ACADEMY OF FINLAND

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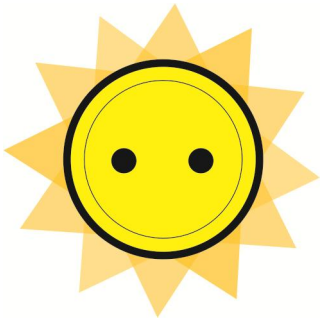

New Energy

Research programme 2015-2018

Programme memorandum

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NEW ENERGY

Programme memorandum

Preface

In its meeting in autumn 2011, in connection with the adoption of the operational and financial plan for 2013–2016, the Board of the Academy of Finland made a decision to launch the preparation of a new research programme in the field of energy research. The idea was to launch the new programme after the completion of the research programme Sustainable Energy (2008–2012). A working group was set up to plan and prepare the programme on 4 March 2013. The group was chaired by Professor Erno Keskinen (Research Council for Natural Sciences and Engineering), co-chaired by Professor Mari Walls (Research Council for Biosciences and Environment), and the members were Professor Jarkko Ketolainen (Research Council for Health), Professor Sirkka-Liisa Jämsä-Jounela (Research Council for Natural Sciences and Engineering), Professor Juuso Välimäki (Research Council for Culture and Society), R&D Manager Marja Englund (Fortum), Head of Research Päivi Tikka (Maj and Tor Nessling Foundation), Industrial Counsellor Timo Ritonummi (Ministry of Employment and the Economy), Chief Technology Adviser Pia Salokoski (Tekes). The following persons from the Academy's Administration Office acted as experts in the working group: Science Advisers Jan Bäckman, Jaana Lehtimäki, Heikki Vilen and Tiina Forsman; Programme Managers Tuula Aarnio and Saila Seppo; and Secretary Elina Sarro.

The Academy of Finland organised two events relating to the preparation of the new programme: a workshop in December 2012 and a seminar in September 2013. The workshop, facilitated by Finland Futures Research Centre, drew up scenarios on future energy use and related research needs. The theme of the September 2013 seminar related to future directions of energy research. Among other things, the seminar participants discussed challenges of energy production, transmission and storage, the optimal combination of different methods of energy production, and the energy solutions of carbon-neutral living. The seminar clearly highlighted the fact that energy solutions vary from country to country and that Finland's solutions should be based on research evidence. The seminar participants included a wide variety of researchers and representatives of stakeholders and end users.

1. BACKGROUND

Maintenance of our current lifestyles and wellbeing requires massive energy consumption. Meanwhile, growing energy consumption has created problems in terms of energy sufficiency and curbing emissions. In an attempt to achieve energy security, some countries have sought energy self-sufficiency. However, in the rare cases in which this has succeeded, it has been based on a country's own natural resources or energy sources.

As nuclear power has become more controversial, in many countries the share of conventional fossil energy sources has grown, hampering the achievement of international emission reduction targets. The research organisation Global Footprint Network[1] calculates that Earth Overshoot Day[2] moved forward to 20 August in 2013. For this reason, some comparable countries have systematically grown their distributed generation, in a move towards carbon-free production independent of nuclear power. Although a large part of its energy supply is based on nuclear power, to meet its international obligations Finland must gradually replace its fossil fuel consumption with renewable and preferably carbon-free production. Low-emission energy production

[1] www.footprintnetwork.org/en/index.php/GFN

[2] Earth Overshoot Day marks the point at which people around the world have collectively reached the end of the Earth's capacity to replenish the natural resources consumed and to absorb the fossil-fuel greenhouse gases emitted for the year in question.

combined with new bioeconomy processes offers Finland a natural opportunity to exploit its natural resources in a sustainable manner. Due to climate-related factors, distributed generation has been viewed as challenging in Finland. Substitute forms of energy production require investment in trial plants, in order to investigate the associated phenomena and processes in a genuine environment. Finland, which is currently at the exploratory stage in identifying energy solutions, is seeking references from countries with a similar climate and consumption profile.

