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Foresight and strategy in national research councils and research programmes

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This paper addresses the issue of foresight and strategy processes of national research councils and research programmes. It is based on a study of strategy processes in national research councils and programmes and the challenges faced by their strategy activities. We analysed the strategy processes of two organisations: the Danish Technical Research Council and the Danish Energy Research Programme. We analysed the mechanisms of the strategy processes and studied the actors involved. The actors' understanding of strategy was also included in the analysis. Based on these analyses we argue that the impact of foresight exercises can be improved if we have a better understanding of the traditions and new challenges faced by the research councils. We also argue that a more formal use of foresight elements might improve the legitimacy and impact of the strategic considerations of research councils and research programmes.

Keywords: technology and innovation studies; socio-technical; public research organisations; foresight; science and technology and innovation policy studies

1. Introduction

The setting of priorities in science and innovation policy is one of the most important rationales for implementing national foresight activities. Important users of this type of foresight activity are often national research and innovation councils, national research programmes and similar entities involved directly in prioritising public expenditure on research and development (R&D).

Research and innovation councils and programmes play a significant role in the development of science and are a central interface between politics and research. Compared with basic funding to universities, the funding for research and innovation councils and targeted research programmes is a more dynamic instrument, suitable for interaction with national science and innovation policy. In some countries (for example, Norway) research councils have played a key role in initiating and sponsoring foresight activities as a strategic input to funding activities. In other countries foresight exercises have been carried out on the national level by entities (private or public) other than research councils and related organisations.

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However, there is often great uncertainty about how to implement foresight exercises within research councils and how to use the results. Many reports from foresight exercises are ignored and foresight practitioners can become frustrated following comprehensive exercises when recommendations based on solid reasoning are not implemented. Analysing and improving the impact of foresight exercises in policy and decision-making are two key issues in the field of foresight studies.

Although the use of foresight exercises as a tool has become widespread over the latest 10–15 years, there are still also many research councils and programmes that do not use foresight exercises in their work. The analysis in this paper builds on the basic observation that all research councils and research programmes – foresight or not – do strategic thinking and set up smaller or larger, formal or informal, strategy definition processes supporting the practical decision making on funding. In some form or another there are always strategy processes in national research councils and research programmes. Instead of analysing directly the difficulties with using foresight as a strategic input to research-council funding activities, this paper takes the detour and analyses the strategy processes in national research councils and research programmes and the challenges that they are facing. Our analysis makes a departure in the contemporary foresight literature and the discipline of strategy. Based on this it is the aim of the article to investigate how foresight exercises can be improved if we have a better understanding of the traditions and new challenges faced by research councils. Furthermore, it is the aim to investigate if more formal use of foresight elements might improve strategic consideration by research councils and research programmes.

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2. Foresight and strategy processes in research

Strategy and priority-setting processes have probably always been used by research communities, but the area has attracted increased interest in the last 10 or 20 years. However, a significant difference between today's knowledge-based economies and the industrial economies of 30 or 50 years ago is that technological development has become crucial for economic development and for meeting the challenges faced by society, such as those concerning health, energy supply and the environment. Modern societies have a strategic interest in research and technological development, and governments have an interest in the overall priorities of national expenditure on these areas. Hence, many countries have initiated technology foresight exercises and other activities for prioritising strategic research. Sociologists have noted this development, highlighting how modern knowledge production has changed from its classical form (Mode 1), characterised by discipline-oriented basic science in universities, to a new form (Mode 2), characterised by problem-driven, application-oriented and trans-disciplinary research taking place partly outside universities (Gibbons et al. 1994). While Mode 1 research does still exist, Mode 2 research has gained considerable influence in recent years.

We see foresight as a specific type of strategy activity. Foresight is a part of the much larger area of strategy activities in general, and of the range of methods and systematic approaches existing in the strategy field. With its long-term perspective and its emphasis on connecting perspectives of different knowledge areas and different actors and stakeholders, foresight differs from corporate strategic planning, which typically looks three, five or maybe eight years ahead and involves only a very limited number of stakeholders.

An oft-cited definition of foresight in science and technology was formulated by Ben Martin as 'the process involved in systematically attempting to look into the longer-term future of science, technology, the economy and society with the aim of identifying the areas of strategic research

and the emerging generic technologies likely to yield the greatest economical and social benefits' (Martin 1995). Other definitions can be found elsewhere, but it is generally acknowledged that foresight is concerned with a broader, cross-societal discussion of the future prospects for science and technology and with implementing the results of such discussions in priorities for public expenditures on research. Hence, foresight challenges traditional-thinking (or Mode 1-oriented) research communities in at least two ways. First, foresight exercises include future societal and economic needs and possibilities in the setting of priorities. Traditional priority-setting in research focuses on 'scientific quality', usually measured in such terms as novelty of the research field, publication rates and citation indices. Using foresight the focus is shifted from science-internal quality terms and evaluating past performance to identifying possibilities in the future. Second, foresight exercises usually include actors in the priority discussion other than scientists. In some cases only industry representatives are included in the process but usually foresight involves a cross-societal discussion of needs, possibilities and priority-setting. Therefore, it seems obvious why many traditional research communities take a reluctant stance on foresight exercises.

