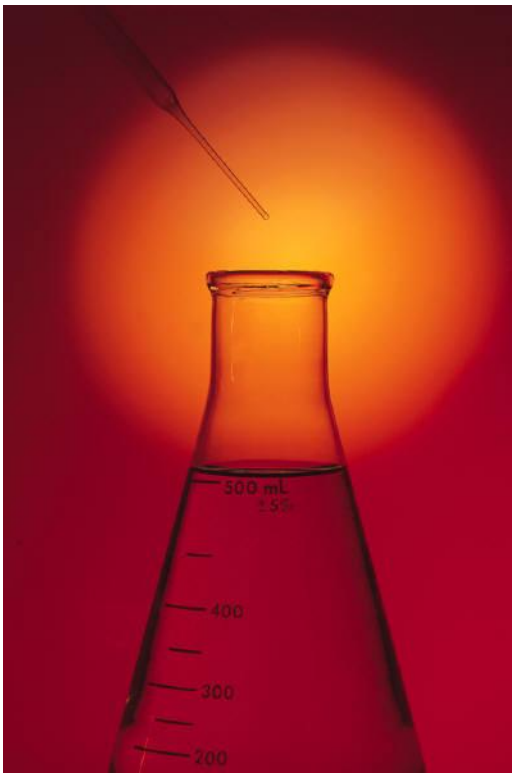
Experts' Group on R&D
Priority Setting and Evaluation

Summary Report

Evaluating R&D

9-10 November 2010

International Energy Agency



International Energy Agency

iea Energy Technology Network

International Energy Agency

The International Energy Agency (IEA) is an autonomous body established in November 1974 within the framework of the Organization of Economic Co-operation and Development (OECD) to implement an international energy programme. It carries out a comprehensive programme of energy cooperation among 28 of the OECD member countries.

The basic aims of the IEA are to:

- Maintain and improve systems for coping with oil supply disruptions.
- Promote rational energy policies in a global context through cooperative relations with non member counties, industry, and international organizations.
- Cooperate in maintaining a permanent information system of the international oil market.
- Improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use.
- Assist in the integration of environmental and energy policies.

The IEA member countries are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, Germany, Hungary, Ireland, Italy, Japan, Republic of Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. The European Commission also participates in the work of the IEA.

Experts' Group on R&D Priority Setting and Evaluation

Research and development (R&D) of innovative technologies is crucial to meeting future energy challenges. The capacity of countries to apply sound tools in developing effective national R&D strategies and programmes is becoming increasingly important. The International Energy Agency's Experts' Group on R&D Priority Setting and Evaluation was created 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 current issues through international workshops, information exchange, networking and outreach.

Nineteen countries and the European Commission participate in the current programme of work. The results and recommendations support the IEA Committee on Energy Research and Technology (CERT), feed IEA analyses, support the G-8 and Major Economies Forum (MEF), and provide a global perspective on national R&D efforts.

More information is available on the website: **http://www.iea.org/about/experts.asp**

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Executive Summary

Government budgets for energy technology research have declined significantly in real terms since 1980. Yet across the globe government leaders have underlined the need to take action to accelerate deployment of energy technologies. As a result (and as a part of economic stimulus packages) , many governments have recently increased expenditure, in a few cases quite substantially, in order to add impetus to existing RD&D programmes and projects, or to explore new, and in some cases, frontier technologies. An entirely different trend can be seen in the private sector, where RD&D expenditures have increased consistently since 1980. However, given the recent worldwide economic downturn, multinational companies are more mindful of reducing costs. And RD&D budgets are often one of the first allocations to be reduced. In both public and private organizations, raising awareness, setting priorities, allocating funding, and designing programmes are all necessary ingredients for technology breakthroughs. However, what ensures that funds allocated are well-managed or that programmes are successful? Programme evaluation, whether it takes place before, during, or after project completion, is essential. Whether carried out systematically or on an ad-hoc basis, evaluations provide key information that enables more balanced, informed decision-making, and, as a result, save precious resources.

Policy evaluation uses a range of research methods to systematically investigate the effectiveness of policy interventions, implementation and processes, and to determine their merit, worth, or value in terms of improving the social and economic conditions of different stakeholders. Policy evaluation for government thereby privileges no single method of inquiry and acknowledges the complementary potential of different research methods. It can thus make use of quantitative as well as qualitative methods, experimental and non-experimental designs, descriptive and experiential methods, theory based approaches, and economic evaluation methods. It is therefore not surprising that evaluation studies of RD&D activities differ according to time, scope, unit of analysis, the type of actors that perform or contribute to the evaluation. This heterogeneity does make it difficult to compare evaluation designs and outcomes and identify best practices.

Insights regarding such best practices are increasingly needed given the challenges faced by the current energy system. Energy policy goals have become more encompassing in recent years including goals with respect to security of supply, market efficiency and environmental goals. Realizing these goals in an era of increasing environmental concerns and increasing global competition for new energy solutions requires ambitious energy RD&D policy. The policy process itself has also become increasingly complex involving an increasing number of stakeholders at different levels. Correspondingly, these developments have added a new complexity to the task of evaluating energy RD&D. Other factors that complicate the task of energy policy evaluation are the long time scale at which changes in the energy system occur, the fact that energy technologies are part of so-called large technical systems which implies that technologies can never be evaluated in isolation but that technological performance depends for example on the availability of a compatible infrastructure.

We describe the different approaches to energy RD&D evaluation through 5 leading questions:

- *What* is evaluated?
- *Why* does this evaluation take place?
- *When* does this evaluation take place?
- *Who* is evaluating *whom*?
- *How is the evaluation designed?*

These questions can be summarised into a classification framework as illustrated in the table below.

Table 1: A classification framework for energy RD&D policy evaluation

	Indicator	Description
What?	Unit of analysis	Description (programme/ project/technology)
	Scope	US/EU/regional/national
Why?	Strategic Intent	Description (learning/allocation of funds/advocacy/accountability/legitimacy)
Who?	Actors	Description (Commissioners, evaluators, stakeholder involvement)
When?	Timing	Ex-ante/In-process/Ex-post
		Systematic/Ad hoc
How?	Measures/Indicators	Input/output/impact/attribution technological/economic/environmental/security/other
	Feedback	Ensured yes/no
	Burden	(High/medium/low)

This classification framework allows us to give a uniform description of the wide variety of evaluation approaches presented during the workshop. Below a concise overview of the approaches is given whereas the remainder of the report gives a more detailed overview.