In Finland, multidisciplinary research on mechanisms for energy consumption, production and storage is required in order to find an affordable energy solution. "New Energy", the name of the Academy of Finland's research programme, refers to the transition to a resource and system-efficient economy in which emission-free energy is produced from inexhaustible energy sources. Among other measures, such solutions will require the optimal combination of various production methods in order to manage fluctuations in production and consumption. This will present us with a difficult management issue in a scenario where there are myriad microgeneration units. These will be subject to unpredictable fluctuations in production as the weather changes; i.e. in a manner reminiscent of variations in consumption, but for different reasons. The development path in shifting towards renewable energy will require a convergence of interests between society, individuals and energy producers and consumers. Change will require bold investments, the adoption of new technologies and the upgrading of business models. We can therefore view this as an energy transition. Naturally, great changes occur slowly. However, consumer behaviour could act as a catalyst for change, steered by issues such as environmental awareness and a new role for consumers as energy producers. That is why the aim has been to place the consumer at the core of the programme.

The new energy research programme is in line with the strategic goals of the Academy of Finland. It also dovetails squarely with the goals set for the National Climate and Energy Strategy. In accordance with the research policy laid down by the Academy of Finland's Board in 2011, research programmes should answer the grand challenges, as identified by the Board, that are facing humankind and society. Sustainable energy is one of these challenges. The focus of the Academy of Finland's Sustainable Energy (SusEn, 2008–2012) research programme was on energy production technology, energy systems and energy efficiency. The themes of the New Energy programme reflect a changing operating environment in which key issues include the overall management of energy production and consumption, the new energy markets, and new integrated energy solutions for industrial production, the residential living environment and waste management.

2. OBJECTIVES

The programme will involve a search for energy-sector solutions for managing the coming transition. Because the transition is already progressing elsewhere in the world, it is important to be at the forefront of the related research, despite the fact that no models applicable to Finland as such have been tried elsewhere. Under the programme, scientific methods will be used to resolve complex issues related to the great energy transition. Solutions will be applied to the creation of new energy products; business models; process principles; types of energy; storage, transmission and distribution mechanisms; solutions for managing complex grids; as well as the integration of energy in new ways with habitation, transport, commerce, recycling and the exploitation of biomass.

Despite the complex, multidisciplinary nature of this field of research, three key themes emerge:

- Consumers' energy choices
- Adaptation of energy production and consumption
- Integrated energy solutions

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Consumers' energy choices

Energy solutions will serve society's aims of achieving greater wellbeing, while taking due note of the values of, and appraisal by, society and individuals. Demand for energy is based on consumer choices, which are themselves influenced by purely economic considerations as well as concerns about the sustainable and fair exploitation of natural resources. The programme seeks to investigate the economic and social driving forces behind energy choices, and the public authorities' possibilities to influence such choices.

Adaptation of energy production and consumption

Finland's energy solution will probably be based on a scenario in which growing levels of small-scale distributed production and bioenergy are combined with nuclear power. On the one hand, this will create a technological challenge in managing a large complex grid. On the other, it will give rise to a new energy market in which consumer-producers play a double role. Here, the aim is to create systemic models for managing the balance between production and consumption, and for the dynamics of the new energy market.

Integrated energy solutions

Newly built properties or entire new-built areas could produce part of the energy they need. Parts of buildings could have a heat capture function and bioenergy could be generated from community waste. In addition, processing plants could be converted for the flexible production of, say, materials, biofuel ingredients, chemicals or energy. The aim is to study processes and management methods associated with integrated energy solutions, as well as their compatibility with local production and their connectivity to the power grid.

Other research objectives include:

- the creation of new national and international research collaboration networks for the programme and the establishment of multidisciplinary research groups
- increasing the mobility of research students and researchers
- improving our international research and industrial competitiveness
- taking Finnish energy research to the international leading edge in some research areas
- social impact

3. THEMATIC AREAS

The research community is expected to make multidisciplinary inroads into the three theme areas. In particular, the aim is to interlink consumer behaviour, new energy-based business opportunities and energy sector innovation. Another approach would involve linking basic phenomena identified by the natural sciences with new process principles based on such phenomena, while paying particular attention to Finland's natural resources and climate conditions. A third, systemic approach would involve a focus on the modelling, management and optimisation of integrated systems and complex producer-consumer grids. With Finland's energy solutions approaching a watershed, the international dimension of these projects is crucial. When seeking new solutions and practices, collaboration should provide the basis for an account of the impact of solutions adopted elsewhere, as part of relevant research.

