Energy transitions in Europe – the role of electricity, grid connections and markets

Smart Energy Networks (SEN) workshop

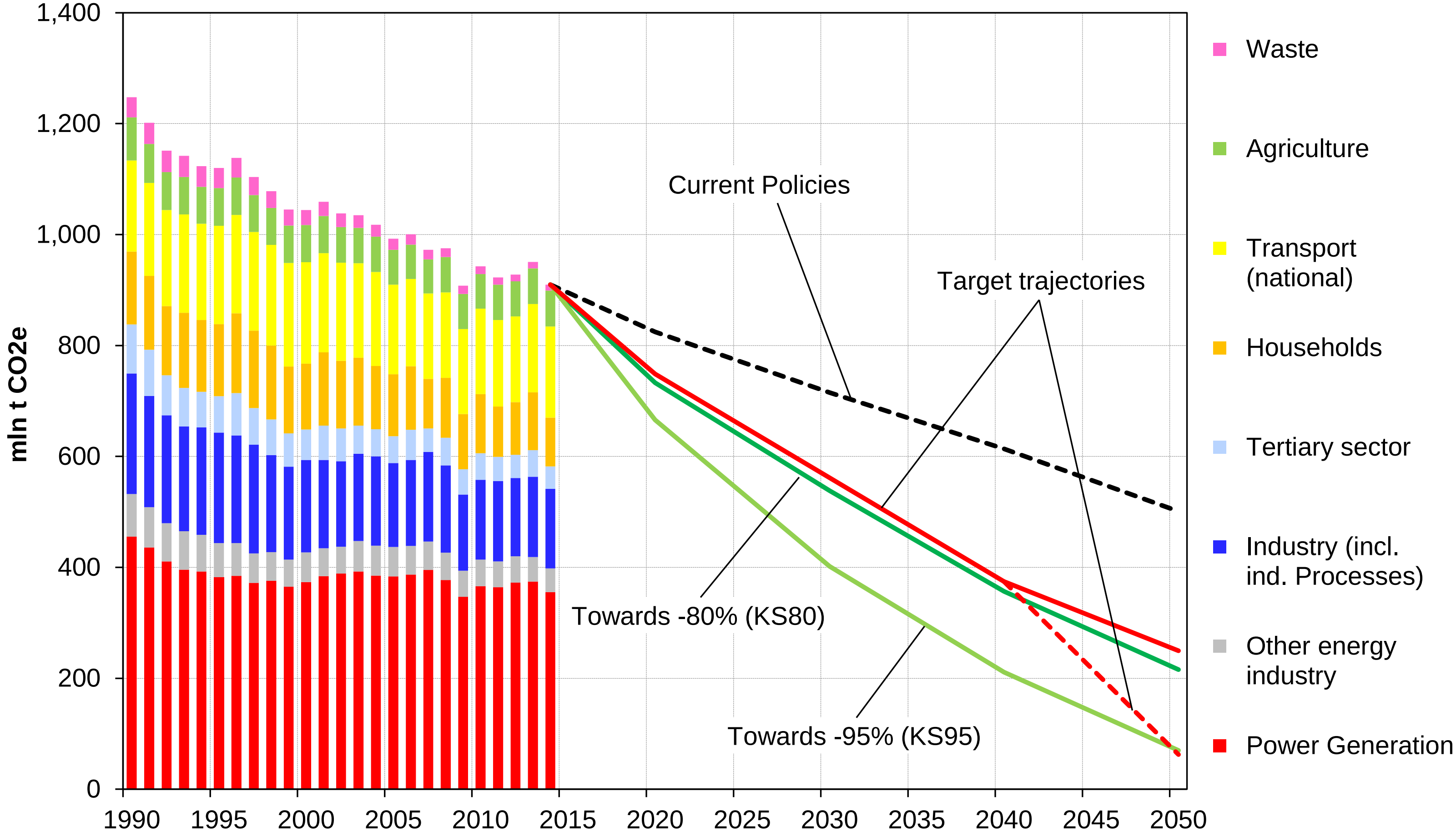
» Pathways to a fossil free, integrated energy system
– a Danish Perspective «

Dr. Felix Chr. Matthes

Copenhagen, 29th May 2017

Decarbonization as a key driver for energy transition (policy-driven structural change of the energy system)

Scenario analysis for different GHG emission trajectories for Germany (as a proxy for many comparable analytical exercises)



Öko-Institut, FhG-ISI, Dr. Ziesing (2015)

Effective and efficient (deep) decarbonization strategies need to reflect other mega trends

New quality of (global) fuel market uncertainties!

New quality of technology development / cost uncertainties!

New quality of regulatory uncertainties?

Liberalisation/ Restructuring	Deep Decarbonisation	Decentralisation Digitalisation	Infrastructure dependency	Sector integration
The competitive environment is there to stay Free customer's choice Unbundling	New technologies with new economic characteristics Energy efficiency implications	New technologies Strong coordination needs New players New economic appraisals	Stronger and partly new roles for transmission and distribution grids Unsettled role of storage	New energy demands Flexibility options from sector integration

Matthes 2016

20 Years of decarbonization analysis, strategies and experiences on the ground: The 4 “A” questions (1)

- **Are potentials AVAILABLE for decarbonisation by mid-century?**
  - the helicopter (screening view)
    - sufficient (non-nuclear) potentials are available and will be available
    - all sectors need to contribute
  - a more differentiated perspective
    - energy efficiency as a key lever
    - the primary and final energy consumption patterns will change significantly: 100% renewables, (much) more electricity
    - some decarbonization levers have a strong international dimension (biomass, PtG, PtL)
  - managing scare resources as a long-term challenge
    - availability and allocation of sustainable biomass
    - availability of land (biomass, onshore wind, grid infrastructure, etc.)
    - conflicting uses of the underground