United States: Programme Assessment Rating Tool (PART)

Unit of analysis: Federal programmes of different types

Timing: In-progress, ex-post, systematic

Measures/Indicators: 25 questions organized into four sections: programme purpose and design (20%); strategic planning (10%); programme management (20%); and programme results/Accountability (50%)

United States: 20-Year retrospective evaluation of DOE programmes

Unit of analysis: Research projects

Timing: Ex-post, ad hoc

Measures/Indicators: Measurement of economic, environmental and security costs and benefits. The evaluation thereby distinguishes between realized benefits and costs, options benefits and costs and knowledge benefits and costs.

United states: Prospective evaluation of DOE programmes

Unit of analysis: DOE programmes

Timing: Ex ante, ad hoc but intended as a methodology for systematic evaluation.

Measures/Indicators: Experts panels were used to identify expected risks and benefits and, for consistency, all programmes were evaluated under each of three standard scenarios

European Commission: Evaluation of the Framework programmes

Unit of analysis: Project level, level of themes (e.g., energy) and programme level.

*Timing:*Ex ante, in process, and ex-post

Measures/Indicators: relevance, effectiveness, efficiency, utility, sustainability.

European Commission: Evaluating of the Strategic Energy Technologies Plan

Unit of analysis: Energy technologies and innovation capacities in EU member states (compared also with other regions)) as well as projects contributing to the programmatic activities of the European Industrial Initiatives (EII) and the European Energy Research Alliance (EERA).

Timing: In process, systematic.

Measures/Indicators: SETIS enables monitoring and evaluation at different levels of implemention – at project level at sub-programme and programme level.

Sweden: Monitoring of the FOKUS strategic plans

Unit of analysis: The Swedish energy RD&D programme, monitoring of the FOKUS strategic plans.

Timing: In process

Measures/Indicators: In assessing the goals an innovation systems approach is taken taking into account a wide variety of qualitative and quantitative indicators at different levels.

Nordic Energy Technology Scoreboard

Unit of analysis: Energy technologies

Timing: Ex-post, ad-hoc

Measures/Indicators: The scoreboard distinguishes between input, throughput, policy, structural and output indicators.

Introduction

The aim of this report is to identify effective processes for evaluating RD&D programmes and the mechanisms for feeding these evaluations back into priority-setting and policy making. The basis for the report is formed by the RD&D policy evaluation practices of IEA members that were presented during the workshop. In this report we aim to present a systematic analysis of RD&D evaluation practices as this enables comparing different approaches. In drafting the report we have also greatly benefitted from knowledge about evaluation exercises outside the energy domain as presented by experts from the RAND Corporation (Europe) and the Technopolis Group.

The remainder of this report is structured as follows. First, in Section 2, we present a general framework for classifying energy RD&D evaluation approaches. This section also includes a description of best practices that were identified during the workshop. The section ends with a table presenting a classification of evaluation approaches. Section 3 then gives a more detailed description of the different approaches.

A framework for classifying energy RD&D evaluation approaches

We describe the different approaches to energy RD&D evaluation through 5 leading questions:

- *What* is evaluated?
- *Why* does this evaluation take place?
- *When* does this evaluation take place?
- *Who* is evaluating *whom*?
- *How is the evaluation designed?*

What is evaluated?

Energy RD&D policies often have multiple goals and operate on different timescales. Accordingly, energy RD&D programmes that seek to contribute to these goals often have a complex nested structure, focusing on different phases of the technology lifecycle. The **unit of analysis** in an evaluation exercise can thus differ from a policy programme as large as the Strategic Energy Technology Plan (SET-Plan) of the European Union to the evaluation of a specific subsidy scheme for wind energy technology in one of the European Union member states.

Why does this evaluation take place?

The **strategic intent** of any evaluation exercise greatly influences its design. Evaluations can be conducted for a multitude of reasons including learning, allocation of funding, advocacy, dissemination of results, accountability, and creation of legitimacy. We can thereby distinguish between evaluations that are conducted to improve the quality of the programme under evaluation and evaluations that are used for other purposes. Evaluation goals can range from a mere description of programme outputs, an evaluation of those outputs with respect to the inputs of the programme (programme efficiency) and to programme goals (programme effectiveness), to impact assessments that relate programme or project outputs to

policy goals. Impact assessments should also include measures of attribution and compare programme outcomes with no-policy and next-best-alternative scenarios. In case of technology push RD&D programmes, the potential role of demand pull stimulation must also be considered (in term of expenditure).

For energy RD&D there is generally a substantial lag of time (up to 25 years) before a particular RD&D investment realizes its impact and the inherent uncertainty and high chances of failure associated with R&D, output related measures should take this into account (stimulating risk taking versus demonstrating success).

The strategic intent of an evaluation exercise thus influences the timing of the evaluation. It is also important to consider the relation between the strategic intent of the evaluation and the goals of the policy programme. Programme design and evaluation design are two sides of the same coin. If programme objectives are unclear systematic evaluation becomes very difficult.

When systematic evaluation is part of policy implementation the strategic intent of an evaluation is known upfront by all actors involved. The US programme assessment rating tool (PART) provides such a clear context. However, we also observe ad hoc evaluations where new goals that were not emphasized in the policy programme are introduced as a basis for evaluation. An example is the recent focus on economic performance of subsidy schemes for renewable energy technologies in the Netherlands where previously sustainability was the more important performance indicator.

Who is evaluating whom?

This question addresses the relation between the **actors** that have commissioned the evaluation, those that are executing the evaluation and the actors that are being evaluated. The energy RD&D programme evaluations described in this report are mostly commissioned by the governments that implemented the RD&D policy programmes. The relation between the evaluating actors and the actors involved in the programme can be very close - as is the case in self-assessment exercises - or the two groups can be unconnected. The evaluators can be known up front as is the case with the evaluation panels in the Swedish case or a procedure of independent peer review can be chosen as in the US case. In general the involvement of independent reviewers is preferable as the use of outside experts provides credibility and objectivity. However, self-assessment can work well if within programme learning forms the main **strategic intent** of the evaluation. Furthermore, programme actors might be more willing to participate in the evaluation when they can give their inputs on the evaluation criteria and outcomes that best represent their programme.

Stakeholders, the actors that are influenced by the policy programme but that are not active in the programme, may also participate in the evaluation. As some of the renewable energy technologies that are currently being developed may greatly impact the way societal functions such as mobility and housing are fulfilled early stakeholder participation can have a positive influence on technology acceptance and adoption in later stages of the technology life cycle. The engagement of end users of research in impact assessments is critical if the assessment has as a goal to improve programme impact.