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2.1. *Rationale and objectives for foresight*

The rationale for carrying out public foresight exercises is often related to the political goal of increasing economical competitiveness by means such as technological or societal innovation. As neither research councils nor national research programmes by themselves create technological innovation, the concepts of national innovation systems (NIS) and technology innovation systems (TIS) are important in understanding how new technologies emerge and how various forces influence this process. An innovation system can be defined as 'the elements and relationships, which interact in the production, diffusion and use of new and economically useful knowledge' (Lundvall 1992). Furthermore, policies on innovation have been suggested by Johnson and Jacobsson to underpin the system by improving its ability to serve five primary functions: (1) to create and diffuse new knowledge; (2) to guide the direction of the search process among users and suppliers of technology (i.e. to influence the direction in which actors employ their resources); (3) to supply resources, including capital, competencies and other resources; (4) to create positive external economies through the exchange of information, knowledge and vision; and (5) to facilitate the formation of markets (Johnson and Jacobsson 2001). It is generally acknowledged that the theoretical rationale for foresight exercises is supported by the perspective (or school) of evolutionary economics (Georghiou and Keenan 2006).

The rationales and objectives of foresight programmes are of course wider than just deciding how to distribute public funding to R&D, as indicated above. With roots in evolutionary economics and their understanding of national innovation systems, Georghiou and Keenan compiled a list of 'common stated goals for foresight', which are widely concordant with Johnson and Jacobsson's suggested functions of innovation systems. These goals are: (1) exploring future opportunities so that priorities for investment in science and innovation activities can be set; (2) reorienting the science and innovation system; this goal is related to priority-setting, but goes further; (3) demonstrating the vitality of the science and innovation system; (4) bringing new actors into the strategic debate; and (5) building new networks and linkages across fields, sectors and markets, or around problems (Johnson and Jacobsson 2001). The same type of rationale is often also used for strategy processes in research councils and research programmes. Examples of strategy and priority-setting processes in public research can be found from Spain, UK, Norway, the Netherlands, France and Denmark in a report from the European project MUSCIPOLI (Siune 2001).

2.2. *Foresight approaches and methods*

Whereas the rationale for foresight gets its legitimacy from the tradition of evolutionary economic foresight, the methods and approaches used in foresight activities have their basis in the academic discipline of strategy. Foresight and similar future-oriented technology-analysis methods, such as trend extrapolation, scenarios, Delphi analysis, focus groups, cross-impact analyses and roadmapping, can be found in traditional business-school textbooks on strategy (Grant 1998; Johnson and Scholes 2002). Based on this strategy discipline quite a few books and journal articles have provided lists of foresight methods and discussed them in light of, for example, technology foresight, technology forecasting and technology assessment (Martino 1983; Millet and Honton 1991). Many of these methods were developed between the 1940s and 1970s, often in the USA and often in affiliation with defence-related analyses or strategic intelligence in large firms. Furthermore, several methods assume the relationship between research and innovation to be linear, whereby innovation is thought to be initiated in pure science and to trickle down through applied research and industrial development, ending up in new products introduced on to the market. As a consequence of this, there is often focus on the opinions of so-called 'elite' scientists and industrialists, and less on the market or on inclusion of the general public. The fact that Delphi surveys often solely include point of views from scientists indicates that scientists in such surveys are expected to know about the future development of technology. Other understandings of innovation would imply that customers or other societal actors also were included in Delphi surveys.

Following foresight exercises in many countries during the 1990s, there now seems to be a new wave of research and thinking on methods and approaches. The COST A22 Action on Foresight Methodologies and the appearance of several journals dedicated to this area are just a few indicators of this. Different updated classifications and lists of approaches and methods for foresight have been suggested by different authors in review articles on foresight and future-oriented technology-assessment methods (Technology Futures Analysis Methods Working Group 2004).

2.3. *Foresight seen in different strategy perspectives*

Strategy, strategic planning or strategic management is a well-established academic discipline that is taught at most business schools and mostly directed towards corporate strategy. Foresight is not to the same extent established as an academic discipline. Rather, foresight is a field of practice with origins in several other more or less established academic disciplines such as evolutionary economy, strategy, technology assessment or social studies of science, futures studies. Most foresight practice in Europe has been focussed on public policy making and especially policy making in science and technology, even though by some authors the term 'foresight' has also been used regarding prospective thinking in corporate strategy. Literature describes how foresight has changed scope since the 1960s from the first generation of technology-oriented forecasting to the current third- or fourth-generation activities that also include wider social dimensions (Reger 2001; Georghiou 2001). A similar evolution has happened in the field of strategy (Mintzberg, Ahlstrand, and Lampel 1998). Some authors have suggested that foresight has emerged from the convergence of the three disciplines and practices of policy development, strategic planning and futures studies (Gavigan et al. 2001), but newer approaches do not totally replace older approaches: different approaches to foresight and strategy coexist. There exists no clear and generally accepted distinction between foresight and strategy, but it seems generally accepted

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that the field of foresight is more indebted to the field of strategy than vice versa. In this article we anticipate that the literature has a more refined view on what strategy is than on what foresight is and based on this assumption we will discuss how different understandings of strategy and decision processes affect the understanding of foresight.

Concepts such as strategy methods, priority-setting and foresight are not always familiar to scientists. Large parts of the science community often associate such terms with administration, bureaucracy, political intervention in science and similar, negatively associated terms, and not with visionary thinking and long-term action. This creates a lot of misunderstanding and even mistrust in these processes. To some extent this issue is also discussed in the strategy literature. In the 1990s Henry Mintzberg, in a book and two papers (Mintzberg 1994a–c), argued that strategic planning focuses too much on analyses and plans and too little in strategic thinking and strategic action. Hence, this raises the question of what the various actors understand as strategy. Mintzberg and colleagues describe 10 schools of thought in strategy formation (Mintzberg, Ahlstrand, and Lampel 1998). It is beyond the scope of this paper to discuss in depth the relationship between all the traditions within the academic strategy literature. A discussion on this topic can be found in Kaivo-oja 2001. However, foresight seen in the light of three of the traditions are described in the following: (1) strategic positioning; (2) strategy as negotiation; and (3) the resource-based view on strategy

A strongly related issue is the understanding of decision processes. The question is whether foresight or strategy processes can be designed as a so-called decision machine, which, if designed well enough and provided with enough information, is able to produce the right strategic decisions. Both the environment-scanning and competence-based approaches are based on the assumption that rational-analytical processes are used in strategic decision-making. Also, the definition of foresight given by Martin 1995, cited above, gives – probably unintentionally – the impression that he understands foresight as a rational-analytical process, but the idea of the rational decision has been challenged for decades by decision theorists (Lindblom 1959; March 1988; March 1994). Traditional alternatives to rational-analytical models of decision processes are political models and anarchical models (e.g. the garbage-can and muddling-through models).

To these authors there seems to be a relationship between Martin's definition of foresight and that part of the discipline of strategy inspired by Michael E. Porter's thinking. Porter's book from 1980 focused on the strategic management of a firms' external environment and on selecting a strategy to position a firm in the market (Porter 1990). In the same way, foresight exercises and similar strategic activities aim to position national research optimally in relation to future opportunities in the strategic environment of national research programmes: that of science, technology, economy and society in general. In the perspective of strategic positioning (Mintzberg, Ahlstrand, and Lampel 1998), the premises of foresight are as follows:

- Foresight is about priority-setting and there exists identifiable positions for research activities.
- The context of science is strategic research and emerging technologies, and it is economical and competitive (and not to better understand nature and humankind).
- Foresight processes form a rational-analytical decision machine, capable of identifying areas that yield the greatest economic and social benefits.
- Foresight practitioners (process consultants or core groups) play a major role in these processes, feeding results to decision-makers in charge of implementing the choices.
- As a consequence, the positioning and organisational structure of a research council or research programme's strategic research, and the development of generic technologies, become determined by generic market structure of global research and technology.

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With this understanding of strategy it is logical to use forecasting methods capable of analysing the uncertainties in the future strategic environment. This includes methods such as technology watching, trend analyses and the use of learning curves.

As already mentioned, the idea of the rational decision has been challenged for decades by decision theorists. Decision-making in organisations is often a result of political negotiation between different interests or powers. Mintzberg and colleagues label this 'strategy formulation as a process of negotiation' (Mintzberg, Ahlstrand, and Lampel 1998). This element is partly present in the emphasis in foresight exercises on participatory processes and societal dialogue. The methods used in this approach to strategy formulation are, among others, stakeholder analyses, networks, negotiations, political games, alliances and power bases in expertise (i.e. academic reputation). In the archetypal version of this, understanding of strategy priority-setting in research councils comes about after negotiations between its members and each player hopes to achieve their goals as a result of the negotiations. It is obvious that such elements are present in foresight and strategy processes. Delphi studies and other judgemental methods can be perceived as a systematic way of dealing with political interests, or, at least, one should be aware that participants might act politically. In many contexts political interests are as legitimate as 'neutral' expectations about future developments.

In this perspective the premises for foresight might be that:

- Foresight and strategy are also about priority-setting;
- The context is not related to any particular understanding of science or technological development but to powers and political interests in the affected areas of science and technology;
- Foresight processes are political processes where stakeholders or powers negotiate with each other; compromises (which produce results) can be made on goals as well as on means;
- Stakeholders and decision-makers in charge of implementing the choices are the major players in these processes; foresight practitioners (process consultants or core groups) and formal processes play relatively minor roles.

Foresight methods preferred under this approach focus on key actors and their viewpoints, for example stakeholder analyses and Delphi studies.

Whereas the Porter-inspired understanding of foresight focuses on the strategic environment, a contrasting understanding focuses on an organisation's internal resources, or on competencies and learning. This is often referred to as the resource-based view of strategy. It is based on the knowledge-based view of the firm and on organisational learning (Prahalad and Hamel 1990; Grant 1991). The resource-based approach does not replace analyses of an organisation's strategic environment, but supplements these by analysing internal competencies. The argument is that organisations need to understand core competencies before analysing the environment and opportunities to exploit these competencies. As competencies and knowledge are important assets, knowledge creation and learning naturally come into focus (Nonaka 1994; Nonaka and Takeuchi 1995). In particular, Finnish and other Nordic foresight communities have analysed and utilised foresight from this perspective (Eerola et al. 2004; Karlsen and Karlsen 2007). In this perspective the premises for foresight might be that:

- The focus is less on priority-setting as a result of a foresight process and more on knowledge creation and knowledge sharing by the various actors during the process;
- The context for science is that research and technological development are unpredictable; in this sense it is almost a Mode 1 understanding of science and technology;

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- Foresight and strategy focus on competencies and visions for defining future development;
- Whatever priority-setting research councils undertake in this perspective it is based on competence (scientific strengths or weaknesses), and the methods for determining this come from the usual techniques for evaluating scientific merit: numbers of publications and patents, citation indices, peer review, etc.

3. Case studies

3.1. *Research councils and national research programmes*

Research councils and national research programmes account for a smaller percentage of total research funding than direct government funding of universities and research institutions, and in some countries also make up less than funding from private sources. Most European countries have research councils, research programmes or similar institutions, but their structure varies significantly (EU DG Research 2005). It is difficult to obtain comparable statistics for research council funding activities on the scale of the European Union (EU) or countries of the Organisation for Economic Cooperation and Development (OECD). In Denmark, approximately 20–25% of public research is funded through research councils and national research programmes (Forskningsstyrelsen 2003).

Both national research councils and research programmes often channel money to new and important emerging research areas and topics. Through this, they contribute to change and the development of new directions for research institutions and for the research community in general. The strategies and micro-politics of research programmes can thus play a central role – in some cases a key role – in the broader strategies and developments of science and research systems. To manage national research programmes is a highly important part of science governance and research management in general. Research councils and programmes often constitute a more dynamic element in science than do universities and research institutions. Basic funding for universities is associated with the positions held by their staff and, in extreme cases, change only occurs with the retirement of old staff and recruitment of new staff. Research councils and research programmes offer a much more dynamic and prioritisable instrument in national science systems. Also, by representing a second strand of research funding, in addition to basic funding of universities and other government laboratories, research programmes contribute to competition within the research system.

3.2. *About the study and its context*

Two case studies were analysed here, namely the strategy processes of the Danish Technical Research Council and the Danish Energy Research Programme. Empirically, the analysis was based on:

- Studies of relevant texts, such as strategy plans, background notes and other available internal texts prepared in affiliation with the studied strategy plans; and
- Qualitative interviews with the actors involved. Interviewees were typically central council members, civil servants from relevant governmental entities, process and other external consultants, industry representatives and representatives of non-governmental organisations (NGOs); interviewees were selected using a 'snowball' method starting with centrally placed council members and civil servants.

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Since the study was formulated the Danish research sector has changed dramatically. The research councils were reorganised in early 2005. There is now a clearer distinction between the independent research council (with five traditional disciplinary councils; one being comparable with the one we studied) and a strategic research council (with five programme committees). Following the change of government in Denmark in late 2001 the energy research programmes were cut by two-thirds in 2002, and indeed the whole structure of energy research was later changed. Today, total public expenditure for energy-related research and innovation has increased to approximately the same level as before, but with tighter cooperation with the strategic research council's activities. Other reforms are expected in coming years as a result of the Government's *Strategy for Denmark in the Global Economy* (The Prime Minister's Office 2006).