20 Years of decarbonization analysis, strategies and experiences on the ground: The 4 “A” questions (2)

- **Can the range of potentials be exploited in a way that decarboniza-tion by mid-century is ACHIEVABLE?**
  - timing matters
    - transforming long-lived capital stocks
    - lead-times for infrastructure
    - lead-times for innovation
  - infrastructure matters
    - changing geography and structure of the energy system
    - more significant role (and higher costs) of infrastructures in general (for both, transmission and distribution grids)
    - changing characteristics of the grid infrastructure, from today’s A à G à X to more collection ((A, B, C) à G à (X,Y,Z))
    - smarter & stronger networks: electricity (also: cross-border) transmission grids, electricity distribution/collection grids, heat distribution/collection networks (a new challenge)
    - storage (for different profiles)

20 Years of decarbonization analysis, strategies and experiences on the ground: The 4 “A” questions (3)

- **Can the range of potentials be exploited in a way that decarbonization by mid-century is ACHIEVABLE (continued)?**
  - coordination matters
    - a much more decentral/distributed energy system is more coordination incentive
    - markets will be the only institutions that can deliver this new quality of coordination
      - new market designs will be needed (electricity markets in general, locational signals etc.)
      - barriers for effective price signals need to be removed
      - new market designs need to address both dimensions, coordination (energy, system services and CO2 markets) and pay-back for fixed costs and investments (capacity markets/remuneration mechanisms)
  - innovation matters
    - technologies, system integration, business models

- **Will the transformation pathways be AFFORDABLE?**
  - low macroeconomic costs (versus counterfactual), or even macroeconomic benefits (versus counterfactual) of energy transition in general (depending on core beliefs on fuel & CO2 price trends)
  - there are extra costs of non-steady or disruptive pathways
  - the structure of costs will change significantly
    - lower operational costs
    - higher capital and fixed costs
    - lower costs/cost shares of generation
    - higher costs for system integration and flexibility
    - last but not least: more diverse economic appraisals
  - solving distributional issues is key
    - many changes in economics structures tend to be socially regressive
    - devaluation of existing assets as challenge

20 Years of decarbonization analysis, strategies and experiences on the ground: The 4 “A” questions (5)

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

- **Will the transformation approach be ACCEPTABLE to the public?**
  - number of interfaces between the (more distributed/decentralized) energy system and the society increases
    - generation
    - grid infrastructures
    - distributional issues become more visible
  - political participation as crucial dimension
    - a growing role for consistent overarching energy transition strategies
    - a growing role for making more use of local expertise
    - a growing role for compensation strategies
  - economic participation as a crucial dimension
  - structural changes need strong backing from the public

- **Energy transition: a policy-driven structural change of the energy system**
- **The target system is technically feasible and affordable**
  - manifold options at the supply & flexibility side exist already or are in the pipeline
  - total system costs of the target system do not differ significantly from the counter-factual, transition costs and distributional effects could however be significant
- **The real challenges arise from structural changes that need to be reflected carefully for the design of the transition process**
  - structurally changing technology patterns
  - structurally changing economics (a zero marginal costs system)
  - structurally changing players / market participants
  - structurally changing spatial patterns

Effective, innovative & efficient strategies
The Four-Pillars Approach (+ DE assessment)

- **Paving the way – for energy efficiency, clean generation & flexibility options (renewables & complementary flexibility)**
  - innovation, level playing field & roll-out for renewables (J) and energy efficiency (K)
  - sustainable economic basis (coordination & enabling investments) (K)
- **Designing the exit-Game – for the non-sustainable capital stocks**
  - appropriate mechanisms that address security of supply, flexibility, emission levels and fixed costs (K) – for nuclear power (J) and high-carbon assets (L)
- **Triggering the necessary infrastructure adjustments – with sufficient lead-times** L
  - integration of centralized, distributed, storage & DSM/flexibility options
  - reflection of the new geography of the energy system
- **Making the necessary innovation work – in time** J
  - for energy efficiency, generation, flexibility, storage and integration

Thank you very much

Dr. Felix Chr. Matthes
Energy & Climate Division
Berlin Office
Schicklerstraße 5-7
D-10179 Berlin
f.matthes@oeko.de
www.oeko.de
twitter.com/FelixMatthes

Backup

The seven (interacting) segments

1. **The market for energy (kWh) : coordination among generation options as well as generation and demand and partial pay-back for fixed costs of generation, storage and demand response options**
2. **The ancillary services market: system stability**
3. **The market for firm capacity: closing the pay-back-gap for fixed costs for (clean) dispatchable capacities and delivering security of supply (backup, storage, demand response etc.)**
4. **The market for variable capacity: closing the pay-back-gap for fixed costs of non-dispatchable (system-friendly) renewable capacities**
5. **The market for CO2 (allowances): incentivizing the clean dispatch of fossil generation options**
6. **The market for "bulk energy efficiency" (e.g. white certificates): to incentivize energy efficiency beyond load optimization in a market that is increasingly characterized by capacity payments**
7. **A regulatory framework for (regulated) grid infrastructures that enables and incentivizes efficient grid investment and operations**

How we see the challenge of market design
The (necessary) long-term market structure

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology