
Sustainable Energy
Systems 2050
NORDIC ENERGY RESEARCH PROGRAMME

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Sustainable Energy Systems 2050: Energy solutions by the Nordic countries

All five Nordic countries have forward-looking political agendas to achieve the 2020 objectives of the European Union for sustainable energy.

Nordic Energy Research is an institution which operates under the auspices of the Nordic Council of Ministers. Nordic Energy Research funds and coordinates energy research and development, and contributes to Nordic political cooperation through providing support to the Nordic Council of Ministers.

The programme for Sustainable Energy Systems 2050 is the latest edition of Nordic Energy Research's main 4-year research programme, and the thematic focus for Nordic Energy Research during 2011-2014. The aim of the programme is to develop Nordic added value through knowledge and solutions for a future sustainable energy system.

With a budget of 100 MNOK (12.5 M EURO)* over 4 years, the programme supports 10 unique and interdisciplinary projects within Renewable energy technologies, Market & Grids and Low Carbon Transport. Each project includes researchers from at least three Nordic countries. In addition to academic partners the programme sees an increased interest from business partners.

* Exchange rate 8 EURO


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CO_2 Neutral Electrolyzed Synthetic Fuels for Heavy Transportation and Electricity Load Balancing

CO_2 Electrofuels

Type:	Industry Project
Project Manager:	Claus Friis Pedersen, Haldor Topsøe A/S, Denmark
Period:	2 years
Partners:	10 of which 8 industry partners

Key Challenge:

Heavy transportation accounts for roughly 50% of the transport related energy demand, leading to a need for reducing CO_2 emissions from the transport sector.

Objective:

Provide the "missing" fuel needed for an import-independent and sustainable supply of heavy transportation fuels in the Nordic region.

Expected Results:

Demonstrating the cost-efficiency and high value of CO_2 Electrofules can directly affect strategic wind power development plans. The project hopes to prove that combining CO_2 Electrofuels with biofuels could be a solution; it would have significant impact on future energy planning.

Nordic Added Value:

Nordic companies and research institutions hold a strong position in synthetic fuel production and applications. The Nordic countries have a stronghold on the "raw materials" for CO_2 Electrofuels, in the form of i.e. renewable electricity and renewable CO_2.

Solar Power Plants in the North

NorthSol

Type:	Industry Project
Project Manager:	Tobias Boström, Research Leader Solar Energy at Norut Narvik, Norway
Period:	2 years
Partners:	4 of which 1 industry partner

Key Challenge:

The use of solar electricity in the North has been limited to small standalone systems at remote locations far away from the grid. To change this it is necessary to develop large scale solar power plants that are suited for the extremely varying sun path and the cold climate conditions in the North.

Objective:

To demonstrate, under real conditions, that photovoltaic power plants can be technically and economically feasible and may become very important in the work to meet the 2020 and 2050 renewable energy goals set up by the EU.

Expected Results:

Building a functioning solar power plant in Piteå delivering electricity to the grid and providing the research partners with valuable measurement data and possibilities to develop and try new innovative solutions and technologies.

Nordic Added Value:

Innovative technologies, practical experiences, planning, installing and using a grid-connected photovoltaic power plant at high latitude will help understand the special conditions for PV power plants in the cold harsh Nordic climate conditions.


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Conversion of Solar Energy to Infrastructure-ready transport fuels using Aquatic Photobiological Organisms as the Hydrocarbon Feedstock Producer

AquaFEED

Type:	Research Project
Project Manager:	Partik Jones, Univsersity of Turku, Finland
Period:	4 years
Partners:	8 of which 1 industry partner

Key Challenge:

Renewable fuel is a minor contributor to the total energy production, despite recent expansion in bioethanol and biodiesel production. Feedstock cost is a major cost component of fermentative biomass-to-biofuel production.

Objective:

To build an aquatic photobiological platform for chemical feedstock production complementing terrestrial biomass. Generate fundamental understanding and novel technical solutions aimed at raising the efficiency and maximizing chances to implement an economically sustainable production system.