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3.3. *Strategy processes in the Danish Technical Research Council*

One of the activities of the Danish Technical Research Council over the last 15–20 years has been to develop 5-year strategy plans. The council's annual contribution to the national budget negotiations, another strategic aspect of its activities, was coordinated with the 5-year plans. The 15 members of the Technical Research Council were researchers, primarily from universities. The council was located in the Danish Research Agency under the Ministry of Science, Technology and Innovation, as are the other parts of the research advisory system. The Danish advisory and funding system for research was subjected to a large reform in January 2004. Following this reform the Technical Research Council was merged with another council and continued the activities under new terms. In the period studied, the amount of research money managed by the Technical Research Council was in the order of DKK100 million (€13.4 million) per year. To this was added – in most years – a limited number of special programme appropriations in the national budget, targeted specifically at issues defined in the budget.

The latest strategy plan for the Technical Research Council was Strategy Plan 2003–2007, published in August 2002 (Statens Teknisk-Videnskabelige Forskningsråd 2002). The development of this plan was not a formal, structured process, but consisted of three main phases:

(1) Development of vision papers;
(2) Definition of strategic areas; and
(3) Elaboration of the communication format.

The actors involved in developing the plan were primarily members of the research council and employees of the Research Agency. A significant amount of the interactions of these actors, including the decisions on how to advance in the process, consisted of internal discussions within the council. The Chairman and a working group of two other council members carried out much of the work.

However, in the first phase a number of Danish researchers in science and technology, who were not members of the council, were asked to write papers about their vision of developments in their research areas, to be used as input to the strategy process. The vision papers were to cover all areas of science and technology research. The authors came primarily from public research institutions, and also from industry. They were hand-picked by the council as experienced, visionary researchers, who were also able to articulate broader, cross-disciplinary thoughts about the development of research in their field. Approximately 45 vision papers were received, which turned out to be of varying quality, length and structure. All papers reflected on scientific opportunities, but quite a few also included thoughts on education and on the potential industrial and societal

impacts of the suggested research. Some of the vision papers took in views from other experts in the field, and some even had several co-authors.

In the second phase, during the second half of 2001 the council members described and discussed the different areas of research in science and technology, building on, among other things, the vision papers. On the basis of these discussions, seven strategic areas were defined for the Strategy Plan. Therefore, the strategic areas can to some extent be seen as representing the main areas of research in science and technology, so that the complete field is covered, integrated with specific current topics and relevant perspectives. During the process a parallel discussion took place about a new measure to be employed in the council's funding function. Through these discussions, research consortia were defined as a type of funding in addition to existing instruments, such as engineering research centres, framework programmes and talent projects. The research consortia instrument was in response to the demand for improved collaboration between public and private research. In the definition of a research consortium, openness and public access to the results of research collaborations were emphasised and it was stipulated that a number of companies – not just one – must be involved. The research consortia instrument was added to the list of seven strategy areas for the Strategy Plan. The eight areas were: (1) biotechnology and chemistry, (2) energy, (3) environment, (4) nanotechnology, (5) production and materials technology, (6) information systems, (7) simulation and, finally, (8) research consortia.

The third phase in the development of the Strategy Plan 2003–2007 was more important to the end product than was suggested by the term communication format. From the beginning of the process it was clear for many of those involved that the Strategy Plan would be simpler than the previous 5-year plan (1998–2002), but the final decision to present the Strategy Plan in a relatively brief and politician-targeted format was taken late in the process, early in 2002.

The Research Agency played, in collaboration with the council, an important role in the definition of this communication format. The agency produced a template for an accessible, clear and attractive colour layout, which they encouraged all the research councils to follow (only the Medical Research Council resisted using the brief format). The final Strategy Plan was a publication of 28 pages with many pictures, brief passages of text and boxes containing short examples of the use of science and technology research and quotes from well-known and high-level industry representatives. This was in contrast to the approximately 100 full pages of text of the earlier strategy plan. A professional designer and a PR company were also hired to work on the final publication.

Contrary to the earlier 5-year plans, the Strategy Plan 2003–2007 was targeted primarily at politicians, with the aim of inspiring them to spend more on science and technology. Whereas the earlier plans focused on 'internal' prioritisation and strategic action within the research council, and on the different sub-areas of research, the plan for 2003–2007 emphasised the difference that science and technology research can make to society.