Future societal acceptance of new energy technologies may also be improved when the evaluation panel consists of actors that also participate in the public debate on the future of the energy system as in the Swedish case. A downside of such consensus based approaches including actors that represent vested interests is that this setup may reduce the chances for radically new technologies to enter the energy system.

When does this evaluation take place?

The **timing** of the evaluation is very much related to the strategic intent of the evaluation. We distinguish between ex-ante, in-process and ex-post evaluations.

Ex-ante evaluation has an important role in justifying the choices for future priorities and setting programmes and projects in place. Due to the time lag between investment and return, the outcomes of RD&D are difficult to evaluate in advance. In addition, decisions which projects to fund or which strategic competence to pursue must be made under considerable market uncertainty and technology uncertainty. Yet priorities must be set and decisions made. Ex ante evaluations inform these selection processes. We thereby distinguish between thematic (what should we do?) and functional (how should we do it) priority setting. Priority setting processes can be top-down, or bottom-up, expert based or participatory. In their meta-study of priority setting processes for energy technologies Technopolis found that apparent determinants of priority-setting can be found in the maturity of the technology, the existence of a market for this technology and the anticipated progress. This bias is an illustration of the fact that evaluation is an essential component of the strategic policy intelligence that support priority-setting but that it should be used in combination with others (roadmapping, foresight, needs assessment consultation, market surveys).

In-process evaluations are regular reviews of programme and project advancement. Although evaluations carried out in-process are by far the most labour-intensive, they have the capacity to ensure that projects stay focused, within budget and are able to keep to deadlines. This is important when a project has several phases, as funding allocation for subsequent phases may depend on the success of the first phase. In addition, in-process evaluations are the most convenient for managing input from multiple stakeholders. The US Government Performance and Results Act (GRPA) requires that when budgets are proposed (ex-ante) performance metrics are established for performance. Subsequent budgets require prove of progress on a programme level.

Finally **ex-post** evaluations can be described as backward-looking reviews of how and why a programme was a success or failure. Whether ad-hoc or systematic, ex-post evaluations are the most widespread, particularly as the success of a particular programme or project is a reflection on those that agreed to provide the funding. But the success or failure of a programme is dependent on a myriad of factors. Reflecting back over the lifetime of a project provides key information that enables managers to realign processes and reporting methods to either avoid a similar fate or to replicate best-practice for other projects.

How is the evaluation designed?

The 'how' question addresses the evaluation methodology used to realize the goals of the evaluation. This includes a description of **measures of output and input** that are used as well as a description of **measures of impact and attribution**. Measures of impact and attribution analyze the extent to which observed outputs can be ascribed to R&D policy.

Inputs are usually measured in terms of the economic costs of the programme (including opportunity costs). Given the wide range of goals for energy policy, output and impact measures can be defined in different domains such as technological, economic, environmental, and security related output measures.

In general measures/indicators need to be life cycle specific, whereby quantitative measures and indicators become more important as the programme progresses. Evaluations should acknowledge that the issue of attribution is complex as scientific progress is a cumulative and collaborative effort. A case-study approach can help mitigate this by providing detail and demonstrable and verifiable evidence. A verification mechanism is important to build confidence and ensure objectivity. However, a focus on **contribution** rather than attribution is likely to be more realistic

The design of the evaluation in terms of its scope (which actors/technologies/projects/programmes are included) and its scalability (is it technology or programme specific) also determine whether the outcomes of the evaluation can be easily transferred to other projects (policy learning or transfer). In determining the scope of the evaluation it is important to realize that technological learning is global and that programmes should take the challenges and opportunities presented by the international context into account.

Another important factor to consider choosing an appropriate evaluation setup is the **burden** the evaluation places on the evaluators. If review based mechanisms will be needed to assess impact, it is clear that there will be an administrative burden. Extensive operational piloting of a framework is then essential for determining levels of burden and feasibility. Furthermore, determining whether the burden is acceptable depends on the size of the population of potential expert reviewers. In countries with a strong culture of consensus politics a higher administrative burden may be considered acceptable than in countries with a tradition of lean governance structures. Furthermore, the costs associated with a particular evaluation design are considered with respect to total programme budget.

Carrying out the evaluations is fundamental. But it is also essential that the evaluation results are used by RD&D planners when designing programmes or investing in technologies, and by policy makers when setting targets. Knowing which mechanisms of feeding evaluations into priority setting are the most successful will play a role in driving down costs and raising performance. Important for policy learning is thus whether the programme or evaluation design states how the outcomes of the evaluation will be **fed back** into future programme decisions or other programmes. The degree to which evaluation results are taken into account varies considerably among different evaluation exercises. A meta-study performed by Technopolis indicates that the relevance and impact of evaluations seem to increase when:

- There is a real demand for improvement, acknowledged by the service in charge of implementation exists.
- There is openness to also accept also negative evaluation statements and willingness to respond to the recommendations.
- There is substantial participation of external experts.
- The people launching the evaluation and those in charge of implementing changes (if different) must cooperate closely.
- The people affected by the evaluation could be involved in the preparatory phase of the evaluation.
- The timing of the evaluations is favourable to its use as in input.
- The quality of the evaluation study is high.

Summarizing, we propose to classify evaluation frameworks according to the indicators shown in the table below.

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	Indicator	Description
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	Scope	US/EU/regional/national
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Who?	Actors	Description (Commissioners, evaluators, stakeholder involvement)
When?	Timing	Ex-ante/In-process/Ex-post
		Systematic/Ad hoc
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	Feedback	Ensured yes/no
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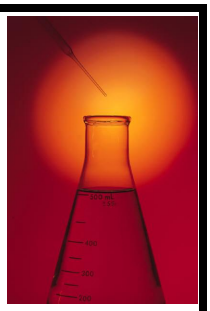
This classification framework allows us to give a uniform description of the wide variety of evaluation approaches presented during the workshop:

- United States: Programme Assessment Rating Tool (PART)
- United States: 20-Year retrospective evaluation of DOE programmes
- United states: Prospective evaluation of DOE programmes
- European Commission: Evaluation of the Framework programmes
- European Commission: Evaluating of the Strategic Energy Technologies Plan
- Sweden: Monitoring of the FOKUS strategic plans
- Nordic Energy Technology Scoreboard



Detailed description of policy approaches in IEA countries

United States: Programme Assessment Rating Tool (PART)

Short description: The Government Performance and Results Act of 1993 (GPRA) was enacted by Congress. It requires agencies to define goals/outcomes and to report results. GPRA can thereby contribute to greater transparency to the federal government of the relation between programme spending and programme and results and create incentives for a better performance in meeting goals. GPRA was passed in response to concerns that waste and inefficiency undermine the confidence of the American people, programme managers are disadvantaged because of inadequate goal setting and performance measurement; and policy making, spending decisions and programme oversight are handicapped by insufficient information about programme performance. GPRA is a law with specific planning and reporting requirements including a five-year strategic plan, an annual performance plan and annual performance report for all programmes.

The Programme Assessment Ratings Tool (PART) (2001* – 2008) enables such as systematic and consistent process for developing programme performance ratings and using that information to make budget decisions as required by GPRA. The US Office of Management and Budget (OMB), in collaboration with other Federal agencies, developed PART. It establishes a high, "good government" standard of performance and is used to rate programmes in an open, public fashion.

Due to the high aggregation level of the analysis it is sometimes difficult to assess which elements of the programme led to failure which makes it difficult to adequately respond to these failures. Furthermore government-sponsored R&D is often risky, and frequent failures are expected. It is not clear whether PART can adequately portray and fairly assess such risks. Currently GPRA continues to exist but PART will be phased out in a transition from a planning and reporting approach to three performance improvement strategies:

- Using performance information to lead, learn, and improve outcomes
- Communicating performance coherently and concisely for better results and transparency
- Strengthening problem-solving networks to improve outcomes and performance management practices

Source/Further information: http://www.whitehouse.gov/omb/expectmore/

Unit of analysis: Federal programmes of different types

Scope: All federal programmes, including Energy Technology RD&D – used across government

Strategic Intent: To improve government management by providing greater accountability and transparency to programme results. To allocate scarce resources and to induce organizational change and learning through improvement plans.

Actors: self assessment, but programmes have to provide evidence.

Timing: In-progress, ex-post, systematic. The focus is on whether programmes meet their annual (outcome) targets. Assessments take place at least once every 5 years

Measures and indicators: Each programme within the Department, (e.g., Fossil Energy, Nuclear Energy, Energy Efficiency and Renewable Energy, etc) develops annual targets that are submitted with the budget request. Once the fiscal year begins, the programme establishes quarterly milestones to track R&D progress against the annual target. Once the fiscal year ends, the programme submits an annual report with justification to the Office of Management and Budget (OMB) that target was met/not met.

PART streamlines this process by asking a series of questions (usually 25 or more) designed to provide a consistent approach to rating programmes across the Federal government. It is a diagnostic tool that relies on professional judgment to assess and evaluate programmes across a wide range of issues related to performance and it is intended to develop consistent and defensible ratings of programmes for the Budget Request.

The evaluation includes 25 questions organized into four sections that are each assigned a weight for calculating an overall score: programme purpose and design (20%); strategic planning (10%); programme management (20%); and programme results/Accountability (50%), some questions may not apply to every programme. Responses are aggregated into an overall score. The performance evaluation questions are written in a Yes/No format. A brief narrative explanation of the answer provided. The PART requires a high level of evidence to justify a "Yes" response, and credit for a question cannot be given without evidence.

Evidence should address every element of the question, be credible, and current (i.e., from the last five years). No single question determines the performance of a programme. Questions within each section are given equal weight, unless the evaluator decides to alter their weight to emphasize certain key factors of importance to the programme. Hard evidence of performance may not be readily available for all programmes. In these cases, OMB assessments will rely more heavily on professional judgment. The summing of weighted answers results in an overall PART Score. There are 7 Versions of the PART Worksheet, each Fit to a Different Type of Federal Programme (one of the categories is R&D).

OMB converts the PART scores into qualitative ratings using the following scoring bands:

- Effective 85 – 100
- Moderately Effective 70 – 84
- Adequate 50 – 69
- Ineffective 0 – 49

However, regardless of the overall score, a rating of "results not demonstrated (RND) is given if the programme does not have performance measures that have been agreed-upon by OMB, or if the measures lack baselines and performance data. Programmes thereby have to demonstrate evidence of impact attribution to get credited (otherwise a rating of 'effectiveness not demonstrated' can result)

Feedback: The results of the PART evaluation feed back into decisions about programme continuation and about future programmes. PART results are mainly used to track ongoing progress of a programme and not as the exclusive means to judge the merits of technology. Furthermore results are public.

Burden: The burden of evidence lies with the programmes although independent expert may also contribute to the assessments. OMD collects and processes responses.

United States: 20-Year retrospective evaluation of DOE programmes

Short description: In 2001, the National Research Council (NRC) completed a congressionally mandated assessment of the benefits and costs of DOE s fossil energy and energy efficiency R&D programmes. The evaluation asks whether the benefits of the programme have justified the expenditure of public funds since DOE's formation in 1977, and it takes a comprehensive look at the actual outcomes of DOE's research over two decades.

Source/Further information

Energy Research at DOE: *Was It Worth It? Energy Efficiency and Fossil Energy Research 1978 to 2000* Committee on Benefits of DOE R&D on Energy Efficiency and Fossil Energy, Board on Energy and Environmental Systems, Division on Engineering and Physical Sciences, National Research Council.

ISBN: 0-309-07448-7, 240 pages, 8 1/2 x 11, (2001) http://www.nap.edu/catalog/10165.html

Unit of analysis: Research projects

Scope: DOE's Energy Efficiency and Fossil Energy Programmes, research funded in the period 1978-2000 through the evaluation of 39 randomly selected case studies. From the fossil energy programme 22 case studies were selected representing $11B out of $15B budget, 17 case studies in the energy efficiency programme were selected representing $1.6B out of a $7.3B budget

Strategic Intent: To assess whether the benefits of the programmes justified the expenditure of public funds since DOE's Formation in 1977.

Actors involved: DOE

Timing: Ex-post, ad hoc

Measures and indicators:

The analytical framework for the evaluation is given below.

20 – Year Evaluation of Benefits and Costs
(1978 – 2000)

	Realized	Options	Knowledge
Economic			
Environmental			
Security			

Economic benefits and costs are thereby defined as: The change in total value of goods and services in the U.S. economy (under "normal" conditions) made possible by the technological advances stemming from the R&D programme. Environmental benefits and costs are defined as: Change in the quality of the environment made possible by the new technology. Security benefits and costs are defined as: The change in the probability or severity of adverse abnormal events made possible by the new technology.

The evaluation thereby distinguishes between realized benefits and costs, options benefits and costs and knowledge benefits and costs. Realized benefits and costs are those benefits that are almost certain; the technology has been developed and the conditions for deployment are favourable. Options benefits and costs, in contrast, occur when the technology has been developed but conditions are not currently favourable for deployment, although this may change in the future. All other potential benefits are covered by the knowledge benefits and costs category.

