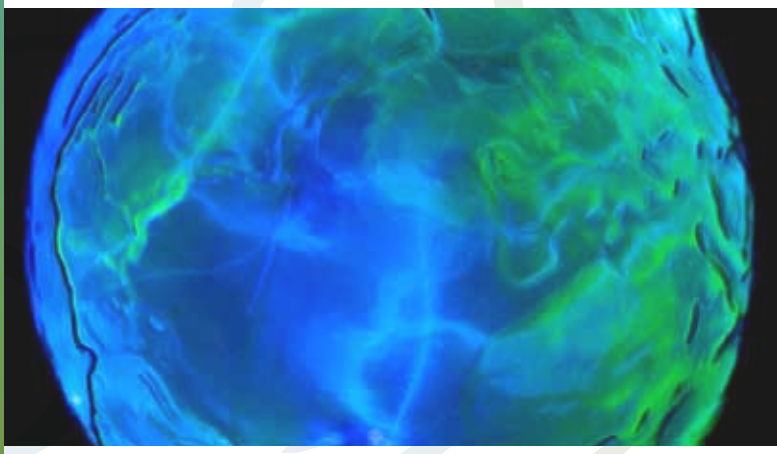
CEDREN

English version

Centre for Environmental Design of Renewable Energy



SINTEF NINA NTNU

CEDREN is one of the eight Centres for Environment-friendly Energy Research (CEER) that was formed as a direct response to the political agreement for a substantial increase in the research and development in the fields of renewable energy in Norway. After a detailed and comprehensive selection process administered by the Research Council of Norway, CEDREN was appointed as a research centre in 2009. The main assessment criteria for the selection of the centres were scientific excellence, relevance and potential for innovation and value creation.

The CEER scheme is an initiative to establish time-limited research centres which conduct concentrated, focused and long-term research of high international quality in order to solve specific challenges in the field of renewable energy and the environment.

CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH

CEDREN

Renewable energy respecting nature

The main objective of CEDREN is to develop and communicate design solutions for renewable energy production that address environmental and societal challenges at local, regional, national and global levels. More specifically, the research is focused on hydro and wind power production and power transmission systems. CEDREN is an interdisciplinary research centre, building integrated knowledge from the technical, environmental and social science into better policies and solutions.

The global climate change is probably the greatest threat to human development and welfare the coming decades. One of the solutions to these global problems lies in research and development of renewable energy sources. However, this development to meet global challenges should not comprise with protection of habitats and biodiversity locally. A key issue is how to operate and develop hydropower and wind power resources in a sustainable way, by balancing the protecting of local ecosystems and the utilisation of natural resources. This will call for a coordinated effort involving a large number of scientific disciplines and co-operation among a wide range of stakeholders in policy, industry and society.

The European Directive on Electricity Production from Renewable Energy Sources will lead to increased use of all renewable energy sources and also require adaptation of the existing energy systems to meet the increased volumes of intermittent sources, such as wind power. Regulated sources with storage possibilities such as hydropower will possibly step into an even more vital role by being the source balancing the total energy production with the consumption. In order to handle more rapid and frequent changes, hydropower will be facing new and challenging technical requirements. At the same time, the impacted ecosystems will meet additional stress unless appropriate mitigating actions are taken.

CEDREN is aiming to develop and demonstrate innovative design solutions for renewable energy production at both national and international levels, and will actively communicate these solutions to authorities, the industry and the general public.

Projects:
HydroPEAK
EnviPEAK
EnviDORR
BirdWind
OPTIPOL
GOVREP

Centre organization

CEDREN has a total budget of more than 250 million NOK for the period 2009-2016. The funding of CEDREN is a joint operation by the public Research Council, the private energy industry and the engaged research institutes and universities. At present, the research activities are organised through 6 projects, with the future ambition of increasing both the volume of projects and widen the scope in order to meet requirements from the industry, the authorities and the public.

The Consortium agreement describes the operation of the Centre and how the General Assembly, The Board and the Centre Management are working together.

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Vision

The climate crisis is threatening the world. Population growth and increased welfare lead to increased demands for energy production. Natural resources are scarce world wide. A large number of species, ecosystems and nature are already threatened by human activities. How can we meet all these challenges? The answer is not simple but rather complex and diverse, but parts of the answer are more *knowledge*. We are not able to find the good solutions without knowledge of the past, present and future possibilities. Knowledge is not going to be the only requirement; we also have to have actions. For instance, we need to enhance the efficiency in energy production, we need to increase the share of renewables in our energy production, we need to mitigate negative environmental impacts of power production and we need political ambitions and implementation of more sustainable interaction between energy and the environment.