Earlier strategy plans for the Technical Research Council, as well as plans for other research councils, such as the Natural Science Research Council, received broad input from many different actors during the process of strategy development. In contrast, apart from the actors mentioned above – the research council members, the agency employees, the PR company and the authors of the vision papers – only a few other persons were involved directly in the development of the Strategy Plan 2003–2007. It was not expected that the 2003–2007 plan would have a mediating and coordinating role in the research community or internally within the research council. In practice, however, there are indications that the Strategy Plan 2003–2007 has, at least to some extent, had the effect of coordinating and giving direction to the research community. More concrete initiatives, or action plans, following the Strategy Plan are not expected from the research council for the time being.

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3.4. *Strategy processes in the Danish Energy Research Programme*

The Danish Energy Research Programme is managed by the Danish Energy Authority, which is part of the Ministry of Economic and Business Affairs (which also covers energy). The programme and its strategies are coordinated with general national energy polices and often also with other policy areas; for example, the general national research strategy developed in the mid-1990s (Miljø- og Energiministeriet 1996a–c).

Danish energy research experienced considerable turbulence following the change in government in late 2001. Together with major changes in the Energy Authority and the ministry responsible for it, this turbulence had a major influence on the strategy activities of the Energy Research Programme. Even more clearly than in our first case study, it is obvious that one cannot understand strategy developments in isolation from other activities in and around the programme. Content and context are closely interrelated. This case study focuses on the round of strategy development in the period after 2001. In this period, another funding programme for energy research, the Public Service Obligation (PSO) Energy R&D programme of the two operators of the Danish electricity grid, gained importance.[1] The PSO R&D programme has resources made available to it from funds raised through selling electricity to the public. Since its establishment in the late 1990s an increasing amount of money has been channelled through this programme. With a budget of around DKK100 million (€13.4 million) a year (rising to DKK130 million (€17.4 million) in 2005) it has become the same size as the Energy Research Programme.[2] The PSO R&D programme supports R&D on environmentally friendly energy-production technologies. The PSO R&D programme was operated by the two electricity grid operators, but the Minister for Economic and Business Affairs – through the Energy Authority – had overall political responsibility and approved the areas prioritised in the programme. A third funding source for energy research, a new Energy and Environment Research Programme, was also established in the period through the Strategic Research Council, under the auspices of the Ministry of Science, Technology and Innovation.

The core group for the strategy-development processes, apart from the programme-management staff in the Energy Authority, consisted of representatives from the planning and development departments of the two electricity grid operators. In addition, a number of consultants were involved, primarily in individually selected priority areas within the energy field. Staff from the Strategic Research Council played a passive role in the core group.

Strategy development thus existed between several programmes rather than being connected directly to a single programme. The programme managers and the institutions involved in the core group subscribed to and felt committed to the common strategies developed, and the programmes were integrated to a considerable extent. However, the development of strategy between these programmes also implied that there was room for activities other than those defined in the strategy plan.

The Advisory Council for Energy Research (Det Rådgivende Energiforskningsudvalg, REFU) is an advisory board for the Energy Authority and the Ministry of Economic and Business Affairs. Its members are primarily high-level representatives from industry and research. In some periods the main role of the board has been to comment on and give suggestions about the work of the Energy Authority in the governance of energy research. Thereby, it contributed to legitimating these activities. However, at the beginning of the turbulent period following the change in government, the role of the Advisory Council changed slightly, dealing more with overall and general perspectives of energy research. During the first year of the turbulent period, the Advisory Council recommended the drawing-up of a strategy plan, but the Ministry did not approve this

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suggestion. Given the smaller total budget for the Energy Research Programme, it was decided that strategy development from early 2003 should be concentrated on four areas: biomass energy, solar cells, wind energy and fuel cells. These priority areas were decided by the Danish Energy Authority in collaboration with their counterparts in the PSO R&D programme. The selection of areas basically reflected Danish energy policy and its focus on environmentally friendly energy-production technologies, a policy also reflected in the overall aims of the PSO R&D programme. The selection of only four priority areas resulted in a stronger and narrower technology focus than the broader priority areas of the Energy Research Programme's earlier strategies.

Previously, standing advisory committees for each of the priority areas had existed, with members from industry and research institutions. The committees played an essential role in the programme and provided input and background papers to strategy developments (IEA 1999). These committees were closed down. Instead, the core group lead the strategy work in the four areas, supported by a few experienced consultants. A common template for the strategy development was drawn up. It consisted of four parts or steps:

(1) Analysis of the state of affairs in the area, leading to draft proposal of a strategy plan;
(2) Discussion of the proposal with the actors in the area at a hearing meeting;
(3) Publication of a final version of the strategy plan;
(4) Planning for specific actions and follow-up activities (roadmaps, etc.).