Feedback: The evaluation showed that the existing evaluation practices lacked clear rules, consistency and transparency. The framework used in the study was used as in an input for later prospective studies described below.

Burden: The evaluation was performed by the DOE based on existing data on projects.

United States: Prospective Evaluation of DOE programmes

Short description: The Congress followed the retrospective study described above by directing DOE to request the National Research Council to develop a methodology for assessing prospective benefits. The first phase of this project development of the methodology began in December 2003. Phase two focused on making the methodology more robust and exploring related issues. In developing this project, three considerations were particularly important. First, the study should adapt the work of the retrospective study. Second, the project should develop a methodology that provides a rigorous calculation of benefits and risks, and a practical and consistent process for its application. Third, the methodology should be transparent, should not require extensive resources for implementation, and should produce easily understood results. Phase one focused on adapting the retrospective methodology to a prospective construct suitable for ex ante evaluation. Phase two refines the methodology from phase one and conducts six case studies of DOE programmes.

Source/Further information

Prospective Evaluation of Applied Energy Research and Development at DOE (Phase One): A First Look Forward Committee on Prospective Benefits of DOE's Energy Efficiency and Fossil Energy R&D Programmes,

National Research Council

ISBN: 0-309-54913-2 (2005)

http://www.nap.edu/catalog/11277.html

Prospective Evaluation of Applied Energy Research and Development at DOE (Phase Two)

Committee on Prospective Benefits of DOE's Energy Efficiency and Fossil Energy R&D Programmes (Phase two), National Research Council

ISBN: 0-309-66840-9 (2007)

http://www.nap.edu/catalog/11806.html

Unit of analysis: DOE programmes

Scope: The aim is to develop a methodology suitable for the evaluation of all DOE programmes, the study described here applies the methodology to six case studies of DOE programmes.

Strategic Intent: Evaluation of all DOE programmes

Actors: DOE

Timing: Ex ante, ad hoc but intended as a methodology for systematic evaluation.

Measures and indicators

As a prospective study the evaluation focuses on expected benefits and the expected risks of a programme. Experts panels were used to identify expected risks and benefits and, for consistency, all programmes were evaluated under each of three standard scenarios: A reference case (the AEO base case), A scenario with high oil and gas prices and a carbon constrained scenario. Panels were encouraged to explore whether technologies might be valuable under a specialized fourth scenario, as defined by the panel. An outline of the evaluation framework is given in the Table below.

Refined Benefits Matrix for Prospective Evaluations

		Global Scenarios		
		Reference Case	High Oil/Gas Prices	Carbon Constrained
Programme Risks	Technical			
	Market			
Expected Programme Benefits	Economic			
	Environmental			
	Security			

Expected programme risks are divided into technical risks that arise due to uncertainty of technological outcomes and market risks that arise due to the uncertainty of technological improvements in competing technologies. Three types of expected benefits are considered: economic benefits, environmental benefits and security benefits. The methodology thereby seeks to attributes benefits to programme investments using expert panels that estimate benefits with and without DOE's R&D Investments and take the difference. All benefits are quantified. The methodology takes into account that benefits are conditional on multiple events, each subject to probabilistic outcome by taking a decision tree approach.

Feedback: The evaluation is incorporated into budget requests; however priorities depend on policies and judgments, not just on the mechanical application of cost-benefit analysis.

Burden: Full implementation requires 40 Expert Panels/Triennial Rotation (13 Panels/Year) and the use of consultants to work with all panels, DOE supports the panels by providing needed info.

European Commission: Evaluation of the Framework Programmes

Short description: Framework programmes are subject to a compulsory series of interlinked evaluations. In the period 1995 – 2006: Two major exercises took place: the annual monitoring of FP implementation and the five Year Assessment of the implementation and achievements of research carried out over the five preceding years. FP7 evaluations include indicator-based annual assessments of programme implementation ("annual monitoring"), a 2009 progress report, a 2010 interim evaluation and an ex post evaluation.

Source/Further information:

EU Framework Programme Evaluation and Monitoring

http://ec.europa.eu/research/evaluations/index_en.cfm?pg=home

Archive of FP Programme Evaluation and Monitoring Documents

http://ec.europa.eu/research/evaluations/index_en.cfm?pg=archive

Study on Role and Impact of Small and Medium Size Enterprises in Energy Research Framework Programme Projects

http://www.partnersforinnovation.com/PDF_web/publicaties/091203%20PfI_final_report_Role_impact_SMEs.pdf

Unit of analysis/Scope: Evaluations of the framework programmes occur at the project level, at the level of themes (e.g., energy) and at the programme level.

Strategic Intent: The framework programme evaluations aim to create insight in the general performance of the programme, the performance of/impact on specific groups (e.g. SME's, gender aspects, new member states, the performance of instruments (ERA-Nets, PPPs, JTIs, Networks of Excellence), and the quality of the programme processes (e.g. call evaluation procedure, time to contract)

Actors involved: Different actor groups evaluate or contribute to the evaluations, these can be framework staff (often in combination with monitoring) institutionalized expert groups such as the Advisory Group on Energy or ad hoc expert groups (e.g. panel for evaluation of ERA-NETs), interest groups, committees representing Member States and members of the general public (e.g. public consultation as part of the interim evaluation of FP 7)

Timing: Ex ante impact assessment (e.g., for FP8), in process (e.g., interim Evaluation FP7, mid term review of projects), and ex post (e.g., 5 years assessment of FP5).

Measures and indicators:

Evaluation criteria depend on the specific evaluation demand. However, in most cases programme evaluations look at:

- **Relevance:** To what extent are the objectives of a programme appropriate regarding the needs and the problems the intervention is meant to solve?
- **Effectiveness:** Were the specific objectives attained and were the intended results achieved?
- **Efficiency:** How well have the inputs (resources) been converted into outputs, results and impacts? Were the effects obtained at a reasonable cost?
- **Utility:** Do the impacts achieved by an intervention correspond to the existing needs and the problems to be solved?
- **Sustainability:** Will the effects achieved last in the medium or long term, i.e. after the funding has stopped?

We now give a short description of the different types of evaluations within the framework programme.

The **ex ante** impact assessment for FP7 was based on stakeholder consultations, internal and external evaluation studies and the 5 year assessment of FP5. The assessment focused on the main objectives, expected impacts, monitoring and evaluation procedure, the actors in the S&T system that would be affected and the expected results under a "no policy change" scenario.

