Energy Turnaround

National Research Programme NRP 70

Call for projects

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What are National Research Programmes (NRPs)?

The research carried out by National Research Programmes consists of targeted research that contributes to the solution of contemporary problems of national importance. Under the provisions of Article 6, paragraph 2, of the Federal Act on the Promotion of Research and Innovation of 7 October 1983 (as of 1 January 2013) the Federal Council selects the topics and foci to be researched in NRPs and mandates full responsibility for implementing the programmes to the Swiss National Science Foundation (SNSF, Division IV).

Article 4 of the Federal Ordinance on Research and Innovation Promotion of 10 June 1985 (as of 1 January 2013) describes the purposes and contents of NRPs as follows:

"[1] National Research Programmes are a means to direct and support coordinated research projects that have a common goal. Where needed, National Research Programmes should strengthen scientific research capacities.

[2] Topics of research are generally appropriate for National Research Programmes if:

a. scientific research on the problem is of national importance;

b. Swiss research can make a significant contribution to the resolution of the problem;

c. solutions require research contributions from multiple disciplines;

d. the research goals cannot be met exclusively through basic research, through research within a specific section of the administration, or through industrial applications research;

e. research on the problem can be expected to produce research results that have practical applications within a five-year time period.

[3] The following criteria should be taken into consideration in setting forth the topics of National Research Programmes:

a. the programmes can provide the scientific basis for decision-making by government and the administration;

b. the programmes can be conducted with international collaboration and are also of great interest to Switzerland."

Summary

The simultaneous implementation of the Federal Council's "Energy Strategy 2050" and the next stage in Swiss climate policy represent a major challenge for the energy sector, as well as for politicians, the economy and consumers. In view of this, in May 2011 the Federal Council took the fundamental decision to limit the NRP (National Research Programme) call for proposals from the State Secretariat for Education and Research (SER)[1] that was planned for 2011 to energy research, and thus specifically to new NRPs focusing on the energy issue. Against this backdrop, on 4 July 2012 the Federal Council approved the National Research Programme "Energy Turnaround" (NRP 70) with a budget of CHF 37 million, and the National Research Programme "Managing Energy Consumption" (NRP 71) with a budget of CHF 8 million, and entrusted the Swiss National Science Foundation (SNSF) with their implementation.

NRP 70 primarily focuses on scientific and technological aspects of the change in energy strategy and on the preparation and introduction of the various stages of implementation of the new energy system at the social, political and economic levels in Switzerland. The focus of NRP 71 is on examining the options for realising the efficiency and sufficiency potentials in the consumption of energy by private, commercial and public-sector end users through steering measures. These two research programmes are closely related and are therefore to be carried out in the period from 2014 to 2018 alongside one another and in a closely coordinated manner.

In Switzerland, research in these two areas is broad-based and internationally competitive, but a variety of important aspects have nonetheless not yet been dealt with to date. With NRP 70 and 71 the aim is to concentrate the existing research potential and generate know-how which will provide politicians and the economy with support for the implementation of "Energy Strategy 2050" and the attainment of other energy and climate policy objectives. Special importance is to be attached to the integration and consolidation of the findings, and thus to fostering their transfer at the political and economic levels.

This call for proposals refers solely to NRP 70 "Energy Turnaround". A separate call has been prepared for NRP 71 "Managing Energy Consumption".

An information event for interested researchers will be held at the premises of the SNSF on 21 August 2013.

[1] With effect from 1 January 2013, State Secretariat for Education, Research and Innovation (SERI).

1. Introduction

In May 2011 the Federal Council took the fundamental decision to limit the NRP call for proposals from the State Secretariat for Education and Research that was planned for 2011 to energy research, and thus specifically to the NRP focusing on the energy issue. The aim is to compile the scientific fundamentals needed by players in the areas of politics, the economy and the administration who are responsible for taking decisions relating to the resolution of the Federal Council concerning "Energy Strategy 2050", within the scope of which Switzerland's energy supply is to be substantially restructured and its electricity supply secured over the long term without the use of nuclear energy.

In order to secure a reliable, environmentally compatible and economical energy supply in Switzerland, the Federal Council resolved to restructure the country's energy system on a step-by-step basis. The necessary measures were specified in the new "Energy Strategy 2050". In the first stage, the goal is to reduce end energy consumption, promote the use of renewable energy and cut CO_2 emissions. Then, in the second stage, the CO_2 fee and the network surcharge for financing remuneration of feed-in at cost are to be combined into a single energy levy. This represents a shift in strategy from the existing promotion concept to a steering system. The intention is for the transition to take place seamlessly and within an acceptable timeframe.

In order to be able to meet the future demand for energy, in particular for electricity, the most important requirement is to reduce consumption. The Federal Council is therefore focusing on promoting energy efficiency right across the board, i.e. in buildings, electrical appliances, trade and industry, the services sector and mobility. In order to accomplish this, it intends to introduce suitable measures, including additional funding for the buildings programme and more stringent energy efficiency requirements. It also expects the public sector to set a good example in this regard.

In order to offset the loss in electricity production from nuclear energy, the Federal Council aims to secure the country's electricity supply by greatly increasing the use of renewable energy while maintaining an acceptable balance between the conservation and use of resources. To ensure that the utilisable potential of renewable energy sources can be exploited, in the initial stage the intention is to increase the level of financial support. Here the focus is on optimising and expanding the existing model for feed-in remuneration at cost. The remaining energy demand is to be met through the use of fossil-fuelled thermal power plants and/or electricity imports.

Against this backdrop, on 4 July 2012 the Federal Council adopted NRP 70 (Energy Turnaround) and NRP 71 (Managing Energy Consumption) and entrusted the SNSF with the mandate of implementing them. For the planned five-year research period, the budgets for NRP 70 and NRP 71 are CHF 37 million and 8 million respectively. The National Research Council elected a Steering Committee for each programme and instructed them to prepare and coordinate the two calls for proposals based on the respective programme outlines (SNSF, April 2012) and feasibility studies (SNSF, April 2012). The two Steering Committees commenced work on 14 March 2013, and the respective calls for proposals were approved on 1 July 2013 by the head of the Federal Department of Economic Affairs, Education and Research (EAER).