Steps 1–3 were carried out in 2003 and the first half of 2004, whereas the follow-up activities and the roadmaps for some of the areas are being undertaken currently. The strategy work was used in the funding decisions of the research programmes as early as 2003. In the second half of 2003 and in 2004, two other areas were defined as priorities for strategy development. First, work on hydrogen technology was initiated, an area with application to research on fuel cells. Second, strategy activities concerning energy-efficient technologies and biofuels were launched by the Danish Energy Authority. In addition, for the other priority areas of technology roadmap exercises were recommended as a follow-up activity.

It was, in general, the intention of the programme managers and the core group of the strategy activities to interact with key actors in energy research. There is a distinct energy community in Denmark, and members of the core group knew many of the actors in the area. There was a relatively strong network, both informal and formal, between the programme management and the established industrial and research actors in the field of energy technology. In this sense, the strategy processes of the Energy Research Programme corresponded with the Mode 2 model of research. Demands for research were incorporated into strategy planning primarily through the energy systems' actors and industrial actors, and through governmental policy.

3.5. *Summary*

The two case studies described here represent two quite different sets of circumstances. For the Danish Technical Research Council the rationale for the strategy process was to argue for more funding and to respond to pressure for more collaboration between science and industry. For the Danish Energy Research Programme the rationale was to set priorities for Danish energy research and innovation in the light of Danish energy policy.

In the case of the research council there does not seem to be a formal or predetermined process for developing strategy. Development of strategy is a muddling-through process, and decisions

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do not follow any rational-analytical scheme, but rather are a construction of meanings or from political negotiations.

There is no clearly defined time horizon in either case. The Technical Research Council plan mentions that its strategy is about prioritising areas of science with special importance for society during the next 10–20 years. The Energy Research Programme refers to targets and their horizons in the Government's energy policy: 2030 and the Kyoto Protocol's timeframe of 2008–2012.

An interesting observation in both the cases analysed is that the members of the core strategy groups are also those responsible for implementing the strategy. The same groups of people also take decisions on the funding activities.

Table 1. An overview of the two case studies.

		Technical Research Council	Energy Research Programme
Actors involved	Programme management	• Research council • Research Agency (secretariat)	• Energy Authority
	Core group in strategy processes	• Research council • Research Agency (secretariat + strategy and information functions)	• Energy Authority • System operators (PSO actors) • Consultants
	Other actors involved in the process	• Scientists • Communication consultants • Ministry of Science, Technology and Innovation • Partly the Confederation of Danish Industries	• Advisory Council for Energy Research • Energy-production companies • Energy-technology companies • Scientists • Interest groupings/NGOs
	Target groups	• Upward • Government, Minister, parliamentary politicians	• Downward • Programme management • System operators (PSO actors) • Energy-production companies • Energy-technology companies • Scientists
Approaches and methods	Key scope	Science-oriented	Technology-oriented
	Time horizon	10–20 years	2008–2012 and 2030
	Method, systematics and tools	• Invited vision papers • Council discussions • Council members' own descriptions of areas of strategy effort	• Analysis of areas (present state and actor views) • Hearings • Roadmaps (as follow-up)
	Duration of the process	15 months	Approximately 18 months
	Legitimization	• Given from the outset • Minister contact • Support from known industry leaders, etc.	• Actor dialogues, partnership, consensus seeking • Advisory Council for Energy Research

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Although there is a rich and growing application-oriented literature on foresight in science and technology this does not seem to have significantly influenced strategic thinking and strategic processes in Danish research councils and research programmes. Erratic evidence from the study behind this paper also indicated this. The preliminary results from the study were presented and discussed at a workshop with the participation of research council members and civil servants affiliated to some of the relevant research councils and research programmes. One presentation was intended to initiate a discussion of how foresight methods could enrich strategy processes within the councils and programmes. However, the audience was not at all ready to discuss methodological details. Instead the discussion focused on questions on the nature of strategy and whether it is possible to make strategies in science at all, and on the merits of the Mode 1 and Mode 2 types of research. In the case of the Technical Research Council, it has obtained its legitimacy through law, as the council has a legal obligation to make strategy plans. In the case of the Energy Research Programme, legitimacy is secured primarily through hearings.

Table 1 gives an overview of the two case studies. As the two strategy cases were analysed in the context of foresight, parameters for comparing the case studies draw partly from contemporary discussions of foresight typology.

The case studies revealed many different rationales for and understandings of the strategy processes that were undertaken (see Table 2). In the case of the Technical Research Council a variety of rationales and understandings are represented. In contrast, in the Energy Research Programme there seems to exist a more coherent understanding of strategy associated with developing new energy technologies.