Expected Results:

Develop a general platform and technical solutions that will make a strong contribution towards the development of commercial aquatic biomass production. This will also contribute to the development of more direct fuel production systems in the future.

Nordic Added Value:

The results will benefit the Nordic region when it comes to science, economy and environment.


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Wood based Energy Systems from Nordic Forests

ENERWOODS

Type:	Research Project
Project Manager:	Palle Madsen, Forest & Landscape, University of Copenhagen, Denmark
Period:	4 years
Partners:	8 research partners

Key Challenge:

There is an urgent need to develop, improve and optimize renewable, sustainable and cost-effective woody biomass energy systems. The complete energy chain has to be considered when designing bioenergy strategies to maximize climate changes mitigations and security of supply.

Objective:

Strengthen the role of Nordic forestry as a significant contributor to the development of competitive efficient and renewable energy systems. Woody biomass must contribute more to meet fossil independence by 2050 as well as the EU 2020 renewable energy goals.

Expected Results:

Highly productive and cost effective novel as well as modified conventional silvicultural models including recommendations for fast growing tree species capable of significantly increasing the Nordic forests biomass productivity and carbon storage capacity.

Nordic Added Value:

The Nordic added value emerges primarily through (1) scientific collaboration across the Nordic countries, (2) intensive collaboration between scientists and end-users and (3) critical reviews of current forestry practices.

Technology Opportunities in Nordic Energy System Transitions

TOP-NEST

Type:	Research Project
Project Manager:	Antje Klitkou, Nordic Institute for Studies in Innovation, Research & Education, Norway
Period:	4 years
Partners:	4 research partners

Key Challenge:

To meet the 2050 energy and climate policy goals a major transition is needed. This may require fundamental social changes almost reminiscent of an industrial revolution. Therefore industry and policy makers need insights and analyses that will help guide the decision-making process.

Objective:

To guide industrial strategies and governments in making the transition to sustainable Nordic energy and transport systems 2050 and enhance the competitive position of Nordic industries in the international market for clean technologies.

Expected Results:

Development of a methodology to assess the innovative potential of pathways to sustainable energy and transport systems. It can also be used by other stakeholders for other technologies or in different settings.

Nordic Added Value:

Establish a number of guidelines for Nordic policy makers and industrial actors for better informed decisions on Nordic R&D, innovation and industrial development policy, helping them develop and implement effective instruments to achieve the ambitious energy and climate goals by 2050.


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High Efficiency Integrated Solar Energy Converter

HEISEC

Type:	Research Project
Project Manager:	Jyrki Tervo, VTT Tecknical Research Centre of Finland, Finland
Period:	3 years
Partners:	5 of which 2 industry partners

Key Challenge:

Focus on photon enhanced thermionic emission (PETE) in energy production, which was introduced in 2010. It combines photovoltaic and thermionic effects into a single process taking advantage of both the high energy of photons and the available thermal energy due to thermalization and absorption losses.

Objective:

To demonstrate and verify the phenomenon of PETE and study the means to optimize material properties as well as to build a working demonstrator that can be utilized in further research and development. Ultimately the project aims for new solar energy converter technology demonstration including structure, materials and assessment.

Expected Results:

Create a clear vision of the applicability of PETE in energy production and scaling of such methods. It is anticipated that industry driven R&D project will emerge as a result of the project.

Nordic Added Value:

All Nordic countries have a well proven track record for integration of fluctuating renewable energy resources in the power grid, the large scale implementation of PETE in power grid ought to be fairly straight forward.


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Nordic Iniative for Solar Fuel Development

N-I-S-F-D

Type:	Research Project
Project Manager:	Prof. Dinko Chakarov, Department of Applied Physics, Chalmers University of Technology, Sweden
Period:	4 years
Partners:	7 of which 2 industry partners

Key Challenge:

The ambition is to design, develop and evaluate a system that captures solar light and generates renewable chemical fuels from CO_2 and water. Powering vehicles with (photo)synthetic fuels is a plausible scenario for the transport sector because of their relatively easy integration into the present infrastructure.