The main objective of both research programmes is to propose potential solutions that can be implemented in Switzerland in the coming 10 to 30 years. For the development of the planned research programmes, the SNSF was able to make use of background material provided by the State Secretariat for Education and Research (SER) and the

Swiss Federal Office of Energy (SFOE), including in particular the two reference reports, "Status and Perspectives of Energy Research" (29 April and 12 May 2011) and the "Coordinated Swiss Energy Research Action Plan" (24 April 2012).[2]

1.1 Background

The annual level of greenhouse gas emissions attributable to Swiss consumption, including "grey" emissions (i.e. those resulting from the production of goods outside the country's borders) is approximately 12.5 tonnes per capita, of which 7.2 tonnes are emitted within Switzerland and the remainder occur in the form of grey emissions from the manufacture of products and the processing of energy carriers abroad. In 2010, the direct end energy requirement amounted to 911,550 TJ, comprising 215,230 TJ of electricity (56.5% hydropower, 38% nuclear power), 616,190 TJ of fossil fuels, and 38,090 TJ of wood energy. The share of renewable forms of energy (excluding hydropower) was only 14,750 TJ (or 2.4%).

The challenge for the change in energy strategy consists of two related tasks, namely the withdrawal from nuclear energy as a means of electricity production and the reduction of climate-relevant emissions, both of which have to be accomplished with the aid of sufficiently safe, environmentally compatible and economical technologies for maintaining a high quality of life. For this purpose, the technologies for securing significantly greater efficiency and the use or optimisation of resources that have not been (or have barely been) utilised to date, need to be promoted, on both the supply and demand side. In addition, the potential associated with consciously refraining from energy-intensive behaviour (sufficiency potential) has to be assessed and studies need to be carried out to determine how this potential can be realised. How these tasks are handled is influenced by developments in the areas of energy technology and energy policy in neighbouring countries and at the global level as well as by new climatology findings.

All energy technologies are subject to the laws of nature, which for example determine the maximum degree of conversion from one form of energy into another. The increase in energy consumption that has been ongoing for many years is a social phenomenon that can only be partially attributed to economic factors. It has to be assumed that the relative proportion of electricity to overall end energy consumption will continue to increase.

It is clear that the change in energy strategy concerns not only the substitution of electricity produced from nuclear energy (base-load energy) by electricity generated with the aid of other technologies, but also, in an optimised future energy mix, the use of fossil and synthetic fuels, heat (including geothermal energy), sunlight and mechanical energy. Renewable energy based on solar radiation and wind is unable to meet demand everywhere and at all times, and this means that storage and transport, as well as connecting networks, are of particularly high importance. These primarily scientific and technological aspects form the main emphasis of NRP 70.

However, it will not be possible to bring about the change in energy strategy solely through the development of new technologies. The creation of an effective incentive system for encouraging a change in the behaviour of all participants in the energy market, and establishing the necessary social and political consensus and securing its successful implementation at the federal, cantonal and municipal levels, represent ma-

[2] BBl 2012 9017; BBl 2013 2611-2616; BBl 2013 2481

jor challenges. This socioeconomic and regulatory side of the process relating to the change in energy strategy is dealt with in NRP 71.

There are numerous relevant interdependencies between NRP 70 and NRP 71. In view of this, close cooperation and coordination between the two programmes is desirable in terms of both development and implementation, even though the programmes themselves are organisationally separate from one another, are the subject of separate calls for proposals and have their own Steering Committees.

1.2 National and international research environment

As in every industrialised nation, energy research is an important pillar of energy policy in Switzerland. The public sector spends between CHF 160 and CHF 200 million a year on energy research. The main objectives are to ensure a secure and sustainable energy supply, promote Switzerland as a centre of technological research and development, and maintain the high quality of Swiss research. A great deal of value is attached to international cooperation and the efficient transfer of research findings into practical application.

Energy research is explicitly defined as one of the strategic cornerstones of the federal government's "Energy Strategy 2050". In the period from 2013 to 2016, the Federal Council therefore intends to promote research and innovation in the energy sector through additional funding in order to support the implementation of the new energy policy. Additional funding of CHF 202 million for the cited period was approved by Parliament during its 2013 spring session following its debate on the special dispatch concerning the action plan "Coordinated Swiss Energy Research". Support will focus mainly on applied research in areas with particularly high potential for the new energy strategy. An important aspect is also the development of the required expertise with research experience. The proposal has been put forward to create up to seven Swiss Competence Centres for Energy Research (SCCER) in selected thematically oriented areas of research, as well as thirty new research groups at universities and forty SNSF professorships.

Publicly funded energy research is carried out in line with the federal government energy research concept, which is updated every four years by the Swiss Federal Energy Research Commission (CORE). In its concept for the period from 2013 to 2016, CORE has defined four thematic priorities: "Life and work in the future", "Mobility in the future", "Energy systems of the future" and "Processes for the future". Closely linked to this concept are the research programmes of the SFOE (mainly in the areas of energy-economy-society), the pilot and demonstration projects of the SFOE, the newly launched SCCERs as well as the research programme of the Federal Roads Office.

A substantial proportion of the funding for energy research throughout the world is spent on research and development in the area of renewable energy, efficient energy use and energy efficiency. In Germany, for example, within the framework of its 6th Energy Research Programme, the government budgeted just over a billion euros for research and development in the area of renewable energy and almost a billion in the area of efficient energy use and energy efficiency for the period from 2012 to 2014. To take Japan as a further example, the Ministry for Economy, Trade and Industry (METI) budgeted the equivalent of CHF 960 million for 2013 for the promotion of research and development in the field of renewable energy. This amount corresponds to around 10% of the Ministry's overall budget. The largest amounts are intended for research on wind energy (CHF 398 million), geothermal energy (CHF 193 million) and solar energy

(CHF 72 million). A significant amount is also reserved for research in the area of electricity grids, since the timely further development of this infrastructure is essential for the reorientation of the energy system with an increase in the use of renewable energy.

The national research environment

Switzerland's universities and research institutes have highly qualified energy researchers at their disposal and are also able to call on leading specialists from closely associated fields such as climatology, meteorology, hydrology, seismology, psychology, sociology, political science and economics. Energy research is also very well networked at both the national and international levels.

Leading researchers are working in the competence centres at the two Federal Institutes of Technology: the Energy and Mobility Competence Centre (CCEM) with "Leading House" at the Paul Scherrer Institute; the Environment and Sustainability Competence Centre (CCES) with "Leading House" at the Federal Institute of Technology, Zurich; the Energy Science Centre at the Federal Institute of Technology, Zurich; the Energy Centre (CEN) at the Federal Institute of Technology, Lausanne; the Swiss Federal Laboratories for Testing and Research (Empa) and the Federal Office of Meteorology and Climatology. In addition, energy research is carried out at various universities, and a variety of Universities of Applied Sciences specialise in applied energy research and development.

The international research environment

International projects have been an integral part of energy research in Switzerland for many years. Special importance is attached to cooperation within the framework of EU and International Energy Agency research programmes.

The EU supports research and development through its long-term framework research programmes, the main objectives of which are to strengthen the scientific and technological fundamentals of the industry, promote the development of their international competitiveness and expand the European Research Area (ERA).

The 7th Framework Research Programme was initiated in 2007 for the period up to 2013 with a budget of EUR 53.2 billion. Non-nuclear energy research is one of the priorities and is being supported with a budget of EUR 2.35 billion. The goal here is to transform the present-day European energy sector into a more sustainable industry with a broad mix of energy sources.

To facilitate the realisation of beneficial synergies between national and European support policy, a variety of European technology platforms have been created (e.g. "Fuel Cells and Hydrogen", "Zero Emission Fossil Fuel Power Plants", "Electricity Networks of the Future") in which Switzerland is represented by the Swiss Federal Office of Energy (SFOE). In addition there are various "ERA Nets", for example "Hydrogen and Fuel Cells" and "Fossil Energy Coalition".

As noted above, Germany has been strengthening its focus on energy research for a number of years and is currently intensifying its efforts after having taken the decision to withdraw from the use of nuclear energy. In the Helmholtz Association of German Research Centres alone, energy is one of six fields of research and receives EUR 1,300 million in financial support for the period from 2010 to 2014. This includes an additional 130 million earmarked for "energy policy change" to support programmes such as "Renewable Energy (Photovoltaics and Concentrated Solar Power)", "Networks in

2020", "Efficient Supply of Energy", "Future Energy Supply Infrastructure: Sustainability and Social Compatibility" and "Synthetic Liquid Hydrocarbons: High Energy Density Storage, Stationary Electrochemical Solid Matter Storage Media and Converters".

Switzerland was a founding member of the International Energy Agency (IEA). In the 27 IEA member states, the public sector invests a total of several billion US dollars annually in research and development in the areas of renewable energy, efficient energy use and energy efficiency with the aim of supporting the development of innovative technologies.

For its members, the IEA functions as an extensive forum for coordinating major energy issues, but also as a platform for international research cooperation in the form of "implementing agreements". The main areas of focus are renewable energy, fossil fuels, energy efficiency and nuclear fusion. Switzerland is currently actively involved in more than 20 implementing agreements. All projects relating to energy research are coordinated by the Committee on Energy Research and Technology (CERT), in which Switzerland is represented by the SFOE.

The international networking of the SFOE's programme activities is further intensified via contacts within the scope of thematically relevant IEA initiatives, and this opens up opportunities for cooperating on the implementation of projects that have a significantly more widespread (international) effect and which Switzerland would not be able to realise on its own.

2. Goals

In its "Energy Strategy 2050" the Federal Council assumes that Switzerland's population will increase to over 9 million by 2050. It expects the number of gainfully employed to remain more or less constant in the period from 2010 to 2050, and anticipates an average annual economic growth rate for the same period of around 1.1%. According to the "Political Measures" scenario,[3] the growth rate for the mean absolute end energy demand is expected to fall from +0.7% per annum (1995 to 2010) to around –1.0% per annum (2010 to 2050), while the growth rate of the mean absolute electricity demand is expected to fall from +1.5% per annum (1995 to 2010) to around zero up to 2020, followed by a period of slightly negative growth up to 2035 and subsequently by a slight increase up to 2050. Expressed in terms of energy requirement per unit of GDP, end energy demand is expected to fall from the current –1.2% per annum (2000 to 2010) to between –1.9% per annum (in the "Political Measures" scenario) and –2.3% per annum (in the "New Energy Policy" scenario),[3] while electricity demand per GDP unit is expected to fall from the current –0.2% per annum (2000 to 2010) to between –0.7% ("Political Measures" scenario) and –1.7% per annum ("New Energy Policy" scenario). In the area of production of electricity from new renewable energy sources, the Federal Council anticipates an increase to around 24 TWh per annum (from the present-day level of < 1 TWh) thanks primarily to an increase in the use of photovoltaics (to approx. 11 TWh), wind energy (to approx. 4 TWh) and geothermal energy (to approx. 4 TWh).

Both NRP 70 and NRP 71 are geared to the targets of the "Energy Strategy 2050" of the Federal Council. In doing so, they focus not solely on saving energy as such but on

[3] Die Energieperspektiven für die Schweiz bis 2050, Energienachfrage und Elektrizitätsangebot in der Schweiz 2000 – 2050 (Energy Perspectives for Switzerland up to 2050: Energy demand and electricity supply in Switzerland in the period from 2000 to 2050). Prognos AG, Basel, 12 September 2012.

reducing substantially the consumption of non-renewable energy sources and energy sources with detrimental impacts on the climate, the environment and human beings. Both NRPs operate on the basis of a matrix which shows that for the implementation of the Federal Council's "Energy Strategy 2050" and the attainment of other energy and climate policy objectives there are gaps in knowledge on the supply side and in the area of demand for (renewable) energies, as well as at the interface between supply and demand (market conditions, pricing, structuring of framework conditions through the political and social process, etc.), and that on both the supply and demand sides, scientific, technological and socioeconomic issues will arise.

	Technological aspects	**Socioeconomic aspects**
Supply side	NRP 70	NRP 70
Demand side	NRP 70	NRP 71

Figure 1: Matrix illustrating coverage of essential thematic requirements

The matrix reflects the fact that society and technology are closely interrelated. For this reason, isolated technological solutions can either not be applied at all or not until a later stage unless the relevant scientific aspects of the social, economic and political environment are integrated into the development and application of the technology concerned. On the other hand, the challenges associated with "Energy Strategy 2050" will not be met solely with the aid of new business models or legal reforms.