Centre for Environmental Design of Renewable Energy (CEDREN) is working and acting in the meeting point of many of these enormous challenges. In order to address the identified problems we know that we have to change and develop our energy system to match future needs. We also know that the aquatic environments and the nature around existing and planned wind power plants and transmission lines are vulnerable. We have to implement *environmental design* in new and old renewable energy projects. Environmental design means that planning, building and operation have to include technical, economical, environmental and social aspects from the beginning. This is the only way to develop future hydropower plants, wind power parks and transmission lines in a sustainable manner.

The problems, challenges and tasks seem multiple and large, but I am sure that we are going to be able to break them down into topics for research and development that will bring us closer to the improved solutions. The research partners have many years of experience in working together and the collaboration will be reinforced and developed further within CEDREN. The solutions are *trans-disciplinary* and we are going to challenge and integrate the knowledge and skills of all partners. We are not able to find applicable solutions without a strong involvement by users from the energy industry and the authorities, but I am sure that many users will be very active and pull together in order to reach our challenging goals.

Good luck!

Atle Harby, CEDREN Director

Photo: Geir Mogen

HydroPEAK

Hydropower development for peaking and load balancing

Future hydropower design

The main objective of HydroPEAK is to develop know-how in order to adapt the Norwegian hydropower system to support and balance the increasing volume of intermittent wind power entering the power system. The highly regulative Norwegian hydropower system has a unique potential to fill the gaps between available production and demand. The ability to act as the regulating unit will become more and more valuable in the future as an increasing percentage of the power will be produced by intermittent sources such as wind.

In order to step into such a position, the Norwegian hydropower system must be adapted to the new technical requirements. HydroPEAK will identify technical constraints, develop and propose technical innovations to adapt both new and existing hydropower plants to the foreseen future production patterns with more rapid and frequent load changes.

HydroPEAK aims at:

- Establishing scenarios for future production patterns
- Identifying technical constraints
- Developing solutions to mitigate and reduce the negative effects of increased variable load
- Developing methods for optimizing operation, maintenance and refurbishment of the hydropower system

The development of knowledge in HydroPEAK is primarily based on a large number of PhD projects.

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EnviPEAK

Environmental Impacts of hydropeaking

Effects of rapid and frequent flow changes

The main objective of EnviPEAK is to develop knowledge and tools to analyse, predict and mitigate environmental impacts from rapid and frequent changes in hydropower production regimes ('hydro-peaking').

Increased electricity trade with Europe and the increased production of wind power is expected to lead to changes in the operation of Norwegian hydropower plants. Future scenarios predict more flexible operation of hydropower systems which may lead to more frequent and rapid changes in water flow and water levels in rivers, lakes, reservoirs and fjords. The main focus is the impacts in rivers. These variations will change the living conditions for fish, benthic animals and other animals and plants living in and near regulated rivers. There is a great need to analyse and predict these impacts, define the tolerance levels and find cost-efficient mitigation strategies.

The development of knowledge will be pursued through laboratory experiments and pilot studies in rivers carefully selected in collaboration between hydropower producers, authorities and researchers. Experiences from the pilot studies will form the basis for the development of basic knowledge and generalized tools for all types of regulations and water bodies.

EnviPEAK will develop:

- Knowledge of environmental impacts from rapid and frequent changes in the operation of hydropower plants
- Knowledge of mitigation measures for the reduction of potential impacts
- Tools and methods to analyse the impacts and mitigation measures
- Guidelines for environmentally acceptable hydropeaking

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Photo: T. H. Bakken/SINTEF

EnviDORR

Enviromentally Designed Operation of Regulated Rivers

Increased power and salmon production

Salmon scientists, hydrologists, hydropower engineers, industry and management join forces in EnviDORR to develop optimal solutions for both salmon and hydropower production in regulated rivers.

The main focus for mitigation in regulated rivers used to be to mimick natural flow conditions. EnviDORR focuses on enhancing positive and reducing negatve effects of river regulation, while maintaining or increasing the power production. To design optimal solutions, it is vital to expand our knowledge on the effects of environmental variables on the different life stages of salmon.

