Model-based assessment of the impact of the SET-Plan on the European power sector

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Presentation overview

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Background – SET-Plan COM(2009)

- SET-Plan adopted in 2008; The EU Energy and Climate Technology Pillar; aims at accelerating the development of low-carbon technologies

- Communication on investing in the development of low carbon technologies COM(2009) 519
  - Technology Roadmaps
  - 10 year costing of the SET-Plan Efforts
  - Estimation of current R&D(&D) investments in SET-P priority technologies

- Role of the Information System of the SET-Plan (SETIS) to monitor and assess technology developments and their impact on the EU policy goals to support the SET-Plan decision-making
Scope and objectives

✓ Aim: to capture the effect of increasing RD&D efforts on a set of low-carbon power technologies on the development of the European power sector by 2020 and beyond.

✓ Two main questionings related to the proposed SET-Plan RD&D efforts
  ✓ Change in technology investment costs of the selected SET-Plan priority technologies
  ✓ Impact on the economics of achieving the EU Energy and Climate targets by 2020 and beyond
Assess the impact of increasing RD&D efforts on several SET-Plan priority technologies at the same time in Europe?

Methodological problem: Can we establish a quantified relationship between R&D efforts and technology development?

Data challenge: How to calibrate such an equation? Are sufficient historic data available?

Implementation challenge: Can we model this RD&D impact?

Definition problem: What means ‘increasing RD&D efforts’? What are baseline efforts, what does the SET-Plan imply on RD&D investments?

Modeling challenge: Ensure that the model present well these (novel) technologies.

Methodological, data and model challenge: Learning effects are global –need to have data and a model that allows for a global assessment while having the necessary detail on the EU.
SET-Plan low-carbon energy technologies for power generation considered:

- Wind Energy: on- and offshore wind
- Solar Energy: photovoltaic and concentrating solar power
- Bioelectricity
- Carbon Capture and Storage (CCS)
- Nuclear Fission Generation IV is not included due to the time horizon. However, GEN II, III are considered with similar developments in both scenarios

Time frame of the study is 2030
Learning process for a given technology has multiple origins and is a multi-dimensional problem (*Learning by doing*, *Learning by researching*, *Learning by using*, *Learning by interacting*, *Learning by scaling* etc.).

Additionally, market constraints (e.g. raw materials and engineering and building capacities) play an important role.

Modelling approach used: Consider two factors of learning – knowledge stock (approximated by RD&D efforts) and innovation feed-back acquired through market deployment (approximated by installed capacities).

Simplification of the technology cycle but allow to meet the objective of analyzing the impact of additional RD&D efforts.
Well established: Unit costs are reduced with increasing production volumes

Two-Factor-Learning Curve: Establishes a relation between cumulative production, knowledge stock and technology costs

\[ C(Q, KS) = aQ^{-\alpha}KS^{-\beta} \]

With  
\[ C = \text{Costs of unit production} \]
\[ a = \text{Costs of the first unit produced} \]
\[ Q = \text{Cumulative Production} \]
\[ \alpha = \text{Elasticity of learning by doing} \]
\[ KS = \text{Knowledge stock} \]
\[ \beta = \text{Elasticity of learning by researching} \]
Methodology (3)

Coupling POLES with a spreadsheet learning model

- One factor learning-by-doing rate
- Base year investment cost
- Historical data on deployed capacities
- Investment cost
- Two-factor learning curve
- Convergence with POLES Model
- Investment costs
- Deployed capacities
- R&D Investment profile
- Conservation of Public investment
- R&D corporate intensity

Innovation Profile: Learning-by-researching & Learning-by-doing rates

- Two-factor learning curve
- Investment cost
- Convergence with POLES Model
- Investment costs
- Deployed capacities
- R&D Investment profile
- EU R&D Investments (SET-P)
- EU public/private ratio
- EU corporate R&D Intensity
- Global corporate R&D Intensity
- Global Public/private ratio
- Global R&D Investment
Model characteristics

- Recursive simulation model of the energy sector, covering:
  - 6 energy intensive sectors
  - power generation
  - transportation
- Global model with 47 regions/countries
- Technology rich model
- Time horizon 2050
Methodology (4): POLES model

Typical output

- Energy balances by region/country
- Development of energy prices
- Emission profiles
- Deployment of technologies

Applications

- GHG emission reduction pathways (GRP)
- Energy demand/supply scenarios
- Technology outlooks (WETO-H2)
Input data