3.1 Consumers' energy choices

Energy consumers' choices lie at the heart of the energy production and consumption transition. As the available energy supply changes, users will adapt their consumption patterns quickly, as required. Energy needs are affected by individual decisions on habitation, transport and communications technologies, and the production technologies favoured by industry. Such choices will form the basis of a low-carbon future that provides the basis for wellbeing. They will be influenced by economic incentives, ecological, ethical, social and health perspectives and public policy. These are precisely the themes on which the research programme will focus:

- Economic incentives affecting energy choices
- The ecological, ethical, social and health perspective in making such choices
- Public policy opportunities for influencing such choices

By changing their consumption habits and technology solutions, individual households can have a profound effect on their energy consumption. Examples of economic incentives include the shaping of consumer habits through smart power grids and the quantification of savings achieved during long-term investment lifecycles.

In addition to purely economic considerations, greater environmental awareness is influencing consumers' energy choices. Foodstuffs are categorised according to their carbon footprint and goods are marketed as having been produced using local wind power. Choices are based on the general consensus on what constitutes the sustainable use of natural resources and the maintenance of wellbeing. Research is needed on the emergence of individual and societal values related to the environment and energy production, and on their influence on consumer choices.

Energy policy aimed at consumers has been implemented on the basis of regulations and various subsidies and taxes. A fundamental aspect of enlightened energy consumption lies in distributed production, localism and conscious individual choices. People forge their identities through their consumer choices. How can we provide support and incentives for citizens who are ever more autonomous in decision-making? An efficiently implemented policy will need to make use of research on the impact of measures and benefit from the charting of new ways of having an impact.

3.2 Adaptation of energy production and consumption

The production, transmission, distribution and consumption of energy form a challenging technical and commercial whole, which also involves a heavy and costly infrastructure. Pressures to switch to carbon-free production are leading to an increase in distributed power generation as part of a whole based on centralised production. A major technological and commercial challenge lies in the prospect of consumers being able to connect to the production network under such a model. The research programme's systemic themes are as follows:

- Management of a complex grid
- New energy markets

As part of a grid based on distributed generation, nuclear power will secure the base load and level out fluctuations with the help of other forms of production. However, the situation is being made more complex by the fact that distributed generation solutions (wind, solar) are weather-dependent and do not follow the same cycle as energy consumption. Filling this gap will require flexible production and the use of various mechanisms, such as storage, to secure energy availability. In addition, the flexibility and reliability of nuclear

power will gain new significance. Together, these issues will create the need to manage complex grids, which can be investigated using system-level simulations. Weather information affecting local production and consumption could form part of this model and virtual power plants connecting various kinds of producers could be created. Comprehensive lower-level models of individual and interconnected distributed units will be required in order to depict the entire grid. This will also require principles for the optimal management of consumption in terms of the load borne by different power sources. Such optimisation could involve minimising transmission losses and covering consumption spikes and production gaps associated with certain places and times. In addition, consumer models should take account of local energy production, such as ground heat, through techniques such as off-grid capture methods.

In the case of distributed production of renewable energy, supply and demand on the one hand, and the role of consumer and producer on the other, are seldom in balance in terms of time or place. Optimisation of distributed production requires systemic management, technological innovations and the activation of customers. Grid use will become more diverse in the future, with electricity consumers also able to become power sellers. The grid will be characterised by great diversity in production and consumption (e.g. various forms of microgeneration, charging of electric cars) guided by energy-saving goals, the possibility to distribute loads and possible energy storage facilities. No economically viable solutions have so far been developed for the large-scale storage of electricity. With respect to future pricing, we must consider how to incentivise the workable distribution of loads, how the grid's maintenance and construction costs can be distributed between different parties (producers, consumers) and how power surges can be reduced. Hourly measurement and new technical solutions will enable the more diverse monitoring and management of consumption and the sale of new services to customers.

3.3 Integrated energy solutions

A situation in which energy is available at the point of consumption provides fertile ground for integrated solutions. This provides opportunities for both energy self-sufficiency and production. Such solutions will be an excellent fit in sectors such as the following:

- Community energy supply
- Energy as part of the bioeconomy

New properties or entirely newly built estates would be presented with an attractive opportunity to realise the distributed generation philosophy in an integrated manner. For example, the cladding and roofing of buildings could form integrated heat and solar energy capture elements, helping to render buildings energy self-sufficient. Waste fractions that are unsuitable for community recycling could also be used in energy production in local waste incinerators, which would require the development of low-emission burning processes. Tomorrow's industrial estates will be designed as energy self-sufficient sites, by integrating HVACE (heating, ventilation, air conditioning and electricity) features with production processes or connecting estates to distributed generation grids. While numerous corresponding opportunities exist for the smart use of energy to power various activities at community level, more research is needed in support of the related planning and realisation.