The **in process** interim evaluation consists of a report drafted by group of 10 external experts. Inputs for the expert group are a self assessment by services responsible for different aspects of FP7, an open stakeholder consultation (500 people), internal and external evaluation studies and an ex post evaluation of FP6. The interim evaluation addresses questions regarding the achievement of general objectives, the impact on the European Research Area (ERA), the efficiency of novel measures (e.g. European Research Council, Joint Technology Initiatives, ERA-NET plus, Risk Sharing Finance Facility), the effectiveness of simplification and the progress regarding the follow up of FP6 evaluation report. The interim evaluation report will include recommendations for the remainder of FP7 and for FP8. The **ex post** evaluation of FP7 will take place after 2013.

Besides evaluations of the framework programmes as a whole, individual projects are also evaluated. At this level **ex ante** evaluation of projects corresponds to the selection of project proposals. This selection is

a consensus based decision by teams of independent experts starting from individual assessment reports of the proposals. Selection criteria are scientific and/or technological excellence, potential impact and the quality and efficiency of the implementation and management. An extended panel ensures harmonized application of criteria across different consensus groups. This process results in a ranked list of proposals above the threshold. The consensus panels are moderated by Commission officials. The evaluation and selection process itself is monitored and evaluated by "independent observers". Many of their recommendations are taken into account in the evaluation of the next call.

An **in-process** midterm of review of projects takes place only in some themes and only in the case of big projects. Midterm reviews are carried out by external experts and could in principle result in project stop although this happens very rarely. Finally an ex post evaluation of projects or group of projects

Feedback: "The legal basis of FP7 requires the Commission to communicate the conclusions of the interim evaluation accompanied by its observations and, where appropriate, proposals for the adaptation of this Framework Programme, to the European Parliament, the Council, ….."

Burden: high due to the large number of actors involved and the elaborate set of evaluation goals.

European Commission: Evaluating the Strategic Energy Technologies Plan

Short description: The Strategic Energy Technology (SET) Plan forms the technology pillar of the European energy and climate change strategy. It is the EU's energy technology policy with the goal to accelerate the development and demonstration of cost-effective, high performing low carbon energy technologies leading to their large-scale deployment. SETIS (Strategic Energy Technologies Information System) is the decision making support tool for the SET-Plan led by the European Commission's Joint Research Centre. It supports the strategic planning and implementation of the SET-Plan. It makes the case for technology options and priorities, monitors and reviews progress regarding implementation, assesses the impact on policy, and identifies corrective measures if needed. SETIS continuously monitors the public and industrial R&D investments and other innovation capacities in low-carbon energy technologies and reports it periodically in the Capacities Maps. It also monitors technology progress, which is published in the periodically updated Technology Maps. In addition, there will be regular reviews of the specific technology developments performed under the SET-Plan initiatives – European Industrial Initiatives – based on agreed Key Performance Indicators (KPIs).

Source/Further information: http://setis.ec.europa.eu

Unit of analysis/scope: Energy technologies and innovation capacities in EU member states (compared also with other regions)) as well as projects contributing to the programmatic activities of the European Industrial Initiatives (EII) and the European Energy Research Alliance (EERA).The monitoring and evaluation includes an assessment of the technology progammes, the estimation of impacts on the policy goals as well as the monitoring of specific projects and wider actions.

Strategic intent: To support the SET-Plan, the mission of SETIS is: (1) to establish an open-access information system on energy technologies and their innovation aspects. This information is geared towards supporting effective strategic planning, monitoring and assessment of the SET-Plan implementation, and (2) to develop an integrated approach for information and data exchange on energy technologies and capacities for innovation throughout Member States, international organisations and energy sectors.

More specifically, SETIS informs the SET-Plan Governance regarding research and innovation capacities for the SET-Plan portfolio of technologies in the EU, the selection of technology options and priorities, the monitoring and progress reviews of implementation, the assessment of the impact on policy, and the identification of corrective measures if needed.

Actors: The governance of the SET-Plan is based on the Steering Group(SG). The SG is composed of high-level representatives from the EU Member States, chaired by the European Commission. Iceland, Norway, Switzerland and Turkey participate as observers.

Stakeholder involvement: SETIS seeks full engagement with the relevant European stakeholders. This includes of course working closely with the SG and its Sherpas; organising dedicated workshops and hearings on specific technologies and capacities, bringing together European Technology Platforms, trade associations and industrial stakeholders; working closely with European Industrial Initiative teams (Member States supporting the Initiative and industries that lead and steer its development) and exchanging with the European Energy Research Alliance and key European projects funded by either the R&D Framework Programme and/or National funds.

Timing: In process, systematic. The focus is on in-process evaluation (monitoring and review). SETIS provides a consistent environment for monitoring and evaluation of the SET-Plan progress. Given the dynamics of the SET-plan SETIS is continuously adapting to the monitoring needs of the various phases of the SET-Plan implementation.

*Measures/Indicators***:** SETIS enables monitoring and evaluation at different levels of implemention – at project level at sub-programme and programme level.

It adapts to the policy needs and provides monitoring and assessment at different levels, applying a variety of tools. Besides the regular monitoring of technology progress and R&D&D capacities on the basis of some key indicators, 'tailor-made' tools are also used to adequately meet the needs of specific policy questions. SETIS exploits synergies between the various monitoring mechanisms, benefiting from a stable monitoring architecture that ensures continuity in expert knowledge and facilitates a systematic exchange with experts, stakeholders, Member States etc.

At the highest level SETIS monitors and reviews the implementation of the SET-Plan. As a basis for the evaluation several benchmarks were developed in order to facilitate impact assessments and measures of attribution in later phases. These benchmarks include regularly updated Technology and Capacities Maps. The Technology Map is the SET-Plan reference document on the state of knowledge for the current and future potential of low carbon technology in Europe, currently presenting a snapshot of the energy technology market situation for 2008-2009.

The Capacities map, a map of energy RD&D capacity, describes the status quo of the public national systems of energy-related R&D in the EU. This status quo analysis was based on available qualitative and quantitative information from previous literature studies as well as from JRC research and available statistics on the institutional setup of member state energy R&D and on public and private R&D budgets and priorities (Eurostat: GBAORD; GERD; BERD; EU Industrial R&D Investment Scoreboard). It also includes an estimation of current corporate and public research investment in the low-carbon technologies portfolio of the SET-Plan.

Together with the European technology roadmaps developed within SETIS, the Technology and the Capacities maps allowed the determination of the investment gap for energy technologies. Knowledge about this investment gap serves as input for the SET-Plan planning phase in conjunction with the identified priorities of the respective Implementation plans accompanying each roadmap.