Table 2. Rationales for strategy functions as reflected in the interviews with actors involved in the strategy process.

Technical Research Council	Energy Research Programme
The strategy of covering all existing research areas: supporting existing areas, the opposite of priority setting	The strategy of new technologies: technology and not science-discipline-oriented
The strategy of positions of strength: underpinning priorities related to scientific strengths rather than future societal or industrial potentials	The strategy of developing new production and consumption systems: innovation-system-oriented
The strategy of gaps and weak points: underpinning priorities related to scientific weaknesses compared to the international state-of-the-art	The strategy of serving industry: as above but with industry playing a more central role
The strategy of more money: focusing attention on research by showing its societal importance	
The strategy of no strategy meaning no priorities made: the strategy is a description of existing activities and some interesting perspectives	
The strategy of coordination: strategy is about coordinating activities, creating or reinforcing networks	
The strategy of new measures or instruments; the strategy of (technological and scientific) territory: demarcation, e.g. against natural science and the natural science research council	

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4. Conclusion

In contrast to basic funding for universities and other research institutions, research councils and national research programmes are a dynamic part of national science systems. If a national science system is perceived as an important element of the overall national innovation system then priority-setting processes of research councils and research programmes can be of legitimate strategic interest to governments.

Our analysis shows that research councils and research programmes do carry out strategy processes and that the processes are based not only on scientific excellence (peer review, etc.), but also have a strong element of prospective outlook similar to foresight exercises. The processes can be improved by implementing the procedural elements of foresight exercises, especially with respect to elements such as the legitimacy of discussing long-term future perspectives and the inclusion of actors.

Not least the research council case could have benefited from a more formal and structured process. This would have improved the transparency of the process. Especially, it is not clear what process led from the 45 position papers to the first drafts of the strategy plan.

Our study indicates that the impact of foresight exercises on strategic decisions in research councils and programmes can be improved if we understand better the existing strategy traditions and current challenges faced by these institutions.

First, foresight exercises that take national policies into account as a boundary condition are easier to implement than those challenging national policies. One could argue that, in situations where national policies are to be challenged, the process needs to include decision-makers at the national policy level – government, politicians and key civil servants – at least if implementing the results is important. Of course, awareness rising or advocacy might also be the reasons behind foresight exercises, but implementation and impact must be measured in other ways.

Second, as illustrated in our case studies, priority-setting goes beyond selecting between areas of science and technology: to develop measures and instruments are also important issues in research strategies. The implementation phase is a key element in any foresight exercise, but the process should also be designed to include thoughts about the 'policy toolbox' in the process itself.

Third, the study shows that different understandings of and approaches to strategy exist concurrently among the participants in the cases studied, and this is especially true for the Technical Research Council. Furthermore, the scientific community is not always familiar with common foresight terminology; in some cases such 'business-school language' even disturbs meaningful strategic discussion. This problem might be mitigated by adapting language to fit the traditions of the research arena. For example, wordings like 'hypotheses about future applications' are easier understood than 'Delphi statement'.

Fourth, foresight exercises are often understood and outlined according to rational-analytical models of decision processes whereas research councils seem to follow other models. There is no doubt that a more rational-analytical approach is appealing, especially for technical research councils. In reality, however, the processes involve a strong element of power play and political negotiation. Foresight processes must be designed to give legitimate room to such political negotiations between interests and powers. It is important in foresight processes to distinguish more clearly between process elements of analyses and process elements of decisions based on the analyses.

The strategy processes can benefit from better articulated expectations about future technologies. It is not enough to argue that a certain technology offers great opportunities for future commercial exploitation. Also here the foresight practice offers procedures and tools. For example,

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a full Delphi survey could be applied, but the process could also benefit from just getting inspiration from formulation of Delphi statements.

A clearer inclusion of stakeholders and of the general public in the research council case would have improved the plan's legitimacy; especially its legitimacy affiliated with innovation and business opportunities and of broader societal needs and improved the discussion on science possibilities to contribute to these.

In any case it is a long-term venture to improve academia's and the science communities' understanding of foresight and of strategy in general. Therefore, a special obligation rests upon the foresight practitioners to take this into account when planning foresight exercises.

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Notes

1. The two electricity grid operators were at that time Eltra and Elkraft System. The government then merged the two organisations into EnergiNet.dk, a governmentally controlled entity that operates the main electricity and natural gas transmission grids in Denmark.
2. Another PSO funding programme is represented in the strategy process, namely the energy efficiency PSO, managed by the association of energy-production companies, ELFOR. However, ELFOR has less influence than the energy-systems operators.

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