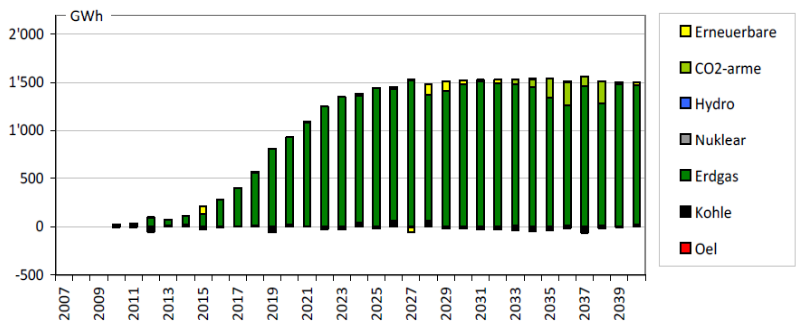
of additional heat pump demand (Scenario 1)



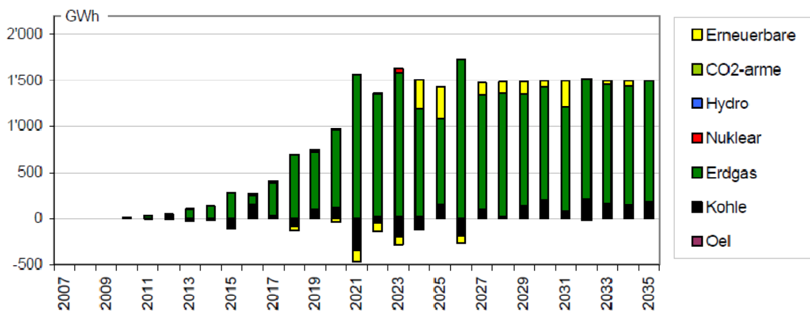
Generation mix of additional HP demand (Switzerland and Europe)

Resulting marginal generation mix

of additional heat pump demand (Scenario 2 and 4)

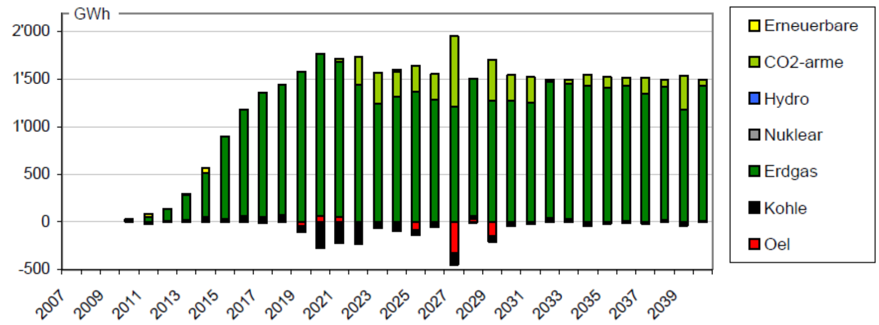


Scenario 2:
New nuclear power plant in Switzerland



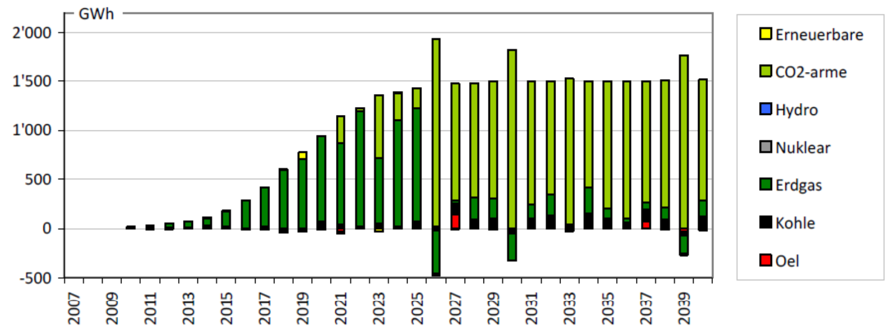
Scenario 4:
Demand side efficiency, promotion of renewables in Europe