If green energy technology achieves its anticipated annual growth of 15-30 per cent, the world market for the sector will double or even quadruple by 2020. Growth potential will also be sought in traditional industries, where low emissions and resource efficiency are increasingly viewed as providing a competitive edge. Bioenergy is important to Finland's opportunities to grow its green energy sector. It includes logging residue, crop biomass, industry side streams, biowaste and macroalgal biofuel. Research needs to cover issues such as integrative production concepts and the lifecycle environmental impacts of bioenergy, raw materials and end

products. To reduce its reliance on fossil fuels, Finland must develop the use of domestic biofuels in transport and mechanised production. New burning processes that bind carbon and, if necessary, store energy in chemicals, for example, should be based on heat energy derived from secondary biomass. The processing plants of the future will form a part of the bioeconomy. As such they will be capable of flexible adaptation to fluctuations in demand, by producing, say, materials, fuels, chemicals and/or energy, as the situation requires. However, such adaptive production methods will require research, since they will entail highly challenging optimisation and process management.

4 IMPLEMENTATION

The research programme aims at strengthening multi- and interdisciplinary research in the field represented by the programme. All projects included in the programme will thus be encouraged to establish research collaboration that integrates both multi- and interdisciplinary approaches.

4.1 Funding

The New Energy Research Programme is a four-year research programme (2015–2018) funded and coordinated by the Academy of Finland. Through the programme, funding is provided to multidisciplinary research conducted by research projects and consortia with a view to supporting national cooperation and networking. A research consortium is a collaboration of independent fixed-term projects working under a joint research plan by combining different methods and research fields with a view to achieving greater added value than is achieved by normal project collaboration. The research programme's funding budget for the 2014 call is EUR 10 million.

4.2 National cooperation

The Academy of Finland's New Energy Research Programme is set to include collaboration with Tekes' programmes and CLEEN Ltd, the Strategic Centre for Science, Technology and Innovation[3] in the field of energy and the environment. There are interfaces between the New Energy Research Programme and Tekes' programmes Green Growth – Towards a Sustainable Future and Groove – Growth from Renewables. This will create an excellent framework for collaboration between the programmes.

The New Energy Research Programme is also associated with the Academy's upcoming Arctic Research Programme (2014) and the ongoing research programmes OMA (programmable materials) and FICCA (climate change).

4.3 International cooperation

The New Energy Research Programme aims to selectively establish cooperation with research funding agencies in other countries that are committed to supporting leading-edge scientific research and with whom collaboration in energy issues could be beneficial for Finnish research. The Academy of Finland's research programme Sustainable Energy (SusEn, 2008–2012) included several international joint calls with the Nordic countries, Germany, Brazil, China and Chile, for instance.

In 2012, the Academy carried out a joint call in the field of sustainable energy with both a Brazilian (National Council for Scientific and Technological Development, CNPq) and a Chilean (National Commission for Scientific

[3] Read more about the strategic centres at www.aka.fi/en-GB/A/Programmes-and-cooperation/Strategic-centres/.

and Technological Research, CONICYT) research funding agency. The projects funded within these calls will later be included in the New Energy Research Programme.

The Academy also participates in funding cooperation within the EU's framework programmes, in particular ERA-NET New Indigo (www.newindigo.eu), which aims to increase collaboration between European and Indian researchers by, for instance, providing funding for joint calls. The theme of the August 2013 New Indigo call was energy research: Smart Energy Grids and New Energy Materials. The projects funded within this call will later be included in the New Energy Research Programme.

India is one of the Academy of Finland's key partner countries in international cooperation. The Academy is preparing a joint call with the Indian Department of Science and Technology (DST) on sustainable energy. The call is set to be opened in 2014.

The Academy also aims to promote collaboration between energy researchers and the International Institute for Applied Systems Analysis (IIASA).

Decisions on other international collaborations will be made separately.

4.4 Schedule

The national-level call for letters of intent will open in connection with the Academy of Finland's April 2014 call. Projects that proceed to the second stage will be asked to submit their full applications in autumn 2014. The funding decisions will be made in late 2014.