The two programmes that are to run side by side will be implemented in a closely coordinated form and will jointly focus on the complex issues associated with the targeted change in energy strategy. The following areas of activity are expressly excluded from the scientific focus and priorities of NRP 70 and NRP 71:

_ Research aimed at incrementally enhancing the status of knowledge

_ Nuclear research (covered by existing sources of support)

_ Pilot and demonstration facilities (supported by the SFOE)

_ Basic research (supported by Divisions I to III of the SNSF)

2.1 Goals of NRP 70

The main goal of the National Research Programme "Energy Turnaround" (NRP 70) is to implement specific research and development projects with the aim of developing technologically innovative as well as institutionally and socially attractive concepts and solutions for securing a sustainable energy policy in Switzerland.

The resulting solutions have to meet energy supply and demand requirements that secure a high quality of life, while also increasing the innovation potential for energy-related products and services. These have to be developed through close cooperation in a variety of areas in coordinated projects that focus on integrated, system-oriented value chains. This involves both high-risk cutting-edge research at universities (high-risk/high-reward research projects), as well as innovative research and development projects aimed at radically improving existing technologies in cooperation with private companies and public authorities.

NRP 70 is also intended to contribute towards sensitising the general public and politicians to the energy issue and helping break down barriers and potential opposition to sustainable energy technologies. The results, which in part are to be obtained through international cooperation, are also intended to serve as a contribution by Switzerland towards the resolution of European and global energy issues.

The coordinated participation of various researchers and industry partners in a value chain is intended to lead to the creation of new business models which reduce the entrepreneurial risk for each partner. This integral approach will result in higher value-added for Switzerland, since the integration of individual research projects into specific value chains will make it possible to more fully take the general conditions and features particular to Switzerland (geographic, political, sociological and economic) into account.

2.2 Goals of NRP 71

The National Research Programme "Managing Energy Consumption" (NRP 71) focuses on the social, economic and political aspects of the change in energy strategy and, in particular, on the fourth quadrant of the matrix depicted above illustrating the coverage of essential thematic requirements.

The main focus of NRP 71 is on social, economic and political issues which largely concern energy demand. Attention is also to be paid to comprehensive issues that concern the interaction between supply and demand. The programme is primarily intended to examine how energy efficiency and sufficiency potentials can be realised in private households, companies, public facilities and institutions through steering measures or corresponding framework conditions. It is also intended to examine how energy suppliers can be encouraged through suitable measures, including official regulations, to develop business models that incorporate incentives to use energy economically (demand-side management). On top of this, economic, legal, political, psychological and social framework conditions and trends are to be identified that foster (or hamper) efficiency improvements or the realisation of sufficiency potentials. This includes impact analyses of federal funding and steering measures. Special attention is also to be paid to interdisciplinary approaches and the integration and involvement of various social groups (including minorities). The intention is for research into practical intervention to be supported in a special module in cooperation with power suppliers and/or municipalities.

3. Organisation and structure of NRP 70

The structure of the National Research Programme "Energy Turnaround" deliberately deviates from the conventional project support model, which focuses on specific technologies and is already extensively utilised both at home and abroad and supported with major investments. The thematic areas on which NRP 70 focuses correspond to market segments, where problems are addressed that are not only scientific and technical in nature, but are also of social relevance. In each of the five market segments ("Building and Settlement", "Transport and Mobility", "Industrial Processes", "Services" and "Electricity Supply"), value chains exist which range from demand through to introduction to the market. These market segments largely correspond to the priorities defined in the recently published federal energy research concept for the period from 2013 to 2016 that was developed by the Federal Energy Research Commission (CORE). In each of these segments, research activities are to focus on four dimensions (cf. ver-

tical columns in Figure 2), and research projects that are oriented on a specific value chain are to be combined into joint projects, for which a qualified management committee is to be formed that is responsible for leading and coordinating the projects and which is to be remunerated separately.

The five market segments are supplemented by a further area, "Sustainability assessment", the purpose of which is to demonstrate the ecological, economic and social advantages and disadvantages of the individual value chains in a quantitative manner. Sustainability assessment is to form an integral part of the research projects.

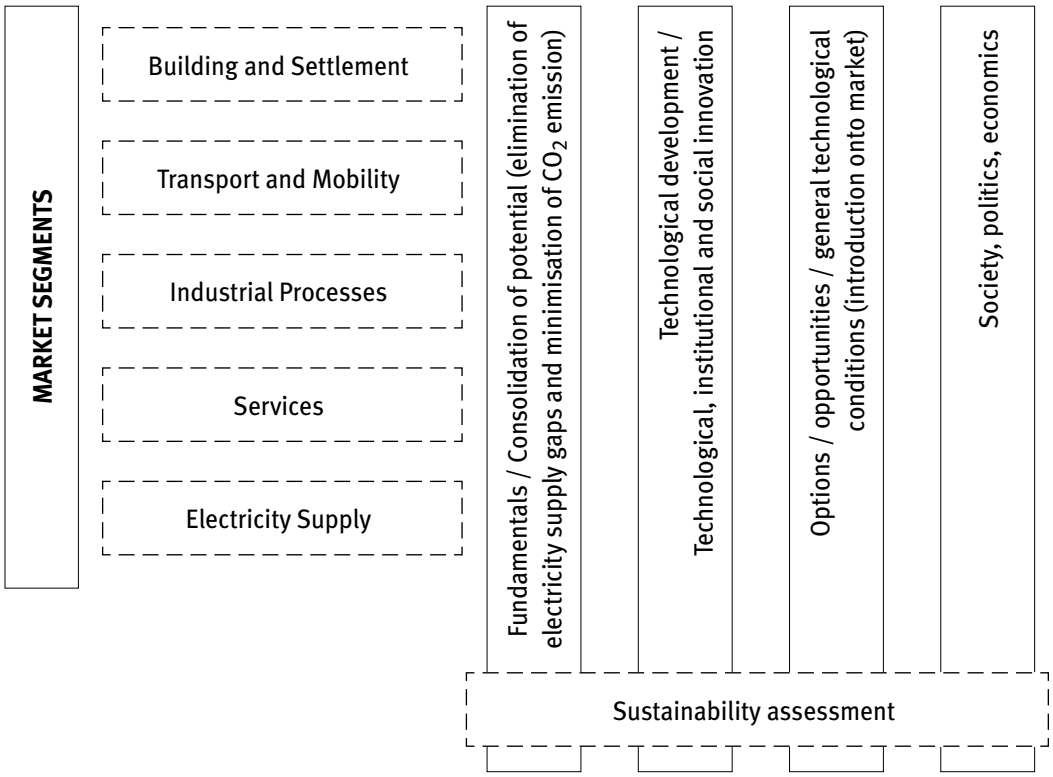

Figure 2: Study dimensions in value chains

In accordance with the logic of this structure, a complete market segment thus incorporates research projects relating to both the demand and the supply side, whereby "Society, politics, economy" primarily concerns the demand side and therefore NRP 71.

Figure 2 above depicts the overall structure of NRP 70 in terms of content. The structure within a given market segment with its research projects can be illustrated as shown in Figure 3 below:

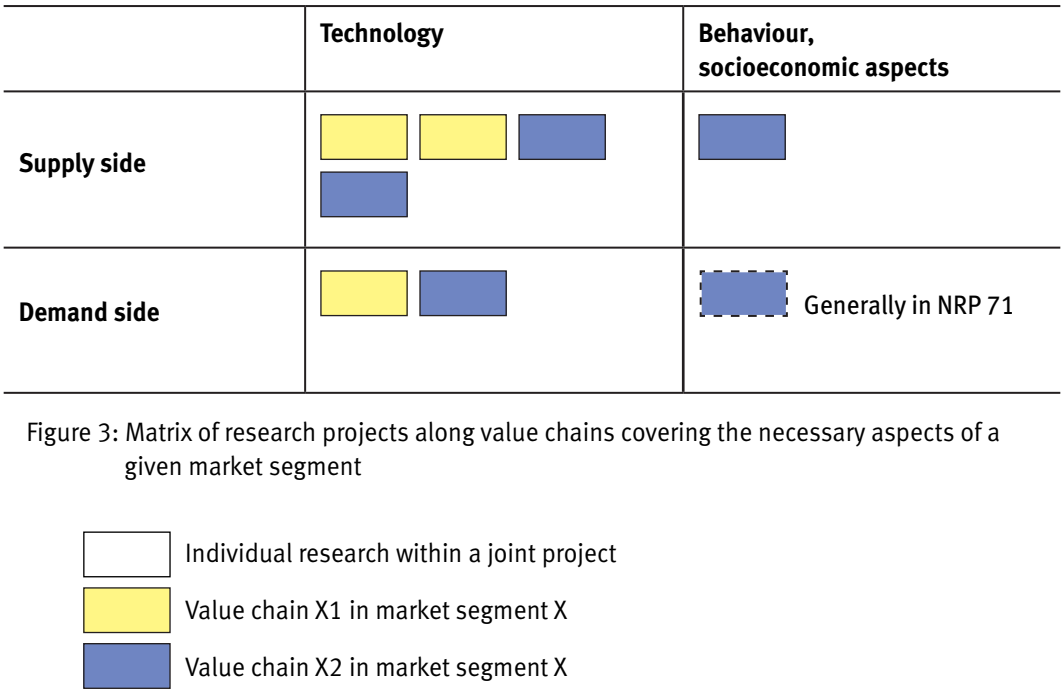

Figure 3: Matrix of research projects along value chains covering the necessary aspects of a given market segment

This matrix is to be applied to each market segment to demonstrate that both the supply and demand side and scientific/technological, social, political and economic aspects are integrated in the research. The number of research topics per quadrant depends on the market segment in question and is therefore variable. This integration is the key to developing value chains with clearly defined roles for private- and public-sector players.

Research projects in the fourth quadrant (demand side/behaviour, socioeconomic aspects) generally belong in NRP 71. However, if such projects are also an integral part of a value chain for a specific market segment, projects in the fourth quadrant may also be submitted in NRP 70. These sub-projects will then be co-evaluated by members of the Steering Committee of NRP 71.

4. Main research topics

The National Research Programme "Energy Turnaround" (NRP 70) focuses on the technological, institutional and societal potentials on the demand and supply sides for realising "Energy Strategy 2050", while the main focus of the National Research Programme "Managing Energy Consumption" (NRP 71) is on socioeconomic aspects on the demand side. Since NRP 71 is the subject of a separate call for proposals, this chapter only deals with the research priorities defined for NRP 70.

It should be emphasised once again that the research in NRP 70 does not address the thematic areas that are normally defined according to discipline, but instead focuses on market segments and value chains that are of high relevance for the successful implementation of "Energy Strategy 2050". As described in Chapter 4, in NRP 70, the five market segments ("Building and Settlement", "Transport and Mobility", "Industrial Processes", "Services" and "Electricity Supply") form the thematic areas. Within each market segment there are one or more relevant value chains in which both the supply and demand side and scientific/technological, institutional and socioeconomic aspects have

to be addressed in the course of research. It is also important to pay sufficient attention to the international ties in the respective market segments. The various research topics are to be defined and positioned along such value chains.

Clearly, the targeted integrated solutions can only be realised through close interaction between a broad variety of disciplines (the sciences, engineering, architecture and urban development, economics, law, politics, sociology, psychology), and close cooperation between science and the private sector is essential with a view to industrial applications.

For the NRP 70 research projects this means that the activities in the various areas of research have to be carried out in a coordinated manner in joint projects comprising several research groups from different disciplines, which in each case requires joint definition of objectives and issues by the research groups in question. In the overall NRP 70 budget, special funding has been included for the coordination and management of these joint projects. By way of exception, individual discipline-related projects can also be funded if they fully comply with the objectives of NRP 70.

Figure 4 shows the value chains which, from the present-day perspective, are of relevance for Switzerland for the five market segments in terms of research priorities. The identification of specific themes along these value chains which have the potential to make a contribution towards the implementation of "Energy Strategy 2050" is left up to the teams of researchers. For this purpose, the specified study dimensions have to be taken into account (cf. Figure 2).

Market segment	**Main research topics along the value chain**
Building and Settlement	Energy efficiency
	Integration of renewable energy
Transport and Mobility	Transport systems
	Efficiency and reduction of CO_2 emissions
Industrial Processes	Energy and material efficiency
	Substitution of fossil fuels
Services	Energy efficiency
Electricity Supply	Electricity production
	Electricity networks
	Storage of electricity
	CO_2 management

Figure 4: Potential research topics along the relevant value chains in the five market segments

With reference to Figure 4 and the cited value chains (priorities) it should be noted that applications for financial support for pilot and demonstration projects have to be submitted to the SFOE. In the best case, only a limited degree of co-financing or assistance with the scientific evaluation of such projects is possible through NRP 70. On the other hand, projects in NRP 70 are conceivable that deal with aspects of technology policy, for example the potentials and limits of technology promotion.

In addition, the area of "Sustainability assessment" serves the purpose of quantitatively demonstrating the ecological, economic and social benefits and drawbacks of the individual value chains. Sustainability assessment will be an integral part of the research projects in NRP 70. Here, tried and tested analysis and evaluation methods are to be applied and, where necessary, focused more closely on the particularities of the change in energy strategy and further developed. Research and development aimed at creating new methods is therefore explicitly excluded.

A total of 5% of the funding has been earmarked for the sustainability assessment of research projects in NRP 70. The long-term objective of this area of activity is to quantify the contribution of the research findings towards the change in energy strategy, and thus support effective policy-making.

Examples of research along the value chain

The principle of research along value chains is illustrated below on the basis of one example per market segment. In addition, at the end of the example for the "Electricity supply" market segment, examples of potential research topics for the "Electricity networks" value chain are cited (cf. Figure 3). The examples below are merely a selection and are in no way intended to represent an exhaustive list:

Building and Settlement: Integration of renewable energy

If we consider the area of photovoltaics, the value chain ranges from the development of new, more efficient and more durable cell technologies with correspondingly economical large-scale manufacturing processes to their diverse application in private households, companies and public institutions, decentralised electricity storage and stochastic internal demand/external feed-in to the network including steering and architectonic integration into individual buildings and housing developments, through to incentive systems for mostly private property owners.

Transport and Mobility: Efficiency and reduction of CO_2 emissions

This value chain extends from the extraction, processing and distribution of fuels for private and commercial transport, to vehicle construction and conversion into drive power (efficiency), through to incentive systems for the supply of alternative fuels or car sharing and the training of driving behaviour.

Industrial Processes: Energy and material efficiency

This value chain encompasses all steps from the development of low-energy products to reduced-temperature production processes, through to efficient heat use and distribution (with the aid of incentive systems) and the conversion of heat into electricity and mechanical energy. This may include the energy consumption for the extraction of raw materials, the use of environmentally-friendly materials, the recycling of used products, the implementation of resource-efficient production systems as well as interventions affecting eco systems and landscapes.

Services: Energy efficiency

Increases in efficiency can be realised in the areas of information and communication technology through new forms of data management (e.g. further development of Cloud computing), more energy-efficient hardware and cooling systems, reduction of heat output and increased use of waste heat and improved reusability of individual hardware components and by encouraging appropriate user behaviour.

Electricity Supply: Electricity networks

In the context of a value chain, electricity networks encompass forecasts of future electricity demand and their geographic and chronological distribution, future feed-in of electricity and integration of intermittent renewable electricity, the provision, operation and maintenance of networks, the integration of national grids into the European networks, network stability and power flow management, smart grids and high-performance electronics, as well as system aspects of electricity storage and local and national network administration.

Potential research topics along the "Electricity networks" value chain can be depicted in the matrix as follows:

	Technology	**Behaviour, socioeconomic aspects**
Supply side	Power-flow management models for bidirectional electricity exchange at all voltage levels Storage and load management for the integration of larger quantities of intermittent electricity New network management principles High-voltage DC transmission systems and components for distribution networks	Incentive systems for the renovation and expansion of the electricity network Financing models Decentralised, stochastic feed-in by companies and private households, and the consequences thereof
Demand side	Optimisation (technical and economic) of own consumption, local storage and feed-in from photovoltaic systems Integration of consumers into network management, e.g. provision of reserve energy	Demand for network services, e.g. peak shaving and load shifting through use of more dynamic electricity tariffs

In NRP 70 it is expected that the joint projects comprising scientists from the various disciplines and their industry partners identify research topics along the relevant value chains and process them in a coordinated manner. However, a holistic view must always be applied, ranging from the requirements (supply side) to implementation (demand side), i.e. of technology and behaviour. The expectations with regard to findings include new products, processes, services and/or business models which can make a substantial contribution to the realisation of "Energy Strategy 2050" and be brought quickly onto the market.

Sustainability assessment

The evaluation of the sustainability of technologies or political measures may be based on existing methods such as life-cycle analysis, technology assessment, sustainability impact assessment and risk analysis. Switzerland also has the world's largest life-cycle inventory database ("ecoinvent"), which contains quantitative data relating to emissions and consumption of resources of a broad variety of energy production technologies, electricity mixes in various countries and regions, value chains of fuels, transport systems for energy and heat, heat production processes and other transport systems. Other international projects supplement this resource with inventory data on leading energy technologies of the future.

The main purpose of sustainability assessment is not the development of new theoretical models and methods, but rather the case-specific application and, where necessary, modification or further development of existing models and methods. The expectation here is that for each joint project the contribution of the research results obtained along a given value chain towards a sustainable development can be quantitatively assessed whenever possible. Sustainable assessment is therefore an essential, integral component of every joint project.

5. Practical significance and target audience

NRP 70 is intended to develop scientific fundamentals, technologies and products for players at the political, economic and administrative levels who are responsible for taking decisions relating to the Federal Council's resolution concerning "Energy Strategy 2050", within the scope of which Switzerland's energy supply is to be substantially restructured and its electricity supply secured over the long term without the use of nuclear energy. The anticipated technical innovations and socioeconomically attractive contributions towards solutions for Switzerland apply to the timeframes up to 2020, 2035 and 2050.

