IEA Experts' Group on R&D Priority Setting and Evaluation (EGRD)

Modelling and Analyses in R&D Priority-Setting and Innovation

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Research, development, and deployment of innovative technologies are crucial to meeting future energy challenges. The capacity of countries to apply sound tools in developing effective national research and development (R&D) strategies and programs is becoming increasingly important. The Experts' Group on R&D Priority Setting and Evaluation (EGRD) was established by the IEA Committee on Energy Research and Technology (CERT) to promote development and refinement of analytical approaches to energy technology analysis, R&D priority setting, and assessment of benefits from R&D activities.

Senior experts engaged in national and international R&D efforts collaborate on topical issues through international workshops, information exchange, networking, and outreach. Nineteen countries and the European Commission participate in the current program of work. Results provide a global perspective on national R&D efforts that aim to support the CERT and feed into the IEA Secretariat's analysis.

For further information about EGRD activities, see:
http://www.iea.org/aboutus/standinggroupsandcommittees/cert/egrd/

To view the agenda and presentations for this workshop, see:
http://www.iea.org/workshops/modelling-and-analyses-in-rd-priority-setting-and-innovation.html.

This Executive Summary reflects key points that emerged from the discussions held at this workshop. The views expressed in this report do not represent those of the IEA or IEA policy nor do they represent consensus among the discussants.

The full workshop report, including detailed information on individual sessions and presentations, has been prepared by the organisers and may be consulted at http://www/ieadsm.org/egrd.

EXECUTIVE SUMMARY

Reducing global GHG emissions is a huge challenge for all countries demanding various political and financial measures for all stakeholders. To develop a low carbon economy requires a long time period and the use of novel and innovative technologies that are still in the research phase. With regard to R&D policy a special attention is paid to the OECD countries due to their high technological standards and research capacities. But do we invest R&D money right? Will the technologies be developed fast enough to meet GHG targets without a high loss of wealth globally?

The main topic of the workshop is how to prioritise energy R&D and related innovation funding in order to develop a low carbon economy. To optimise the process of prioritisation the workshop looked into innovative approaches to modelling the energy system and its transformation as well as the R&D and innovation process. National and international examples were presented and discussed. Indicators for innovation were examined and provided for discussion. Beside the process of prioritisation for public R&D budgets best practice examples from private industry and research institutes were also included into the agenda.

As a starting point for discussion existing indicators for innovation were presented giving contradictory statements. Looking at annual growth rate of low carbon technology patenting, we see an enormous increase for all technologies, especially for wind and PV. Analysing the energy R&D expenditure rates for OECD countries, we see a diverse picture. Even though R&D budgets for some areas are decreased or increased in most countries, technologies like nuclear fission show a strong increase in some countries and a strong decrease in other countries. When it comes to the indicator “tracing clean energy progress” we see that only renewable power is “on track”, whereas some crucial technologies like CCS or energy efficient buildings lack behind.

Modelling the energy system as well as the transformation process of the energy system is accompanied with high uncertainty as novel technologies, innovative devices and new organisational structures have to be integrated. The longer the time period is, the higher the degree of uncertainty. Fundamental insights from this work include findings that the transformation of the energy system requires high capital investments as low carbon technologies in general are capital intensive, like wind or CCS. Furthermore, the transformation is as much depending on technologies as on system design and addressing least innovative sectors.

When it comes to R&D priorities that facilitate the transformation of the energy system, studies show that investments in storage and renewable energies as well as vehicles deliver a higher marginal return than nuclear or fossil fuels. This supports a shift of budgets towards low emission technologies to reach a cost optimal transformation path. An important R&D priority for low carbon technologies is to lower the investments costs for these technologies as they are considerably higher than for conventional technologies.

Models show that reducing cost is not only a task for R&D but also for innovation policy. It is very difficult to model “technology learning” based on R&D or higher market penetration (learning curve), but to improve the effectiveness of R&D a simultaneous deployment of low carbon technology is needed. Through public investment in R&D and complementary market regulation, private R&D money can be attracted and strengthen the process of technological learning.