Within the programme, funding will be provided to individual projects and consortium projects for a maximum of four years. The funding period will start on 1 January 2015 and end on 31 December 2018. A detailed schedule for the call and the review of applications is given in Chapter 5 of this memorandum. A kick-off seminar will be arranged in early spring 2015. The Academy will separately announce the funding partners, thematic areas, schedules and application processes of any additional calls to be launched.

4.5 Steering group

The research programme is run by a steering group composed of members of the Academy's research councils and other expert members. Additional experts may also be invited to the group. The duties of the steering group are:

- to prepare the programme and submit to the programme subcommittee a proposal on projects to be funded
- to make a proposal to Academy research councils and other funding bodies on any new calls and/or additional funding
- to manage and monitor the programme
- to steer programme coordination
- to be responsible for the final evaluation of the programme
- to promote the application of research results produced within the programme.

4.6 Programme coordination

The research programme strives to support and promote the development of the selected projects into a coherent and cohesive structure through active cooperation and exchange of information. The programme

coordination is the responsibility of the steering group and the programme managers and project officer appointed by the Academy. They are responsible for ensuring this development and work closely with the projects to facilitate the attainment of the objectives set for the programme. The aim is to ensure that the projects reinforce each other and that the programme generates new multidisciplinary research knowledge. Consequently, the principal investigators (PI) of the projects selected to take part in the programme will be required to commit themselves to the programme objectives and to cooperate actively throughout the programme and during the programme evaluation upon its completion.

The PIs of the projects are required to:

- assume responsibility for and report on the scientific progress of the project and on the use of the funds in accordance with the instructions of the programme manager and relevant funding bodies
- see to that the whole research team attends all meetings, seminars and workshops organised by the programme coordination, and facilitate cooperation and exchange of information between the research teams within the programme
- take part in producing reviews, syntheses and information material around the research programme, and actively disseminate information about the programme's progress and results on public and scientific forums.

During the course of the programme, the research projects will participate in events arranged together with end-users of research results and in any other activities designed to provide information to different stakeholders.

4.7 Evaluation

The implementation and results of the research programme will be evaluated upon its completion. The implementation of the evaluation will be planned in detail as the programme progresses, but the evaluation will consider, for instance, the following issues:

- attainment of programme objectives
- programme implementation (coordination, role of steering group, programme participation)
- evidence of impacts pursued by the programme
- national and international cooperation
- publicity and visibility of research conducted within the programme.

The evaluation may be carried out as part of a more extensive evaluation of Academy research programmes or other national programmes and in cooperation with other national and international actors.

The research teams receiving funding are required to report on the progress of their projects in accordance with the decision of the steering group and to submit a research report to the Academy of Finland upon project completion. The reports must include information on, for example, scientific publications produced and theses and doctoral dissertations completed within the programme.

5. APPLICATION GUIDELINES AND REVIEW CRITERIA

The New Energy Research Programme has a two-stage call. At the first stage, applicants submit letters of intent including short plans of intent (see guidelines in the Academy's April 2014 call for applications). The tentative deadline for letters of intent is 29 April 2014 at 16.15. The deadline is non-negotiable. (Check the

deadline in the call text, which will be published in late February 2014.) The steering group will make a proposal to the programme subcommittee appointed by the Academy Board on projects that would best fit in with the programme aims on the basis of the letters of intent. The projects selected to proceed to the second stage (to submit full applications) will be notified of the steering group's decision in June 2014.

Applicants requested to submit full applications shall prepare a complete research plan and submit it in the Academy's online services according to the tentative schedule no later than 15 September 2014 at 16.15 (see exact deadlines and guidelines in the Academy's April 2014 call for applications). On the basis of the scientific review of the applications and considering the programme aims, the steering group will prepare a proposal to the programme subcommittee on the projects to be funded. The subcommittee will make the funding decisions in December 2014 at the latest.

The letters of intent will be reviewed by an expert panel composed of members of the steering group and possible other experts. The full applications will be reviewed by an international expert panel.

The applications will be reviewed in line with the Academy's general review criteria for research programmes (see www.aka.fi/eng > Funding & Guidance > Review of applications). Besides these general review criteria, focus will also be placed on the objectives set for the programme, as described in Chapter 2 of this memorandum. This aspect will be considered on the review form under section "Relevance of the project to the research programme".

6. MORE INFORMATION

This programme memorandum is available as a PDF download at http://www.aka.fi/energy > in English.

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