The results have to be delivered to the relevant public-sector decision-makers (federal government, cantons and municipalities) in good time so that it will be possible to develop workable instruments for implementing the new strategy. On the other hand, one of the priorities of the programme concerns the development of technological innovations with a high degree of potential for introduction onto the market within the specified timeframes, which means that players in the energy sector and companies specialising in energy and electrical technology, as well as the mechanical engineering and construction industries, are also directly involved. Here it is essential to provide these players with attractive framework conditions at an early stage. As a result of support for top-level projects, it is expected that the results of NRP 70 will also attract international attention.

Through the planned integration of small and medium-sized companies, major groups and industry associations at an early stage and close cooperation with the Commission for Technology and Innovation (CTI), NRP 70 aims to foster the reciprocal transfer of technology and know-how at the national level. This will ensure that the perspectives of the involved industry players are reflected in the respective phases of a given research project and that the attained results of the research and development activities can be subsequently put into practical application ("push-pull" principle).

6. Programme flow

NRP 70 is a five-year programme, and the duration of individual research projects must not exceed 48 months. The NRP Steering Committee reserves the right to implement a second, if necessary more specifically focused, call for proposals at a later date.

It should be reiterated here that NRP 70 strives for the interaction of various disciplines (in joint projects) along the energy-relevant value chain in the five market segments as well as a close partnership with industry right from the start with respect to the formulation of objectives and the transfer of results.

Certain aspects of NRP 70 are especially suitable for implementation in the form of cooperation between the SNSF and the CTI or for transfer to the programme for pilot and demonstration projects of the SFOE. The transfer of NRP 70 projects to CTI projects with industry partners can take place at any stage of the research programme, if sufficient progress has been made in the project concerned.

For the bundling of scientific findings from the various projects, a programme synthesis is to be developed. Here, the focus will not be on the individual scientific details, but on the overlying findings, the potential contribution of the new technologies and products to the implementation of "Energy Strategy 2050" and the political and economic conclusions.

7. Submission procedure and project selection

The call for proposals as well as forms, regulations and directives for the submission on the *my*SNF portal can be found on the website www.snsf.ch.

In order to better coordinate the research projects and set the relevant research priorities, a two stage submission procedure has been set up: pre-proposals are submitted first, then full proposals. Pre-proposals and full proposals must be submitted in English as they will be evaluated by international experts.

Pre- and full proposals have to be submitted online on the *my*SNF web portal. For the use of *my*SNF, prior user registration on the *my*SNF homepage (https://www.mysnf.ch) is required. Previously opened user accounts remain valid and provide unlimited access to all funding schemes of the SNSF. New user accounts have to be opened 14 days before the submission deadline at the latest. The submission of documents by postal delivery is only accepted in exceptional cases and after consultation with the programme coordinator.

The pre-proposals and full proposals must be submitted in accordance with the guidelines issued by the SNSF, and the project duration is to be limited to a maximum of 48 months. A pre-proposal may be submitted either in NRP 70 or in NRP 71, but not in both. The Steering Committee reserves the right to transfer an NRP 70 pre-proposal to NRP 71 after consultation with those responsible for the pre-proposal. If a proposal involving the same research project is or was simultaneously submitted to another research initiative, this must be declared by the applicants.

The Austrian Science Fund (FWF) and the Deutsche Forschungsgemeinschaft (DFG) will participate in NRP 70 within the scope of the Lead Agency agreement. It is therefore possible for German and Austrian researchers to participate in NRP applications, provided that such a co-operation is regarded as useful. More information on these

agreements can be found on the website www.snf.ch. However, it is not permissible for German or Austrian researchers to submit their own projects or take charge of the larger part of an NRP project; they may only act as project partners under Swiss project leadership. With regard to the FWF, the maximum project duration is 36 months and the running time of the Austrian and the Swiss parts of the project must be identical.

7.1 Pre-proposals

The deadline for submission is 17 October 2013. The pre-proposal should provide an overview of the planned research as well as information on the following points:

To be entered directly on the *my*SNF portal:

_ Basic data and abstract

_ National and international cooperation

_ Budget: approximate personnel and material costs

Documents to be uploaded in PDF format:

_ Research plan (project description):

· Research topic and objective of the project

· State of research

· Methods

· Timeframe and milestones

· Expected benefit and possible application of results; specific risks to be considered

· List of the three most important publications in the field of the pre-proposal

· List of the five most important publications and/or patents of the applicants

The project description must be submitted using the template document provided on the *my*SNF portal. It must be written in English and must not exceed six A4 pages.

_ Short CVs of the applicants of a maximum of two A4 pages each

_ Declarations of intent and agreements between the project partners

Possible scenarios for successful industrial application of the results must already be presented in the pre-proposal. In addition, the pre-proposal must contain an assessment of the project's chances of success under the pre-defined framework conditions. When evaluating innovative projects with higher risk, the Steering Committee will attach less importance to these aspects.

The integration of industry partners at an early stage is recommended. In the pre-proposal, the type of cooperation with industry partners in different project phases needs to be explained (e.g. assessment of application potential, partners for validating market opportunities, partners for specifying objectives and defining "show stoppers", partners for commercial exploitation). The role, function and commitment (resources) of the project partners should be confirmed in writing.

Ideally, a joint project should contain three to eight single projects, for each of which a pre-proposal is submitted. At least three components need to be addressed: technological, systemic and application-related. In an additional pre-proposal (umbrella project), the applicants should present the organisation of the project and the project management, for which separate funds may be requested.

The Steering Committee evaluates the submitted pre-proposals and makes a decision based on the criteria mentioned in chapter 8.3. Members of the Steering Committee of NRP 71 will be consulted in the course of the evaluation, if necessary.

7.2 Full proposals

In a second stage of the submission procedure, the Steering Committee will invite the authors of the selected pre-proposals to submit full proposals. The full proposals must be written in English and submitted online via the *my*SNF portal in accordance with the guidelines of the SNSF.

Research proposals are reviewed by international experts. In addition, the Steering Committee may invite the applicants to present their project to the Steering Committee at a colloquium where details of the proposals can be discussed in depth and problems resolved. Subsequently, the Steering Committee will decide which research proposals are to be recommended to the National Research Council (Division IV; Presiding Board) for approval or rejection.