As models rely on previous trends novel technologies, tipping points are difficult to indicate. To model discontinuities in the energy system models can be supported by expert assessment. Due to some inherent weaknesses of this method (e.g. excessive optimism) expert judgment on exogenous trends can be used to assure quality of modelling.

Modelling plays a role in many national and international R&D programs as well as for private companies. The aim of these modelling activities for public authorities is to identify priorities for R&D derived from the specific target (e.g. GHG reduction target) for which the program is developed. Long term energy demand scenarios are also taken into account as well as technology roadmaps to set targets for the program and to allocate money to specific technologies. The design of R&D programs for public authorities as well as private companies is following good practice—meaning external/internal evaluation of proposal and regular evaluations of the program itself. Even though the outcome of R&D investments is a priori fundamentally uncertain, the decision is based on a much more rational foundation than expert judgment or stakeholder involvement only. Several techniques have been developed to reduce uncertainty in modelling like learning curves, expert elicitation or interactive decision-making. In most cases a mix of different approaches is used. Furthermore, the diversification of R&D portfolio helps to reduce the risk for R&D investments.

Public R&D strategies do not only influence public funds but also private investments in R&D. First, many public funds are looking for private co-funding on program or project level, and second, private investments decisions are often based on similar assumptions taking into account public decisions. Even more relevant to private R&D budgets are energy strategies and market developments. The German "Energiewende"—meaning the restructuring of the electricity market with the shutdown of nuclear plants and the massive investments in renewable energy (especially wind and PV)—led to a high uncertainty of utilities and increased not only R&D investments of suppliers for these technologies but also for utilities as the uncertainty about the future market substantially increased. From 2003 to 2013 the R&D budget of 13 major European utilities almost doubled. The focus for utilities moved from energy technologies to systems approach and customer related research as the deregulation of the electricity market in Europe increased competition and reduced the timespan for planning in the utility sector.

Several approaches were presented and discussed to evaluate the innovation process from R&D to market penetration of a technology. Innovation scoreboard or innovation sensor novel approaches were developed to measure and rank the innovation capacity of countries. Based on existing statistics and complemented by new data at the country level an indicator system would be useful to rank the (clean) energy innovation capacity. Energy Innovation Indices should include the following:

- RD&D investments
- "Innovative quality" of deployment subsidies
- Country capacity for innovation
- Taxes and trade metrics
- Public institutions

Beside the indicators mentioned above, other factors that influencing the innovation potential like human capital or scientific publications can be taken into account. Some indicators from the (clean) energy innovation index should also be integrated into general innovation indices to raise the awareness for this topic.

The present state-of-the-art is an adequate stimulator for discussion but is still not developed enough to be implemented. It is recommended to develop a conceptual framework that can build the theoretical basis for further developments. Indicators that can best describe the relevant dimension should be discussed with all relevant stakeholders, as some of these indicators are not available at the moment but have to be developed at national level based on an international agreement resp. standard. If possible the index should also include data from private companies and other areas that are indirectly influencing the energy innovation capacity like human capital.

The need for transformation of the energy system to meet GHG targets, the appearance of new technologies (e.g. electric cars) and changing investment patterns in the electricity market (from nuclear/fossil to renewables) as well as changes in the market regulations increase the uncertainty about the future energy system. Therefore the modelling of energy systems and the prioritisation of R&D budgets is becoming highly relevant and risky at the same time. Improving models for R&D priority setting on the one hand and developing indicator systems for the assessment of energy innovations systems on the other hand is recommended at national and international level. Due to the enormous challenge in the energy sector, an integrated approach of R&D priority setting and innovation policy is recommended. By a coordinated innovation policy, private investments in public RD&D priorities can also be attracted and the feasibility of a transformation process towards a low carbon society at low costs can increase considerably.