With the start of implementation phase in mid-2010, when the first European Industrial Initiatives were launched, the in-process monitoring and review and impact analysis also started.

The European Industrial Initiatives (EIIs) (on Wind, Solar, Bioenergy, Fission, CCS, and Electricity Grids) are monitored through key performance indicators (KPIs). Overarching KPIs, at the programme level of the Initiatives, will be primarily focusing on the levelised costs of energy. More specific operational KPIs will be in place to monitor the specific activities described in the Implementation Plans of each EII.

SETIS also started to assess methodologies for the in-process evaluation of potential impact of policies. In a pilot novel study two main questions have been investigated:

- What is the change in technology investment costs of selected SET-Plan priority technologies if accelerated RD&D efforts are implemented?
- Can an increase in RD&D investments along the lines of the SET-Plan help in reducing the costs of achieving the European energy and climate targets by 2020 and beyond and does it contribute to bringing new technologies onto the market?

As the SET-Plan is essentially based on technology promotion, the assessment focus is on technological progress. In order to answer these questions a novel methodology of model based impact assessment has been developed.

Feedback: Monitoring and review are key elements in every single phase of the technology policy. They are explicitly pointed out in the joint planning and implementation. The European Council has requested the Commission through SETIS to develop and use a monitoring and review of progress framework from the very beginning. Since then, SETIS actively interacts with all stakeholders to adapt the set of qualitative and quantitative tools needed to monitor progress.

Burden: Inputs for the evaluation are generated by various project members and other stakeholders as well as gathered from available data sources and by research of the JRC. Consensus building exercises, background and foreground knowledge sharing from the programme implementation and consistencies with the quantification of impacts from implementation are issues that need to be further addressed.

Sweden: Monitoring of the FOKUS strategic plans

Short description: The overall Energy RD&D objectives as identified by the Swedish government are "to build up the scientific and technical knowledge and expertise within universities, colleges, other higher education institutions, government agencies and in the business sector necessary to enable a transition to a long-term sustainable energy system in Sweden through application of new technology and new services, and to develop technology and services that, through the Swedish business sector, can be commercialised and thereby contribute to the transition and development of the energy system in Sweden and in other markets. "

These overall goals are translated into visions (for 2050), mid-term objectives (for 2020) and goals for the programme period 2011-2014 for each of six thematic areas, the different goals thus have different timeframes. The six thematic areas are demand driven, not technology driven and are: energy on the built environment, transport, fuel-based energy systems, energy-intensive industry, power systems, energy systems studies.

For each thematic area a so-called development platform exist consisting of an advisory expert group for strategic planning and prioritization matched by an agency group of experts and desk officers for each area.

Source/Further information:

Technopolis Ltd: *Evaluation of the Swedish Long Range Energy Research Programme 1998−2004*

http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=3719

Unit of analysis/scope: The Swedish energy RD&D programme, monitoring of the FOKUS strategic plans.

Strategic Intent: Measures and Indicators to ensure proper follow-up and monitoring of action

Commissioners: Swedish government

Evaluator: Swedish Energy Agency

Evaluated: FOKUS strategic plans

Stakeholder Involvement: Stakeholder involvement is organized through the development platforms that provide guidance to the programme. Furthermore the evaluation takes an innovation systems approach also using broader societal indicators.

Timing: In process

Measures and indicators

(input, output, impact)

In assessing the goals an innovation systems approach is taken taking into account a wide variety of qualitative and quantitative indicators at different levels:

Specific indicators for monitoring of the mid-term goals of the FOKUS Strategic Plans are directly related to programme goals.

In addition to this the evaluation includes indicators for knowledge and competence building and indicators for monitoring and commercialisation. Examples of indicators for knowledge and competence building include: number of PhD and licentiat degrees p.a., number of senior researchers in a field, number of peer reviewed publications, use of results from a specific project/programme in public enquiries, new laws and regulations, environmental permit processes, political decisions, new policies and measures etc. (yes/no), participation in international network/collaboration etc (yes/no), results used in education (yes/no).

Indicators for monitoring of commercialisation include: patents, licenses, etc (number), venture capital invested (Million SEK), new companies or employment created (numbers), new/better products/services are introduced to the market, nationally or internationally (yes/no), activity contributes to regional development (yes/no);

Feedback: Current policies have been designed taking into account outcomes of previous evaluation exercises regarding concerns about the focus of R&D efforts and the incentives for commercialization. Evaluation is an integral part of the design of the strategic plans. Evaluation outcomes have fed back into the programme, an example of this is the recent creation of a business development unit to fill university start up gap. Evaluation results serve as input for the decisions of the Swedish Energy Agency and the development platforms on future portfolio decisions within the FOKUS plan.

Burden: Evaluations are performed by the Swedish Energy Agency and cover a wide variety of goals and indicators.

Nordic Energy Technology Scoreboard

Short description of the policy that is evaluated/Description of the evaluation framework

The first edition of the Nordic Energy Technology Scoreboard demonstrates and proposes a set of indicators to measure the conditions and performance of clean energy technology development in the Nordic region.

Source/Further information: www.nordicenergy.net

Strategic intent: First, the goal of the scoreboard is to provide a tool, equipping decision-makers with an understanding of the nature and state of clean energy technology development, and therefore insight into the how to influence this development. Second, the scoreboard seeks to act as a pilot study, utilising a limited geographic and technological scope to develop sound methodologies that can be adapted to more

comprehensive scoreboards in the future. And lastly, to be a vehicle for better data collection, by demonstrating indicators where data is available and proposing indicators where data gaps exist.

Unit of analysis: Energy technologies

Scope: The five Nordic countries of Denmark, Finland, Iceland, Norway and Sweden, alongside reference countries and regions including: The United Kingdom, Germany, Spain, Portugal, France, Italy, the Netherlands, Austria, USA, Japan and the EU-27. It focuses on five low-carbon energy technologies: Wind, photovoltaic (PV) solar, bio-fuels, geothermal, and carbon capture and storage (CCS). The evaluation exercise covers a 10-year period.

Commissioners: The scoreboard was commissioned by Nordic Energy Research

Evaluators: NIFU step in cooperation with an international expert group.

Evaluated: countries

Stakeholder involvement: Currently no data on public acceptance of the technologies is included.

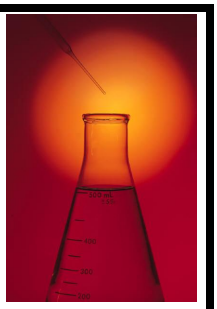
Timing: Ex-post, ad-hoc, although this first scoreboard is explicitly meant as an input for future scoreboards.