7.3 Selection criteria

In the case of joint projects, both the individual pre-proposals and the entire collaboration (incl. project organisation and management) will be evaluated. Pre-proposals and full proposals will be reviewed on the basis of the following criteria:

_ **Scientific quality and originality**: in terms of theory and methods, the projects must be in line with international scientific standards and the state of the art in the field. In addition, they must have innovative components and be clearly delineated from ongoing projects.

_ **Concordance with the goals of NRP 70 and relevance for the "Energy Strategy 2050"**: the projects must pursue clear, realistic goals. They must comply with the scientific objectives and research priorities described in the call and fit the overall framework of NRP 70. The projects must make a specific and significant contribution to the realisation of the "Energy Strategy 2050" or clearly and convincingly show that they have the necessary potential.

_ **Collaboration along an energy-relevant value chain**: the joint projects must address an energy-relevant value chain in one of the market segments, must include a contribution to the "Sustainability assessment" area that is relevant to practice, and must address both the supply and demand aspects as well as the technical and socio-economic aspects. Individual projects are possible if they conform to the objectives of NRP 70.

_ **Application, transfer** and utilisation strategy: National Research Programmes have a clearly defined mandate with regard to knowledge and technology transfer (KTT). Projects that are highly relevant for practice are therefore prioritised.

_ **Personnel and infrastructure**: the personnel and infrastructure of the project must be adequate to the pursuit of its objectives.

Prior to the scientific evaluation, the Administrative Offices of Division IV "Programmes" will check whether the formal criteria are met (cf. Funding Regulations of the SNSF). Pre- and full proposals that do not meet the formal criteria will not be forwarded for scientific evaluation.

7.4 Schedule and bugdet

The schedule of NRP 70 is as follows:

Call for pre-proposals	8 July 2013
Deadline for pre-proposals	17 October 2013
Invitation to submit full proposals	end of January 2014
Deadline for full proposals	end of April 2014
Final decision on full proposals	August 2014
Start of research	September 2014

On 21 August 2013, an information event for interested researchers will be held at the SNSF, Wildhainweg 21, Berne, Plenary Hall 21, 14:15 to 16:15. The number of seats is limited. Please register before 31 July 2013 via e-mail to nrp70@snf.ch.

NRP 70 has a budget of CHF 37 million. The available funds are expected to be distributed across the different thematic areas as follows:

Building and Settlement	CHF 9 million
Transport and Mobility	CHF 4 million
Industrial Processes	CHF 5 million
Services	CHF 4 million
Electricity Supply	CHF 11 million
KTT and administration	CHF 4 million

A total of 5% of the budget have been reserved for the "Sustainability assessment" area of research. Up to 10% of the budget have been reserved for explorative projects of a pioneering nature ("game changer projects").

7.5 Contact persons

For questions concerning the submission and evaluation procedure or NRP 70 in general, please contact the programme coordinator Dr. Stefan Husi at nrp70@snf.ch or 031 308 23 43.

The contact person in financial matters is the Division IV head of finance, Roman Sollberger (roman.sollberger@snf.ch or 031 308 21 05).

8. Actors

8.1 Actors of NRP 70

Steering Committee

Prof. em. Dr. Hans-Rudolf Schalcher, ETH Zurich (President)

Prof. Dr. Göran Andersson, Power Systems Laboratory, Department of Information Technology and Electrical Engineering, ETH Zurich

Prof. em. Dr. René L. Flükiger, Département de Physique de la Matière Condensée (DPMC), University of Geneva

Prof. Dr. Beat Hotz-Hart, Department of Economics, University of Zurich (*member of the Steering Committee of NRP 71 who will attend meetings of the Steering Committee of NRP 70*)

Dr. Tony Kaiser, President of the Federal Energy Research Commission (CORE), Consenec AG, Baden-Dättwil

Prof. Dr.-Ing. Matthias Kleiner, Institut für Umformtechnik und Leichtbau (IUL), University of Dortmund, Germany

Prof. Dr. Martha Lux-Steiner, Director, Institute for Heterogeneous Materials Systems, Helmholtz-Zentrum Berlin

Prof. Dr. Dimos Poulikakos, Director, LTNT-Laboratory of Thermodynamics in Emerging Technologies, ETH Zurich

Dr. Jan van der Eijk, Technology and Business Innovation Consultant, Dordrecht, Netherlands

Delegate of Division IV of the Research Council of the SNSF

Prof. Dr. Peter Chen, ETH Zurich

Programme coordinator

Dr. Stefan Husi, Swiss National Science Foundation (SNSF), Berne

Head of knowledge and technology transfer

N.N.

Representatives of the federal administration

Dr. Walter Steinmann, Director, Swiss Federal Office of Energy (SFOE), Berne

Dr. Sebastian Friess, Head of Innovation unit, State Secretariat for Education, Research and Innovation (SERI), Berne

For the State Secretariat for Education, Research and Innovation (SERI)

Dr. Claudine Dolt, SERI, Berne

8.2 Actors of NRP 71

Steering Committee

Prof. Dr. Andreas Balthasar, Department of Political Science,
University of Lucerne, (President)

Dr. Konrad Götz, Institute for Socio-Ecological Research (ISOE), Frankfurt/Main

Prof. Dr. Beat Hotz-Hart, Department of Economics, University of Zurich

Prof. Dr. Miranda Schreurs, Head of Environmental Policy Research Centre,
Freie Universität Berlin

Prof. Dr. Petra Schweizer-Ries, Prof. of Sustainability Science, Bochum University of Applied Sciences and adj. Prof. of Environmental Psychology,
Universität des Saarlandes

Prof. Dr. Hannelore Weck-Hannemann, Prof. of Political Economy, Institut für Finanzwissenschaft, Universität Innsbruck

Delegate of Division IV of the Research Council of the SNSF

Prof. Dr. Frédéric Varone, Faculté des sciences économiques et sociales,
University of Geneva

Programme coordinator

Dr. Stefan Husi, Swiss National Science Foundation (SNSF), Berne

Head of knowledge and technology transfer

N.N.

Representative of the federal administration

Dr. Pascal Previdoli, Deputy Director, Head of the Energy Economy division,
Swiss Federal Office of Energy (SFOE), Berne

For the State Secretariat for Education, Research and Innovation (SERI)

Dr. Claudine Dolt, SERI, Berne