



RENERGI - Clean energy for the future

Work Programme 2004 - 2013

 Norges forskningsråd

Store programmer

WORK PROGRAMME 2004 – 2013

RENERGI: CLEAN ENERGY FOR THE FUTURE

CONTENTS	PAGE
1. INTRODUCTION	2
2. THE PARAMOUNT OBJECTIVE OF ENERGY RESEARCH	5
3. OBJECTIVES FOR RENERGI	7
4. FRAMEWORK CONDITIONS FOR ENERGY RESEARCH	9
5. DISCIPLINE-RELATED AND THEMATIC PRIORITIES	11
5.1 The need to set priorities	11
5.2 The grounds for priorities	11
5.3 Fields of research	12
5.3.1 Renewable energy production	13
5.3.2 Natural gas	14
5.3.3 Hydrogen	14
5.3.4 The energy system	15
5.3.5 The energy market	16
5.3.6 Energy use	17
5.3.7 Energy policy and international treaties	18
6. PROGRAMME INSTRUMENTS	20
6.1 Adapting to other public activities	20
6.2 Evaluation criteria	20
6.3 Policy instruments	21
6.4 Organisation	22
7. BUDGET	23

June 2005

1. INTRODUCTION

RENERGI is an important instrument for enabling the Research Council to reach its objectives of better co-ordination, more interdisciplinarity and redoubled efforts in energy research. With RENERGI, energy research has become one of the Research Council's strategic target areas for the future.

RENERGI represents a confluence of three existing programmes: Energy for the future, Samstent and the Innovation Programme Energy, Environment, Building and Construction (EMBa). The plans for these programmes and the project portfolios contain important priorities that will be of relevance to the new programme. The Research Council would also like RENERGI to reflect fresh thinking and create new opportunities under the auspices of a large-scale, highly visible programme in an area of strategic importance for the country. Please note that the programme is to facilitate research in both the long-term (30 years) and the short-term perspective (5 to 10 years).

RENERGI will be limited to energy production and transmission, and to stationary and mobile energy use. Offshore petroleum activities will continue to be addressed under separate programmes. It will be important to establish clear boundaries in relation to petroleum research and climate change research (NORKLIMA); importance will be attached to co-operation between the programmes.

The Research Council's Executive Board has decided to establish a new programme entitled RENERGI (CLEAN ENERGY = CLEANERGY). RENERGI will be one of a limited number of new major research programmes in which the Research Council will deploy a wide range of instruments and resources. These programmes are rooted in the Research Council's new organisation, and organised under the auspices of the Division for Strategic Priorities. In November 2003, the Research Board appointed a Work Programme Committee and charged it with the task of drawing up a proposal for a Work Programme for RENERGI. Based on this, a Programme Committee will be appointed to compile a detailed Plan of Action.

The paramount objectives of energy research are otherwise based on the White Paper on Research's assignment of priority to research in the interface between energy and the environment, the Ministry of Petroleum and Energy's budget documents and a number of demonstrations of the energy sector's long-term importance for achieving energy policy, environmental policy and industrial policy goals. In addition to the Ministry of Petroleum and Energy, RENERGI will apply for funding from the Ministry of Trade and Industry, the Ministry of Transport and Communications, the Ministry of the Environment, the Ministry of Agriculture and the Ministry of Local Government and Regional Development.

The Work Programme reflects challenges and opportunities as perceived upon initiation of the programme. The programme will have duration of 10 years. There will be an ongoing evaluation of the need to modify the programme's priorities.

The Work Programme Committee's mandate and composition can be found in attachment 1.

Why energy research?

Energy research is a strong policy instrument for creating new opportunities in a sector of formidable financial and environmental importance. Moreover, the sector and the framework conditions that apply to it are in constant flux, compelling the authorities and industry to renew their thinking continuously.

The exploitation of Norway's energy resources has laid the foundation for huge revenues as well as for the development of energy-intensive industry as well as industries that supply goods and services. Over the past 100 years, the development of hydropower and petroleum has laid the foundation for the position the energy sector occupies in Norway today. These resources will allow Norway to

continue to play such a role in future as well, and energy research is an important instrument for accomplishing that. History also indicates that energy research has played a major part in the general development of Norway. For example:

- Technical, systematic and environmental knowledge about hydropower was produced by research communities in conjunction with industry;
- Norwegian enterprises are currently selling waste incineration plants that comply with the latest pollution standards;
- The production of solar cells and materials for the solar power industry, based on the silicon expertise of Norwegian industry and research;
- Social science research groups have contributed significantly to implementing market reforms in the Norwegian energy sector.

This competence will also help Norway meet the challenges envisaged for the future and deal with new fields such as hydrogen and gas-fired power production based on CO₂ management, as well as international negotiations on energy and environmental agreements.

A number of trends in society-at-large influence the energy sector and the role it plays. Energy research is a means by which to deal with these trends, and research *per se* will engender new opportunities. Although we do not know how the trends will eventually turn out, we can be relatively certain that there will be changes in certain fields.

Increasing competition and the opening of markets. The Energy Act of 1990 was an early expression of comprehensive deregulation and liberalisation in the electricity and gas markets in Europe. There is also considerable general de-regulation taking place in international trade. The changes in the energy sector have shifted a great deal of attention from production to market demand, and contributed to bringing several energy sources and technologies into the foreground. The changes have not made the authorities' role superfluous, but rather presented new challenges by setting the stage for issues involving competition, security of supply and other important political considerations.

Internationalisation. The opening of markets is one of the factors behind the general internationalisation of society. The markets in which business and industry operate are international, and energy research itself is in the process of becoming international. International competitiveness must therefore be a goal for research and economic development, although there will always be special national needs that must be addressed at the national level. The growth of international research programmes underscores the need to clearly identify Norway's national needs and objectives.

Environmental considerations. The need to limit emissions of greenhouse gases has focused more attention on environment-friendly energy systems. Uncertainty about the future of the international climate treaty and about the need for further initiatives implies considerable uncertainty about the future. Meanwhile, some initiatives have already been introduced, e.g. the establishment of a market for green certificates, which will provide incentives for the use of new renewable energy sources. In addition to emissions of greenhouse gases, there is reason to expect continued focus on other polluting emissions such as NO_x, land use, the reduction of biological diversity, etc.

Changing parameters for the supply industry. The opening of markets and internationalisation also have a powerful impact on the supply industry. While suppliers used to be heavily dependent on the investment level in the energy sector, primarily nationally, these days the demand for international competitiveness has become far more urgent. At the same time, changes in the energy sector are opening up opportunities to develop new products and services. In the light of international competition, the ability to comply with new requirements for the environment, user-friendliness, etc.

appears to offer a competitive advantage over those who have enjoyed the privileges of the past for a very long time.

It is natural for applied research to take its point of departure in relevant development trends and in today's technology. However, if we extend that perspective to 30 years, for example, most people will agree that the uncertainty factor is large. Given such a perspective, there will therefore be a considerable need for strategies that are robust enough to tolerate change. From this point of view, Norway needs sustainable resource management, dynamic industry and competence to be an energy nation. Energy research is obviously a means of securing the competence required.

Research is one of several instruments for achieving the paramount objective. The results of energy research can only be exploited if the general parameters that apply to the market stimulate new thinking in public and private enterprises alike. Users' demands for research results will be the best driving force for research to produce results. However, research can also be innovative and open opportunities in other directions than what political decision-makers and others have envisaged. Accordingly, RENERGI must have a perspective that extends beyond topics of current political or commercial interest.

2. THE PARAMOUNT OBJECTIVE OF ENERGY RESEARCH

Energy research is an important part of Norway's long-term energy policy, but it ruptures the parameters of a narrow sector policy by also being part of the authorities' research, industrial and environmental policies. Similarly, research offers a means of revitalising industry, the authorities and society as a whole. Thus research will also provide a platform for new and different political objectives.

The following reiterates some of the objectives the authorities have set for public energy research:

The White Paper on Research (Report No. 39 (1998-99) to the Storting) underlined that *"more emphasis on research in the interface between energy and the environment is essential for achieving the Norwegian government's energy and environmental policy objectives."* This is one of three high-priority target areas in the budget proposed by the Ministry of Education and Research for 2004. The White Paper on Research also underscores the need for escalating research efforts in general: *"the government aspires to bring Norway's research efforts up to at least the OECD average by 2005. One main challenge for Norway is to promote more industrial research."*

The White Paper on Energy (Report no. 29 (1998-99) to the Storting) emphasises that *"the Norwegian government's energy policy assumes that environmental goals will determine production opportunities, and that it is necessary to pursue an active policy to limit energy consumption. Higher production must to a greater extent be based on new, renewable energy sources."* With a view to security of supply, Report No. 18 (2003 – 2004) to the Storting relating to security of supply, etc. underlined that *"improving the security of supply calls for a long-term strategy. This is because it takes time to complete new projects, develop markets for alternative energy sources and change the consumption pattern significantly"*.

In Report No. 46 (1999-2000) to the Storting, the National Transport Plan 2002-2011, the Ministry of Transport and Communications has described the Norwegian government's transport policy. In this sector, the energy aspects are the subject of indirect objectives related to expenses and environmental considerations, particularly emissions to air. *"To deal with the environmental challenges associated with transportation, we have to have a comprehensive suite of instruments aimed at the many different environmental problems. Cost-efficiency and co-ordination will be key elements in the overall framing of the instruments."*

These objectives have been stated to provide political guidance for the management of public research funding. In addition, some parameters are established through specific budget resolutions and the ministries' letters of allocation. The Ministry of Petroleum and Energy's letter for 2004 states:

"The main objective of strategic research is to allow the involved parties in the institute and university sector to fortify their spearhead expertise in long-term, basic energy-related R&D disciplines at the international level, at the same time as the research is further developed to benefit the business community and other relevant users."

User-driven research "shall:

- *contribute to the achievement of the objectives related to the restructuring of the energy sector;*
- *support projects that enhance the efficiency of the production, transport and use of energy;*
- *support economic development in the energy sector and result in venture creation and the application of new products and processes in existing enterprises".*

The Ministry of Petroleum and Energy has also established special guidelines for R&D associated with hydrogen and cleaning technology for gas-fired power plants.

Over and above this, there are few specific instructions regarding the management of energy research funding and the ranking of priorities among the many different interests. Thus the Research Council has been delegated a huge burden of responsibility and considerable freedom of action within the budgetary parameters. As a result, one of the main tasks for RENERGI will be to render concrete the objectives of the target areas, as well as verifiable objectives and a strategy for achieving the objectives.

3. OBJECTIVES FOR RENERGI

The main objectives specified by the authorities present a formidable challenge for the Research Council, since the research is to engender several types of results. Although priorities are different in research, energy, environmental and industrial policy, there is also a high degree of congruence and great expectations that the research will open new opportunities in the long term.

The efforts are aimed at research users. Long-term research generally targets other researchers as users, while applied research targets industry, public administration and the general public.

The following are the objectives for RENERGI, based on government policies and the Research Council's prospects:

Primary objective:

RENERGI is to develop knowledge and solutions as the basis for environment-friendly, efficient and effective management of the country's energy resources, security of supply and internationally competitive economic development related to the energy sector.

To make a clear distinction between the programme's two different time perspectives, the following clarifications are necessary:

Perspective for the next 5 to 10 years:

- New technologies, systems and solutions that facilitate energy restructuring by improving the efficiency of energy production, transmission and use, making more energy available and improving the security and flexibility of the system;
- Environment-friendly energy systems by reducing emissions of greenhouse gases and other air pollution, improving land use, etc.
- New internationally competitive goods and services related to the energy sector;
- Knowledge and analysis as the basis of the long-term energy strategies of the authorities and industry, public debate and the design of public policy instruments;
- Internationally competitive research communities in high-priority fields with extensive collaboration with international research communities and different types of users

Perspectives for the next 20 to 30 years

Such a long-term perspective generates considerable uncertainty about the possible results of the research, how the research might affect reality, and the reality in which the results will be used. The objectives will nevertheless contain the same elements as the perspective for the next 5 to 10 years. This entails, *inter alia*, that the research is to set the stage for social development featuring a high degree of innovation and where the energy sector's development is consistent with ambitious environmental goals.

Some of the goals of importance in this lengthy time span are:

- Energy systems and management that can accommodate the next generation of climate agreements and the EU's long-term objectives for security of supply, the environment, renewable energy, etc.
- Energy policy that paves the way for wealth creation in the energy sector and for the energy-related supplier industry to continue to play an important role in Norway's economy.

When the objectives are to be laid down and the strategy designed, the lengthy time perspective will be coloured by the fact that research efforts will have to be robust to changes in the needs of society and in framework conditions:

- Knowledge-building in fields of relevance for the exploitation of Norwegian energy resources and energy efficiency;
- Recruitment to research communities;
- Building up good co-operation between R&D communities and industry and other users;
- Broad participation in international research programmes;
- Encourage business and industry to innovate and take a long-term perspective;

RENERGI will feature a special systematised 'foresight process' that will run parallel to the Programme Committee's administrative activities. The goal is precisely to recognise new research needs and opportunities so that the programme can adapt to them.

4. FRAMEWORK CONDITIONS FOR ENERGY RESEARCH

The paramount objectives for energy research have remained relatively stable over the past 20 years. However, there have been extensive changes in the external factors that apply to the research, including the financial parameters. Some of these changes are reflected in the characteristics described in Section 1 and the political objectives described in Section 2.

RENERGI is based on three well-established programmes with carefully considered strategies. There is every reason to build further on this, at the same time as it presents a unique opportunity to review research needs and opportunities across the boundaries that separate programmes and instruments. The main challenge in shaping RENERGI is therefore to promote added value, beyond what the three programmes could accomplish separately. In this context, the public policies (described in point 2) along with the Research Council's strategy will be called the *internal factors* affecting energy research.

External factors

In the short term, RENERGI must take its point of departure in external factors. Nevertheless, it is important to recognise that good research results can also lead to changes in external framework conditions.

- Just as the authorities vary the financial parameters they make available for energy research, there are major variations in **industry's ability and willingness to innovate and to engage in research**. This calls for variation in the instruments applied and determined efforts to promote innovation.
- Business and industry's capacity for innovation is also influenced by framework conditions such as **direct and indirect taxes**. The recently introduced **SkatteFUNN** scheme, featuring tax deductions for investments in R&D, has furnished a significant incentive for innovation. Finally, Norway has public **support schemes** for product development and market launches that are important for the business community's ability to use research and its results. Synergies and complementarity should therefore be established with neighbouring programmes, e.g. Enova, Innovation Norway (formerly the Norwegian Regional and Industrial Development Fund, etc.) and subsidy schemes within the EU system.
- Similarly, **international environmental treaties**, e.g. in the area of climate change, will have an impact on large parts of the energy sector and on the opportunity to bring new technologies to fruition. Consequently, the research should develop technological solutions and design instruments that comply with the environmental standards of tomorrow.
- R&D communities' **competence and capacity** are also important parameters for energy research. The university and college sector, the research institution sector, and business and industry have significant research resources and competence at their command. Yet it is important to bear in mind that this is a vulnerable resource. The build up of expertise and of research communities must therefore have a long-term perspective and facilitate co-operation.
- **The internationalisation of research** has resulted in new arenas for co-operation and new sources of funding. Participation in the EU's framework programmes for research has had a strong impact on energy research in Norway, to some extent through project support and network support, but also by providing guidance for national strategies in this field. Although EU research gets the most attention, important research is also being conducted under the auspices of the Nordic Council of Ministers, the IEA and under bilateral agreements with the USA, for example. Norway has joined the Carbon Sequestration Leadership Forum (SCLF) and the International Partnership for the Hydrogen Economy (IPHE). When setting objectives, Norwegian energy

research must take its point of departure in these opportunities for co-operation and in this competitive situation.

RENERGI will find its place as a public policy instrument to trigger research which may, in turn, create new opportunities in relation to the objectives set and the framework conditions that apply. Even with the significant resources allocated for RENERGI, funding will be in short supply and it will be necessary to concentrate on the opportunities that offer the greatest potential.

5. DISCIPLINE-RELATED AND THEMATIC PRIORITIES

5.1 The need to set priorities

The resources available in terms of both allocations and researcher capacity will be insufficient to defend all-out efforts in all areas where needs and opportunities exist. It will therefore be necessary to rank the priorities of the investments.

Priorities must also be ranked because concentration on selected target areas will be necessary to ensure that the research is sufficiently comprehensive and versatile to engender long-term results. In several areas, research appears to be very resource-intensive, making it difficult to maintain top-notch competence in many such fields concurrently. Concentration makes it possible to design a strategy for these areas by taking elements from the different instruments. Meanwhile, the internationalisation of research is forcing researchers to specialise more today than before. Although it has been natural to maintain national competence in most relevant fields, the trend towards a common European Research Area (ERA) implies that particular competence may in future largely have to be brought in from wherever it is best in Europe.

Concentration will create the need to ensure that good ideas that are outside these high-priority areas do not fall by the wayside as a result of formalities. Priority will therefore be given to allocating independent funding for distribution based on merit, the need for subsistence research (also known as strategically focused basic research), etc.

5.2 The grounds for priorities

The objectives of RENERGI (Section 3) have been a natural starting point for evaluating target areas. The evaluation is largely based on the priorities set by the Programme Committees for the three preceding programmes (EMBa, Samstent and Energy for the Future). Emphasis has also been placed on ensuring the research is in accordance with strategies adopted by the rest of the Research Council and by national authorities. In addition, the programme is an expression of the fact that research can have a revitalising effect on policy and strategies by creating new knowledge and new opportunities.

RENERGI will attach importance to long-term objectives and stable framework conditions. The programme will incorporate the flexibility required over time to deal with evolving needs and opportunities. Flexibility will also be important for devising or framing instruments. For example, while one area requires that everything be in place for long-term human resources development, another area will be poised for industrial innovation. Further, it is essential that it be possible to accommodate projects that have special merit and value creation potential even though they may fall outside the pre-defined target areas.

RENERGI will contribute public funding within the target areas based on an evaluation of needs and opportunities. Consequently, the management of financial resources has to reflect how important it is for public funding to trigger research that would not otherwise have been possible. This involves making difficult decisions in relation to the ability and willingness of business and industry to fund research. Equally important, RENERGI will seek to create new opportunities by facilitating co-operation between public and private interests. In some cases, when supplemented by public funding such collaboration may well initiate processes of higher quality and with a longer time frame than what would otherwise have been possible. Differences in respect of industries, technological maturity, degree of basic research and content of researcher training are all aspects of relevance for the selection of target areas, the scope of the publicly funded efforts and the instruments (cf. Section 6) that ought to be used.

The tendency towards more common international research may hold an important key for ranking priorities for national funding. There are five factors in particular that justify special attention and efforts with a view to publicly funded research:

- Fields in which Norwegian research groups have special competence and a special position. They must be competitive by international standards, and thus have what it takes to further develop this position. Although research is becoming ever more international, it is assumed that Norwegian users will be especially well qualified for collaborating with research groups in Norway and for benefiting from the results.
- Fields in which Norwegian business and industry and other user groups possess special competence that will allow them to adopt research results to enhance Norway's economic growth in the broad sense, although it is no longer easy to identify exactly which enterprises are Norwegian. It is assumed that there is a strong probability that the assets of enterprises with a strong attachment to Norway will remain in the country, regardless of the nature of the attachment. Such enterprises or clusters of users with special competence, a certain market position or other qualifications may serve as a natural point of departure for research work.
- Fields in which Norwegian energy resources ensure Norway a special position in the long term. Norway is exceptionally well endowed with several types of energy resources. Hydropower, oil, gas and wind are examples of resources that can, with some help from research, form a starting point for wealth creation.
- Areas in which Norway has special research needs; The Norwegian energy system with its means of production, traditions and climate presents many challenges that are unique to Norway. Other countries' research efforts cannot be expected to cover such areas.
- Areas that involve especially formidable environmental challenges related to the exploitation of Norwegian energy resources. This refers to national environmental policy as well as to the honouring of international commitments.

5.3 Fields of research

The establishment of RENERGI offers a good opportunity for evaluating the research needs of the social sciences and technical/natural sciences as a whole and, insofar as there is a need to do so, to initiate interdisciplinary research. In connection with the categorisation and designation of high-priority areas, importance has been attached to ensuring that most of the areas have the capability to accommodate research from several disciplines.

RENERGI covers a wide range of subjects, and there are significant differences between different fields of research when it comes to users' interest, supply and demand trends, public interest, etc. Accordingly, it is necessary to develop a strategy for each of them on the basis of the assumptions that apply. This work must be based on the nature of the research field, the opportunities that have been recognised, and an assessment of the need for public funding and organisation.

The following fields will form the basis for ranking priorities within RENERGI:

- **Renewable energy production**
- **Natural gas**
- **Hydrogen**
- **Energy systems**
- **Energy markets**
- **Energy use**
- **Energy policy and international agreements**

Many issues for research will cover several of the areas mentioned above, or must be considered 'vertical' in the energy value chain from primary production to end user, with the focus on the role of the authorities and private players. For example, new renewable energy production may require public participation of different types. Phasing new production capacity into existing energy systems will call for investments in network infrastructure, new marketing and sales schemes must be adapted, and the operation of the other system will have to be adapted to the new situation. RENERGI will attach importance to accommodating projects that address such interdisciplinary issues between the areas.

5.3.1 Renewable energy production

Renewable energy sources comprise a wide range of technologies and opportunities, and it is not easy to recognise winning technologies in advance. However, this area also entails opportunities to satisfy long-term global objectives related to more environment-friendly energy production. Objectives set for the development of renewable energy in the EU and globally, and new framework conditions such as green certificates and new technologies, offer prospects for rapidly growing demand for goods and services. There are also opportunities for national and local economic growth by developing new products and services, and for flexibility owing to supplies from several energy carriers.

Norwegian energy companies, suppliers and research groups occupy a strong position in the field of hydropower. Competence in this area should be further developed with a view to future operations and the further development and upgrading of the system, as well as the development of small-scale hydropower plants. Furthermore, the research should support the export opportunities available to Norwegian business and industry.

Norway is rich in renewable energy resources such as wind, solar power and bioenergy, as well as energy from the ocean such as wave energy, energy from salt gradients and tidal energy. The resources are vast, so the challenges are mainly of a technological and commercial nature when it comes to producing power at competitive prices. With the assistance of social science research, it may be possible to identify market niches and mechanisms that will make it possible to develop new technologies and introduce them to the market. It is also necessary to conduct a critical review and to rank priorities in the fields in which Norwegian research and industry can be expected to compete at the international level on the basis of technological or market-related competence.

The internationalisation of research and industry raises the need to rank priorities even more strictly than before to create a platform for research groups and competitive products. Development associated with silicon as the basis for solar cells has, for instance, turned out to represent a successful marriage between Norwegian raw materials and competence. Norwegian research groups may also enjoy advantages when it comes to adapting renewable energy technology to the Norwegian climate. For example, wind power technology has made considerable headway, but there is still room for new products and services related to the use of windmills in Arctic climates, offshore etc. RENERGI will attach importance to encouraging research communities and business and industry to collaborate to identify such areas of potential growth.

The goals for the efforts in this area will be:

Goal 1: Norway will continue to be a world leader in hydropower competence.

Goal 2: Norway should have strong competence that can support several industrial clusters featuring products aimed at the growing international market.

Goal 3: Commercial availability of renewable energy technology adapted to Norway's climate and market conditions.

Possible target areas for achieving the above-mentioned goals may be:

- The optimisation and environment-friendly development of hydropower installations.

- The use of solar heating in buildings.
- Biofuel production and exploitation, based on wood and waste.
- Offshore wind power and other wind power adapted to conditions in Norway.
- The exploitation of energy from the ocean in areas of technology in which Norway is especially well qualified.

There will be no strict distribution of resources among different technologies and energy sources, but there will be an evaluation of commercial potential in relation to international and local markets.

Energy Systems and Energy Markets (sections 5.3.4 and 5.3.5) list important tasks related to the technical and financial integration of renewable energy sources.

5.3.2 Natural gas

Natural gas is an energy resource that puts Norway in a very special position in the international arena based on production solutions and exports. The Norwegian market's consumption of natural gas is minimal. The fact that natural gas is becoming increasingly available on the domestic market opens new opportunities in the interface between this energy carrier and new technology. Other programmes under the auspices of the Research Council support research on production solutions and chemical conversions to industrial products. In this context, RENERGI will focus on new opportunities for energy production and economic development.

Introducing natural gas into the Norwegian energy market will provide a platform for innovative new technical solutions. Moreover, the introduction of natural gas to the Norwegian market will present challenges to social science research on energy markets and systems. Since natural gas is in common use internationally, Norway's opportunities will be linked to the challenges inherent in introducing natural gas into an already smoothly-functioning Norwegian market and system. RENERGI will pave the way for the development of new products and services with an international potential.

The goal for the efforts in this area will be:

Goal: New products with export value for the direct use of natural gas.

Possible target areas for achieving the above-mentioned goals may be:

- New technology for the direct use of natural gas, including fuel cells.
- Decentralised heat production.

5.3.3 Hydrogen

Along with electricity, hydrogen will probably play a key role in a future energy system. Over the past few years, there has been considerable international focus on the development of hydrogen as an energy carrier. This has been motivated by environmental considerations and the need for security of supply. These opportunities are frequently presented in a vision of a 'hydrogen society'. Work in this area is led by the USA, Japan and the EU.

The Norwegian Government has appointed a special committee to propose measures to promote R&D, demonstrations and the establishment of early markets in selected niches. Norsk Hydro, the rest of Norway's gas industry and the Norwegian shipping industry all have sophisticated expertise in the field of hydrogen. On that account, this is to some extent a question of directing relevant competence towards hydrogen-related issues.

Formidable challenges must be resolved along the entire energy value chain, including production, storage, transport and end use. Since the successful use of hydrogen could imply major changes in the energy system, it will also be important to use social science methods to shed light on prospects for the future, to determine what is required to adopt such technologies and to understand the barriers represented by the introduction of new technology. The visions described for hydrogen are based on

very long-term perspectives. Efforts under the auspices of RENERGI will therefore be long-term and of considerable importance to basic human resources development. The common visions established at the international level will pave the way for industrial progress and the testing of hydrogen technology in the years ahead. RENERGI's prioritisation of such research is predicated on long-term interest in the field on the part of major industrial players.

Initially, the programme will give priority to projects that to build further on the knowledge found in Norway, and where the application of the results is of relevance to the gradual development of hydrogen as an energy carrier. It will be important not least to rank priorities in fields in which Norwegian research can play a role in broader international co-operation.

Although the goals for the efforts in this area can first be rendered concrete when the Hydrogen Committee presents its recommendation, for the moment, they can be expressed as follows:

Goal 1: Norwegian R&D groups shall have a leading position in Europe in the production, storage and system analyses related to hydrogen as an energy carrier.

Goal 2: More Norwegian participation in international projects to develop hydrogen technology.

Goal 3: A European R&D centre for hydrogen set up in Norway.

Possible areas for achieving the above-mentioned goals may be:

- The production of hydrogen using natural gas or water electrolysis;
- Hydrogen storage;
- The development of fuel cell components and systems for the use of hydrogen;
- Hydrogen-relevant materials research;
- Systems integration for hydrogen, including security issues and social assumptions;
- The use of hydrogen in the transport sector.

5.3.4 The energy system

Energy markets are becoming increasingly internationalised, so the international perspective must take account of market trends, the need for infrastructure, security of supply, etc. Norway's power market has long had a Nordic perspective, but is now becoming increasingly European. The oil market has long been global, and the gas market may be moving in the same direction. Meanwhile, trends are moving towards increasing emphasis on the security of supply, while local conditions are gaining increasing importance by emphasising the demand side, the development of distributed energy production and that infrastructure capacity is the most prominent limiting factor.

Power system planning has long and strong traditions in Norway. The further development and integration of this planning to embrace the energy system as a whole, including heating and improved interaction between the technical and financial planning models, will be important. There is also a need to further develop interaction between energy planning and other physical and public planning at the municipal and national levels. Research on planning and social governance is important as it enables the authorities to safeguard public interests in the face of a market-oriented energy sector. Besides environmental considerations, the public sector must safeguard important considerations related to security of supply with a view to both the production and transmission of energy.

The establishment of a natural gas network or a district heating network to supply new areas of development will affect the future exploitation of the power supply grid. This type of solution will also facilitate the establishment of local heating production. The establishment of tools to ensure effective interaction between different energy carriers and different technologies will help see to it

that the resultant energy system complies with requirements for security of supply, at the same time as it fulfils long-term environmental goals.

The establishment of infrastructure for the transmission and distribution of energy will in some cases call for public funding, since it will probably involve major, long-term investments. Research on new technology for power transmission, pipe laying, etc. must be considered on the basis of the individual project's potential to compete at the international level. Scaling development and investments in relation to other measures in the energy system will nonetheless call for a high degree of expertise on the Norwegian system.

The goals for the efforts in this area will be:

Goal 1: For Norway to maintain leading, international-calibre competence in the analysis and planning of a market-based energy system.

Goal 2: To deal with electricity, natural gas and heat together in models for system analysis.

Goal 3: A competitive Norwegian supplier industry to provide equipment and services for an efficient, environment-friendly and secure energy supply, concentrating on the electricity supply, gas distribution and the integration of distributed production.

Possible target areas for achieving the above-mentioned goals may be:

- System analysis;
- Efficiency improvement, security of supply/emergency preparedness and the environment;
- Public planning and social governance at the municipal and regional levels;
- Systems integration of distributed power generation;
- LNG technology, with emphasis on small-scale solutions;
- Power transmission;
- Small-scale district heating systems.

5.3.5 The energy market

Extensive changes took place in the energy market in the 1990s. Based on the Energy Act of 1991, the power supply changed from being organised to meet local power requirements to being organised to address a far larger market, where prices balance supply and consumption. During the same period, international environmental treaties and other environmental standards presented new, stricter parameters for energy production and use, while still other international treaties regulate competition, etc. All in all, this adds up to very different framework conditions for the development of energy systems from those that applied previously. Private players and the authorities alike face new roles and challenges.

The market presents substantial challenges to paving the way for market mechanisms that can be used to meet environmental goals. One example of this is the development of a market for green certificates. Likewise, it is a challenge to ensure that the market provides sufficient signals for long-term decisions on the development of new production capacity, and that the market promotes energy efficiency and conservation. Initiatives for sustainable energy production and use will have to build on comprehensive, reliable knowledge about choices that have an impact on energy use and on the development of the energy markets.

Another example is the re-regulation and reorganisation of the gas markets in Europe, which is taking place largely as a result of the EU's gas directive. The challenges Norway faces as a major gas exporter and its need to participate in the research to design an effective international gas sales system, are part of petroleum research. This programme includes the challenges inherent in organising domestic gas sales. In this context, it will be important to build on insight and experience

from electricity sales. Restructuring and internationalisation are also taking place in the power market base, to some extent due to the EU's electricity directive and the growing integration between electricity and gas markets.

The authorities and the market players also need to know more about Norwegian and foreign experience of measures and instruments that have been tried previously, including qualifications and instruments to introduce new technology into the market effectively. It must be assumed that there will be a continuous need to further develop the framework conditions for the market so that the long-term objectives can be reached.

The target and user group for this research will largely be the authorities in the fields of the environment, energy and competition. However, private players in this market will also be users of competence. Research communities will be important trendsetters for what is expected to be a lengthy debate on energy market issues.

Norwegian specialist groups and institutions have a strong position in the energy market and its development. Further development of knowledge and analyses of experience in this area will make it possible to maintain such a position in future as well.

The goals for the efforts in this area will be:

Goal 1: Norwegian expertise is to occupy a leading international position when it comes to market trends, market schemes and regulation mechanisms as the basis for further developing energy markets to achieve the efficient use of resources, security of supply and environmental goals.

Goal 2: Norwegian expertise on market and regulation concepts is to help promote the internationalisation of the energy markets and market integration, and provide a platform for the commercial exploitation of Norwegian expertise so that the country maintains a leading international position.

Possible areas for achieving the above-mentioned goals may be:

- Market integration: spatial and between energy carriers;
- Competition and sector regulation and the harmonisation of regulatory measures;
- Market regulation with a view to capacity and security of supply;
- Market schemes for environmental regulation and the valuation of environmental considerations;
- Technological change and the introduction of new technologies;
- Innovation and economic development;
- Public instruments and their effects.

5.3.6 Energy use

It is the demand for energy, both in relation to consumption levels and patterns, which underlies the development of the energy system. Additional focus on end use and reducing energy consumption are therefore important to limit environmental consequences and to ensure acceptable security of supply. There are many R&D challenges of a technical, marketing and behavioural nature in this context. There is a connection, for example, between technical and behavioural aspects because new systems not will be adopted unless they are perceived as worthwhile and user-friendly.

Improving user efficiency is a universal challenge. Differences in energy prices to consumers, differences in the availability of energy carriers, and differences in climates and cultures mean there are huge differences between countries. Initiatives that are profitable and interesting one place are not necessarily relevant somewhere else.

The realisation of efficiency improvement potential will often be a question of the framework conditions that apply to the players in the energy market. Energy is used in different sectors of society, ranging from households, buildings and industry to transport. Most of these sectors devote limited attention to energy use. The challenges are therefore to develop knowledge and systems that can support financially sound decision-making through information, new funding mechanisms and new technology.

Not least as a result of publicly funded energy efficiency measures, Norway is developing new knowledge and interesting products in selected industries. Relatively low electricity prices are another advantage for Norwegian players since initiatives that are financially profitable in Norway will probably be even more so in other countries where power prices are relatively higher.

The development of new technology must try to be competitive on the market. On the one hand, research will target potential suppliers of such products and services. On the other, the authorities and the general public require that Norway has a high level of competence to deal with opportunities that may arise in future with a view to devising effective instruments and the size of their own investments.

There is still a significant gap between technical-financial efficiency improvement potentials and what is actually accomplished. Additional knowledge about individual and collective behaviour, market mechanisms, legislation and the effect of information is necessary to realise more of this potential. ICT will pave the way for many new opportunities in future, e.g. through two-way communication, and it will be an element of many projects. This field is highly conducive to interdisciplinary research.

The goals for the efforts in this area will be:

Goal 1: Strong interdisciplinary competence on consumption patterns, consumer preferences and the integration of energy considerations even where they are secondary to other considerations.

Goal 2: New business activities based on funding and outsourcing the energy use of building owners, etc. (ESCO's)

Goal 3: Competitive Norwegian suppliers of energy efficient equipment for industry and the building sector.

Goal 4: Energy use for transport purposes established as a parameter for physical social planning.

Possible areas for achieving the above-mentioned goals may be:

- Energy use in buildings; heating, ventilation, indoor environment, lighting, local energy production, etc.;
- Energy use in households; lifestyle, behaviour, propensity to invest, etc.;
- Energy use in industry and other commercial activities;
- Physical planning and energy use for transport;
- Public instruments and their impact;
- Better control and management of energy through outsourcing, ICT, etc.

5.3.7 Energy policy and international treaties

Extensive changes have taken place in energy policy in most countries over the past decade. The main difference is the emphasis placed on competition and market orientation as a policy instrument for efficiency, which has been included in national and international agreements alike, cf. EU directives, etc. In addition, growing attention to environmental problems, particularly climate-related problems, has led to international agreements and comprehensive efforts to find appropriate

instruments to regulate emissions efficiently and fairly. Earlier accords on sulphur, etc. have brought valuable experience, but can hardly be compared with the challenges faced when implementing a concerted reduction of greenhouse gas emissions.

The Norwegian authorities and Norwegian specialist groups have played an important role in this field in the international arena. This is because Norway has needed to develop new instruments in this field for a long time, and because the country faces very special challenges in relation to an international climate regime. The emergence of an international agreement regime has created an immense need for interdisciplinary competence on drafting agreements, negotiations, and the consequences of the agreements. The international environmental agreements set parameters for the development of the energy market in the years ahead, for example, by requiring countries to reduce their emissions to air of different substances (including greenhouse gases and acidifying components such as SO₂ and NO_x). Energy production and energy use are major sources of such emissions. Given that a large part of its stationary energy consumption is covered by non-polluting hydropower, Norway is in a unique position compared with most other countries. By the same token, the international environmental agreements have a severe impact on Norway as a major producer and exporter of oil and gas, raising questions related to the domestic use of Norwegian gas. Other types of agreements establish important framework conditions for internationalisation, competition, etc. There will therefore be a continuous need to revitalise and supplement knowledge about negotiating and implementing international agreements, and on how the agreements affect framework conditions in Norway.

Environmental agreements and other international agreements will substantially alter the framework conditions for the domestic development of energy systems. Similarly, changes in technology and market conditions can cast private players and the authorities in new roles and present new challenges. Energy policy with a view to energy supply and the management of Norwegian resources will continue to be an important area for Norwegian policy. Experience suggests that professional competence and a dynamic political debate are crucial for finding good, long-term political instruments. Over the past 15 years, social science expertise has laid down important conditions for policy making in the interface between energy and the environment and for the development of a market-based system for trade in electricity. In future, there will continue to be a great need for knowledge about the opportunities and instruments for social governance with a view to environmental considerations, security of supply, resource management and economic development, at the same time as the processes of internationalisation and the opening of markets will continue.

The goals for the efforts in this area will be:

Goal 1: Strong specialist groups which, based on interdisciplinary competence, can establish a framework for the energy policy debate.

Goal 2: Publicly available, strong expertise on the framing of international agreements, the negotiating process and the consequences of agreements.

Possible areas for achieving the above-mentioned goals may be:

- Public instruments;
- The effect of public instruments;
- Negotiating processes;
- Knowledge about the development of international energy markets;
- The enforcement of agreements;

6. PROGRAMME INSTRUMENTS

Upon making a transition to a new programme, it is natural to find a common format for projects and instruments that builds bridges to earlier programmes, and between different disciplines and user groups. RENERGI will be a hub for strategic evaluations of energy research in Norway.

Accordingly, it will be a formidable challenge to establish fora where the authorities, industry and researchers can meet to identify fields that require collaboration.

Comprehensive expertise in long-term policy making will be required on the part of research groups to participate in the programme. On this basis, the Programme Committee will provide advice to the political authorities and pave the way for research groups to also contribute to this process.

6.1 Adapting to other public activities

When a new programme is established, consideration has to be given to how it can be adapted to existing programmes and instruments, and to how interaction can be optimised:

- Adapting to SkatteFUNN. The scheme involving tax deductions for R&D spending has given business and industry a strong incentive to increase their R&D activities (2002). SkatteFUNN can help 'recruit' enterprises to the ordinary programmes. At the same time, it gives the Research Council a chance to attach importance to aspects other than the purely corporate ones when allocating subsidies, e.g. network building and collaboration with R&D institutions.
- Relationship between public instruments ranging from R&D to the market. The authorities deploy a wide range of instruments, directly and indirectly, along the chain from research to market launch and application. It is important that this profusion of instruments be co-ordinated uniformly insofar as possible, at least to the point that the instruments are not experienced as being at odds with each other. Enova SF, Innovation Norway and the Norwegian Water Resources and Energy Directorate (NVE) manage public instruments aimed at ensuring that new technologies and products will be used and introduced on the energy market. Through close collaboration on instruments, these three institutions and RENERGI can provide mutual support for each other's activities.
- EU research. Already today, Norway gives high priority to participating in EU programmes and to using EU instruments in its national programmes. The development of the European Research Area will in all likelihood open new opportunities for collaboration. Co-ordination between RENERGI and initiatives for Norwegian participation in European energy research will therefore have high priority.

6.2 Evaluation criteria

While the programme is running, there will be a need for criteria against which the various initiatives and instruments can be evaluated. The programme will be equipped for evaluation right from the start. Based on the goals (Section 3) and the criteria stated below, the Programme Committee will design verifiable performance goals.

- Research merit. High scientific merit will be key to the long-term utility value of the research. Merit can be measured on the basis of ordinary, acknowledged quality criteria such as publications, patents, etc. The quality requirements will only be relaxed if building such competence is an explicit goal.
- Relevance and user-centrism. All RENERGI research is to have potential utility value for Norwegian users (business and industry and the authorities) in the short or the long term.

Collaboration with relevant users is thus a means to ensure relevance, but the form of collaboration will vary.

- Internationalisation. Collaboration with research groups at the international level is necessary for scientific inspiration and competition, and for collaboration with international industrial players.
- Co-operation between technical and social science research. RENERGI will be measured by the scope of interdisciplinary research and collaboration across the boundaries between disciplines.
- Projects that fulfil several goals. RENERGI will be measured by the extent to which projects can organise research that fulfils several types of objectives, e.g. industrial innovation, the development of R&D groups and the establishment of networks at the international and national levels.
- Sales and market shares for new products. New research-based products will ordinarily be introduced in small market niches. Growth and expansion over time will ordinarily be required for the research to be considered successful.

6.3 Policy instruments

The choice of policy instruments will vary based on the time perspective that applies and the distinctive features of the line of business or sector in question. Different instruments have been used in the three preceding programmes. Given the size of the programme and the diversity of users, topics and challenges, it will be necessary to take advantage of the full range of instruments available to the Research Council. Which instruments are to be used for the different topics will be determined by a strategic process in these areas. Key policy instruments for RENERGI will include:

- Researcher projects. This policy instrument is well-proven and offers ample opportunities to support projects, judged mainly on the basis of scientific merit.
- Competence projects with user participation. This policy instrument offers an opportunity to encourage long-term collaboration between research groups and users, but with limited requirements for co-funding on the part of the users.
- User-driven projects with user subsidies. This policy instrument attaches importance to users' management and co-funding so that the results can be adopted quickly, for example, through user-driven innovation projects.
- Independent funding distributed to projects regardless of field priority, with the main emphasis on merit, to interdisciplinary projects or for other proposals not covered by the targeted calls for proposals.
- Strategic knowledge-building programmes aimed at research groups. So-called SIP/SUP (strategic institute and strategic university programmes) will be dealt with outside RENERGI, but will be co-ordinated by the Research Council.

Supplementary instruments will also be used to the extent they are required. Examples of these are:

- Support for network building at the national and international levels alike.
- Support for the development of international projects.
- Support for the demonstration of new technology expected to have market potential.
- Interaction between the strategies for Enova, Innovation Norway and the Research Council.
- Establish an arena for the framing of Norway's national energy strategy with participation by the authorities, research and industry.

6.4 Organisation

A Programme Committee has been appointed and will be responsible for following up the Work Programme, framing a Plan of Action, etc. The Programme Committee will decide the extent to which there is a need for committees to follow up special topics or processes. The routine administration of the programme will be handled by a programme supervisor in the Research Council's Division for Strategic Priorities.

As the work progresses, the Research Council will take advantage of human and material resources from all three of its divisions.

The programme will report its results, comparing them with indicators defined in the Plan of Action. The programme will be planned with a view to external evaluation. The Research Board will decide when to conduct such evaluations.

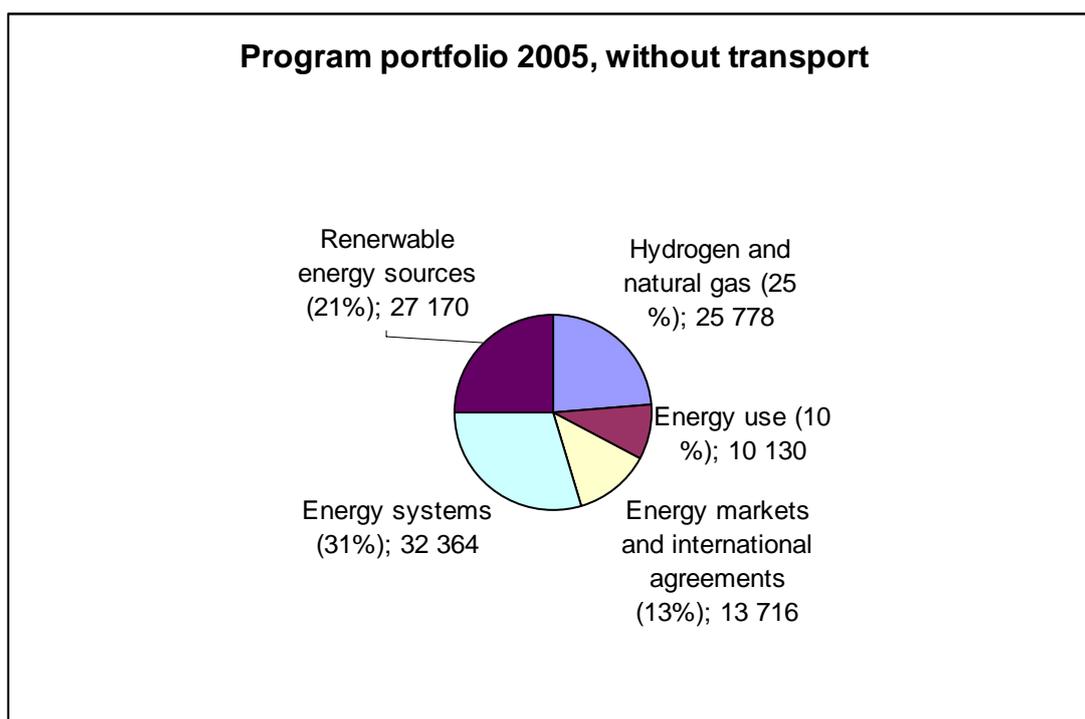
The Programme Committee will draw up a plan for communications and the dissemination of information. This will cover how the programme should set standards for the research groups' communications, how the programme as a whole should present its results and how the Programme Committee can provide advisory services to the authorities and the general public.

7. BUDGET

The 2005 budget contains an allocation of MNOK 137 for RENERGI, of which MNOK 23 from the Ministry of Transport and Communication is earmarked “Environmentally friendly transport technologies”. This implies hydrogen and biofuels for use in the transport sector. The Programme Committee for EMBA has ascertained that energy research as a whole in the short- and medium-long term ought to have a scope of least MNOK 250. Escalation should take place over three to four years. This assessment is based on overall knowledge of the research system's capacity, the need for competence and industrial involvement.

The Plan of Action will specify on an ongoing basis how the Programme Committee would like the resources for the new overarching programme to develop and be distributed in the years ahead to achieve the programme's objectives. Distribution will depend on the merit of applications, the ranking of thematic priorities, the extent to which social science projects are considered an integral part of each individual target area and any earmarking of funds on the part of the appropriating authorities.

The programme's project portfolio in 2005, featuring contributions from several programmes and including earmarked funding for high-priority fields, breaks down roughly as follows among RENERGI's target areas:



- o0o -

RENERGI – Fremtidens rene energisystem,
RENERGI samler den grunnleggende forskningen, den anvendte teknologiske forskningen og den samfunnsvitenskapelige forskningen i ett energiforskningsprogram. Programmet skal legge til rette for forskning både i et langsiktig (30 år) og et kortsiktig (5-10 år) perspektiv.

Det er et uttalt mål at RENERGI skal bidra til samling og koordinering av energiforskningen – både i forhold til å ivareta miljøhensyn, bedre ressursutnyttelsen og utvikle næringspotensialet i sektoren.

RENERGI er avgrenset til energiproduksjon, -overføring og både stasjonær og mobil energibruk.

RENERGI har en planlagt programperiode på 10 år fra 2004, med høye budsjettambisjoner over perioden. Programmet får hovedtyngden av sin finansiering fra Olje- og energidepartementet, men også Miljøverndepartementet, Nærings- og handelsdepartementet og Samferdselsdepartementet bidrar til programmets budsjett.

Mål og faglig innhold for RENERGI er å:

- Utnytte og foredle naturressurser og infrastruktur
- Bidra til forsknings- og teknologibasert næringsutvikling

- Utvikle kunnskap om rammebetingelser og virkemidler
- Utvikle forsknings- og kompetansemiljøer

Sentrale forskningsområder for RENERGI er:

1. Fornybar energiproduksjon
2. Naturgass
3. Hydrogen
4. Energisystemer
5. Energimarked
6. Effektiv energibruk
7. Energipolitikk og internasjonale avtaler

Kontaktpersoner for RENERGI:

Koordinator Hans Otto Haaland,
Telefon 22 03 72 97
hoh@forskningsradet.no

Konsulent Astrid Kristensen
Telefon 22 03 72 95
ak@forskningsradet.no

www.forskningsradet.no/renergi

RENERGI - Clean energy for the future

Norges forskningsråd

Postboks 2700 St. Hanshaugen
N-0131 OSLO
Telefon: 22 03 70 00
Telefaks: 22 03 70 01
www.forskningsradet.no

Store programmer er et viktig virkemiddel i Forskningsrådet for å realisere sentrale forskningspolitiske prioriteringer. De skal gi et kunnskapsmessig løft av langsiktig nasjonal betydning med sikte på å stimulere til innovasjon og økt verdiskaping eller frembringe kunnskap som bidrar til å løse prioriterte samfunnsutfordringer.