Measures and indicators

The scoreboard distinguishes between input, throughput, policy, structural and output indicators. Input indicators capture the investments into RD&D activities and include public R&D budgets and a measure for specialization. Structural indicators are key country variables that include conventional measures into perspective, such as population, GDP, human resources, industry specialization, energy prices, and energy balances by energy source. Throughput indicators are measures that capture the intermediate products of the innovation process such as patent, bibliometric and citation statistics. Output indicators attempt to capture the economic effects of the innovative activity, such as energy technology exports. Policy indicators measure different forms of policy-contributions across countries. These include taxes, tradable permits, financial incentives and subsidies, regulatory instruments, RD&D policies and policy processes.

Feedback: Specific recommendations for the design of future scoreboard are given. Furthermore the policy indicators give guidance to policymakers on how to design future energy policies.

Burden: The scoreboard started from available data, for the mid and long term more extensive data collection is envisioned.



Appendix A: Workshop Agenda

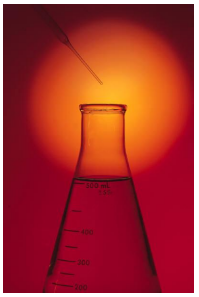
FINAL AGENDA

Tuesday, 9 November
10:00-17:30

10:00-10:15	**Opening Remarks from the Chair**	**Rob Kool, Director, International Sustainable Development, NL Agency, Netherlands**
	TIMING AND MECHANISMS OF EVALUATION	
Session Leader: Birte Holst Joergensen, Riso National Laboratory for Sustainable Energy, Denmark		
Ex-Ante: Synchronizing the Clocks		
Moderator: Herbert Greisberger, Director, Austrian Society for Environment & Technology		
10:30-11:00	Role of Evaluation in Transforming Institutional R&D Frameworks	Lars Guldbrand, Director, R&D Strategy, Swedish Energy Agency
11:00-11:30	Accelerating Energy Innovation Project	Tom Kerr, Sr. Analyst, International Energy Agency
11:30-12:00	**Module Summary and Discussion**	**Herbert Greisberger, Moderator**
12:00-13:00	*Lunch*	
In-Process: Keeping Pace in the Race		
Moderator: Frank Witte, Manager, NL Agency, Netherlands		
13:00-13:30	Tools for Informed Energy Technology Policies and Evaluations	Tobias Wiesenthal, Institute for Prospective Technological Studies, Joint Research Centre, European Commission
13:30-14:00	Government Performance and Results Act and Programme Assessment Rating Tool	Craig Zamuda, Sr. Advisor, Climate Change, Policy and Technology, U.S. Department of Energy
14:00-14:30	**Module Summary and Discussion**	**Frank Witte, Moderator**
14:30-14:45	*Coffee break*	
Ex-Post: Back to the Future		
Moderator: Sea Rotmann, Principal Scientist, Energy Efficiency & Cons. Authority, New Zealand		
14:45-15:15	Nordic Energy Technology Scoreboard	Antje Klitkou and Benjamin Smith, Nordic Energy Research
15:15-15:45	20-Year Review of R&D Programmes	Robert Marlay, Deputy Director, Climate Change and Policy, Technology, U.S. Department of Energy
15:45-16:15	Capturing Research Impacts: A Review of International Practice	Sonja Marjanovic, Sr. Analyst, Innovation and Technology, RAND Europe
16:15-16:45	**Module Summary and Discussion**	**Sea Rotmann, Moderator**
16:45-17:00	**Session Wrap-up**	**Birte Holst Joergensen, Session Leader**

Wednesday, 10 November
9:00-12:00

9:00-9:15	**Rappel Main Outcomes Day 1**	**Rob Kool, Chair, Expert Group on R&D Priority-Setting and Evaluation**
THE ROLE OF EVALUATION IN PRIORITY-SETTING AND POLICY MAKING		
Session Leader: Estathios Peteves, Head, Energy Systems Evaluation, Inst. for Energy, Joint Research Centre, European Commission		
9:15-9:45	Evaluations Tailored to Meet Policy Needs	Philippe Larrue, Director, Technopolis Group France
9:45-10:15	FP7 Evaluation Process	Martin Huemer, Scientific Officer, DG Research, European Commission
10:15-10:45	**Session Wrap-up**	**Estathios Peteves, Session Leader**
10:45-11:00	*Coffee break*	
ROUNDTABLE: KEY OUTCOMES		
Session Leader: Rob Kool		
11:00-12:00	*Participants are invited to share those significant policy decisions in their organisations that were made based on evaluations, and the key elements in that process that were found to be the most effective.*	
12:00-12:30	**Workshop Summary and Outcomes**	**Rob Kool, Chair, Expert Group on R&D Priority-Setting and Evaluation**



Appendix B: Workshop participants

ORGANISATION	LOCATION	PARTICIPANT	
Austrian Society for Environment & Technology	Austria	Herbert	Greisberger
Department of Energy	United States	Robert	Marlay
Department of Energy	United States	Craig	Zamuda
Energy Efficiency and Conservation Authority	New Zealand	Sea	Rotmann
European Commission, Joint Research Centre	Netherlands	Martin	Huemer
European Commission, Joint Research Centre	Netherlands	Estathios	Peteves
European Commission, Joint Research Centre	Netherlands	Tobias	Wiesenthal
International Energy Agency	France	Carrie	Pottinger
International Energy Agency	France	Jacob	Mandel
International Energy Agency	France	Joana	Chiavari
International Energy Agency	France	Tom	Kerr
Italian Association of Energy Economists	Italy	Ugo	Farinelli
Ministry for the Economy	Belgium	Gabriel	Michaux
Ministry for the Economy	Belgium	Ludwig	Vandermaelen
Ministry of Petroleum and Energy	Norway	Marius	Knagenhjelm
National Institute Adv. Industrial Science & Tech.	Japan	Makoto	Akai
NL Agency	Netherlands	Rob	Kool
NL Agency	Netherlands	Frank	Witte
Nordic Energy Research	Norway	Anne Cathrine	Gjærde
Nordic Energy Research	Norway	Benjamin	Smith
Rand Corporation	United Kingdom	Sonja	Marjanovic
Research Center Juelich GmbH	Germany	Michael	Sachse
Risø DTU Nat. Lab. Sustainable Energy	Denmark	Birte	Holste-Jorgensen
Swedish Energy Agency	Sweden	Lars	Guldbrand
Technopolis	France	Philippe	Larrue