Objective:

To develop a system that efficiently and cost effectively produces fuels form water, CO_2 and sunlight. This has tremendous potential both economically and environmentally since it solves the problem of limited fossil fuel supply.

Expected Results:

The main result is a system with increased optical absorption and efficiency of photo catalytic synthetic fuel production by new design and materials composition.

Nordic Added Value:

The project will be an international research frontier in the area of solar energy and photocat conversion of CO_2. Forming a collaborative group where each participant brings in complementary expertise opens up for rapid advances and improved products.

Nordic Power Road Map 2050: Strategic choices towards Carbon Neutrality

NORSTRAT

Type:	Research Project
Project Manager:	Ingeborg Graabak, SINTEF Energy Research, Norway
Period:	4 years
Partners:	3 research partners

Key Challenge:

The Nordic region has sufficient RES potential to create a fully carbon neutral electricity system. However, there is no common knowledge basis among Nordic countries on through what policies carbon neutrality is to be pursued.

Objective:

The overall objective is to build knowledge and understanding among politicians, decision makers and actors in the power industry about possible carbon neutral futures for an integrated Nordic power system.

Expected Results:

The ambition is to create a knowledge base about alternatives for future development of the electricity and transport systems in the long term perspective including which governance aspects are necessary to enable the transformation to a carbon neutral region.

Nordic Added Value:

Will provide knowledge on how the Nordic countries can develop into a carbon neutral region and at the same time achieve a high security of electricity supply by combining RES resources into a cost-effective integrated system.


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Prediction Tools for Offshore Wind Energy Generation

OFFWIND

Type:	Research Project
Project Manager:	Jafar Mahmoudi, International Research Institute of Stavanger, Norway
Period:	3 years
Partners:	9 of which 5 industry partners

Key Challenge:

The flow of wind between windmills is influenced by other windmills – both on a small and large scale wind farm. So predicting the interaction between wind farms and turbines becomes important for optimized wind energy production or large installations offshore.

Objective:

The primary objective is to develop tools for advanced operation assessment and forecasting for offshore wind farms. This will lead to optimal localization of a wind farm and how to allocate future farms with respect to each other within the same wind energy cluster.

Expected Results:

To gain insight of resolution in simulation, which will help improve the characterization of wind farms. Better understanding and new methods for wind-wave interaction. Improve short term prediction tool for wind velocity and phase fluctuations.

Nordic Added Value:

All Nordic countries have large coastlines that lend themselves to offshore wind energy farms. In addition the sites have some of the most favorable wind conditions available. There are significant plans for installation of wind energy farms in the North Sea region.


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Smart Transmission Grid Operation and Control

STRONgrid

Type:	Research Project
Project Manager:	Kjetil Uhlen, Norwegian University of Science and Technology, Norway
Period:	4 years
Partners:	12 of which 6 industry partners

Key Challenge:

Meeting the social goals for the transformation of the energy system to a more sustainable state calls for large scale deployment of renewable and variable sources of electricity. In addition, the European energy market is undergoing changes with the intent of creating a common internal market for electricity.

Objective:

The project seeks to address the challenges that the secure and reliable operation of the power grids will face in the future. We seek to establish an interdisciplinary theoretical and experimental foundation supporting the development of better tools for planning, operation and control of power grids interconnected across traditional national boundaries and at various voltage levels.

Expected Results:

The project will develop a research platform comprised by a power systems emulator, PMUs, PDCs and specialized software. The most crucial element to develop is a set of software interfaces allowing PMU-data application development, and implementation.

Nordic Added Value:

Creating innovative applications that will enable operators to operate and control the Nordic power grid more reliably and with better information about security margins.

Nordic Energy Research

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