Resulting marginal generation mix
of additional heat pump demand (Scenario 3)



Scenario 3: Increased whole sale gas price

+25%



+50%

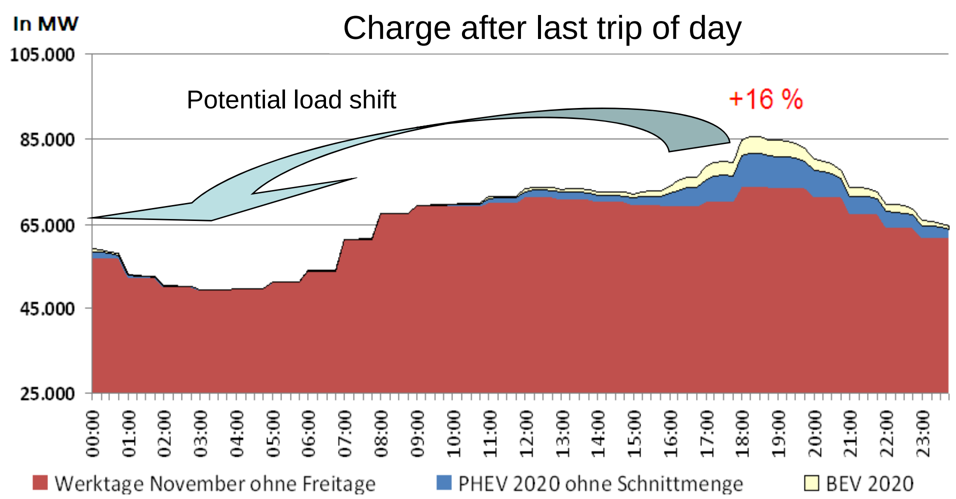
Conclusion form heat pump case study
Impact of demand increase, heating profile

- Increase of additional heat pump demand in Switzerland, might call for additional fossil generation (Switzerland or EU)
- Result quite stable across scenarios (even if excess nuclear energy is available)
- Reason: seasonal load profile with low full load hours (only about 2000 per year) favour capital-extensive techn.
- Outcome may be altered if
  - Heat pump consumers do buy explicitly renewable electricity product which “compulsory” entail according investments
  - Respective policy instruments are set up
  - Daily demand load is adjusted to renewable supply (e.g. wind, solar)
  - Utilities deliberately diversify their portfolios

Extrapolation to electro mobility

- Seasonal demand more equally distributed throughout the year
- Daily load demand depends on
  - car user behaviour,
  - car technology,
  - and possibly price models

Marginal demand of electro mobility
Dayily load increase due to electro mobiliy



Annahmen: 3,68 kW Ladeanschluss; 85% Ladeeffizienz; Monatsmittel beruhen auf dem November 2006 und 2007 (UCTE); Fahrzeugbestand (42 Mio), davon:
- 20,2 % PHEV: 50 km elektr. Reichweite und 0,16 KWh/km-Verbrauch
- 11,7 % Stadt-BEV: 100 km elektr. Reichweite und 0,11 kWh/km-Verbrauch

Source: Fraunhofer ISI

Extrapolation to electro mobility

- Marginal generation mix is also influenced
  - Electro mobility consumers do buy explicitly renewable electricity product which “compulsory” entail according investments
  - Policy instruments are set up
  - Daily demand load is adjusted to renewable supply (e.g. wind, solar which might be backed up by additional fossils, e.g. coal)
- Do not forget marginal effects on transport side (competing technology, changed behaviour)

Fragen und Antworten

Jetzt oder

Download Studie TEP Energy i.A. FOGA, FEV

„CO2-Intensität des Stromabsatzes an Schweizer Endkunden“:

- www.tep-energy.ch

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