- R&D Public Investment: Capacities Map 2009, IEA RD&D statistics, SET-Plan Communication
- Corporate RD&D investment: percentage (R&D intensity) of turn-over of the energy equipment manufacturing industry, CCS (derived from Capacities Map 2009)
- State of the art technology investment cost and one factor learning rate (reference scenario) – Technology Map 2009

- R&D Investment up to 2030
  - Reference scenario: public investment & corporate R&D intensity constant as 2007
  - SET-plan scenario (2010-2020): public investment from SET-Plan estimated cost (incl. current non SET-plan aligned), private is derived through public/corporate ratios as in Capacities Map 2009
  - Post 2020: Public investment Reference scenario = SET-Plan scenario
Scenario assessment framework

Reference scenario
- Fixed ‘quantities’; Achievement of the EU Energy and Climate Policy by 2020
- Global level considered: EU and Rest of the World
- Feed-in tariff - harmonised technology-specific RES support premiums across the EU

SET-Plan Global Scenario, similar as Reference but
- SET-Plan R&D Investment, for CCS, market support scheme
- RES energy premium tariffs and the CO2 price are adapted

Two sensitivity cases
- 'SET-P fixed prices’- Support schemes & CO2 prices constant compared to REF
- 'SET-Plan PV plus' - Premium paid for PV electricity 40% above REF levels; Doubling of PV potential on the building stock & increase share of new dwellings being equipped with PV
Scenario definitions

<table>
<thead>
<tr>
<th>Reference</th>
<th>SET-Plan</th>
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</thead>
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**Price**

- Reference scenario
- SET-P scenario
- Additional R&D investments (SET-P)

**Quantities**

- Cost savings

(% of renewables and GHG emission reductions)
The 2020 targets are met by construction:
- 20% share of RES in final energy demand
- -20% GHG emissions below 1990
- 40 €\textsubscript{2000} per tonne of CO\textsubscript{2}

Recent GDP forecast included

Oil Price 97 €\textsubscript{2007}/bbl in 2020,
106 €\textsubscript{2007}/bbl in 2030
R&D investments for Global SET-Plan scenario additional to the Reference scenario in period 2010-2020

<table>
<thead>
<tr>
<th>Global SET-Plan scenario [bn €\textsubscript{2008}]</th>
<th>EU</th>
<th>RoW (Global - EU)</th>
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<td>Concentrating solar power</td>
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SET-Plan Effect: Increased Learning Rates

- Carbon Capture and Storage
- Biomass Gasification
- Biomass Conventional Electricity
- Wind Onshore
- Wind Offshore
- Concentrating Solar Power
- Photovoltaics

→ Significantly accelerated technology learning due to additional RD&D investments
Changes in installed capacities between the Global SET-Plan, the SET-Plan fixed price and the reference scenario in 2020 and 2030 in the EU
SET-Plan Scenario in 2020 & 2030 (4)

Deployment of CCS technologies with and without SET-Plan in the EU-27 and worldwide
Share of renewable energies in different sectors in 2020 and 2030, EU-27
Economic Assessment (1)

\[ \Delta \text{Net benefits} = \Delta \text{Benefits} - \Delta \text{Costs} \]
\[ \Delta \text{Costs} = \Delta \text{R&D investments}_{\text{corporate}} + \Delta \text{R&D investments}_{\text{public}} \]
\[ \Delta \text{Benefits} = \Delta \text{Electricity Production Costs} \]

- Lower CO\textsubscript{2} price
- Lower specific renewable support

Plus auxiliary benefits
- Benefits to other energy-intensive industries due to lower electricity price
- Lower carbon prices can mean benefits for other sectors
- Positioning of industry in global market
Discounted (3%) net benefits cumulated from 2010 onwards, EU-27

- Cumulative net benefit by 2030, 11.5 bn€\textsubscript{2000}
- 15% IRR over 2010 - 2030
Key findings

• Additional global RD&D investments, in line with the SET-Plan can reduce costs of new low-carbon technologies by 4% - 13%

• Accelerated market penetration of innovative low-carbon technologies (e.g. PV, CSP, wind offshore)

• Market entry of CCS would be brought forward by at least 5 years when assuming a deployment incentive alike the SET-Plan proposal

• Over the period 2010-2030, the SET-Plan alike RD&D efforts would result in a positive IRR of some 15%

• Auxiliary benefits could be expected
THANK YOU

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http://setis.ec.europa.eu