Methods for restoration and improvement of habitat conditions without loss of power production have been used in a few Norwegian rivers. Models show that adaptive hydropower operation will ensure successful spawning, egg (preventing dewatering) and juvenile survival (residual flow patterns). We are also developing strategies to prevent turbine smolt mortality, and in the River Mandalselva strobe lights and optimal diversion of water in the bypass section has increased smolt survival from 10 % in 2003 to 64 % in 2008. Upstream migration solutions are also a major task in the project.

EnviDORR will:

- Collate the best research groups on salmonid ecology, hydrology and hydropower operation models
- Exploit existing data series and models, and develop new models to allow comparison of different design solutions
- Develop optimal solutions for existing facilities, expansions and new facilities, and demonstrate the value of such solutions in selected demo river system

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Photo: morguefile.com

GOVREP

Governance for Renewable Electricity Production

How to combine environmental and energy policy concerns?

The GOVREP project will produce knowledge and policy recommendations that will improve political and administrative practices designed to achieve more sustainable electricity production in Norway and Sweden.

During the last decade we have seen several changes in energy and environmental policies concerning mitigation and adaptation of climate change and management of water resources stemming from different political levels (global, European and national). There is a growing need for electricity in Europe, and it remains a challenge to identify appropriate means for realizing new renewable production capacity while at the same time taking into account environmental and social concerns.

Climate change challenges require changes in European energy use. Solutions based on renewable energy must replace power sources that damage the environment. Although the suggestion of regulated watercourses for electricity production has caused political conflicts, the hydroelectricity remains one of the solutions to the climate change related demands both for Norway and Europe. Moreover hydropower is one of the solutions to ensure power storage and supply and further social development. The GOVREP project focuses on the political management practices, innovation and entrepreneurship in the energy industry. Europe should increase the use of renewable energy, but how can we ensure that this will happen in a way that satisfies both today's and future needs?

GOVREP has social science experts working close together with experts in environmental issues.

GOVREP will answer the following questions:

- In what way the EU Water Framework Directive (EU WFD) bears upon energy policy practice?
- Are small scale hydropower plants necessarily more environmentally friendly than large hydropower plants?
- How can hydropower secure environmentally sound supply of electricity compared to other renewable energy sources?
- How can we better conciliate local, national and global environmental concerns?

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Photo: Stortingsarkivet/foto: Teigens fotoatelier as

BirdWind

Pre- and post-construction studies of conflicts between birds and wind turbines in coastal Norway

Bird-friendly localisation and design of new onshore wind power plants

BirdWind will extend the knowledge of bird behaviour and mortality near wind turbines. Such knowledge is essential to implement focused and efficient measures to mitigate negative impacts from wind power production on populations of different species. The project will also develop technical and methodological tools for mapping and data collection.

BirdWind aims to provide an improved knowledge base and better tools for energy and environment authorities and the energy industry in their efforts to plan, manage and operate new onshore wind power plants. High quality environment impact assessments (EIA) for new plants, and improved sustainable solutions for existing plants, will be of high importance for the power industry and society in the future. BirdWind's research products will significantly enhance our ability to implement climate friendly energy without damaging bird populations.

BirdWind will:

- Develop systems for collecting data about birds near wind turbines: – e.g. radar, surveillance camera, radio-telemetry, terrain modelling, dog search and manual observation techniques.
- Analyse bird mortality caused by wind turbines, with regard to bird manoeuvrability, aerodynamic conditions, hunting techniques, age, migration routes, weather, light etc.
- Develop tools for EIAs, and mitigation procedures for onshore wind power

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Photo: Kjetil Bevanger/NINA

OPTIPOL

Optimal design and routing of power lines in ecological, technical and economic perspectives

Optimal design and routing of power lines

Power lines can be a major threat to some bird populations, and birds short-circuiting power lines and transformers lead to damage and societal costs. Power line corridors can be both harmful barriers and useful habitats for birds and mammals. There is both ecological and economical potential for improved technical and planning solutions in routing and design of power lines. The project will identify high-risk areas for bird collisions, and the infra structure's importance as barriers and habitats for animals.

Using this information OPTIPOL will develop new tools for minimizing negative impacts and at the same time utilize the potential for positive effects for wildlife near power lines. The aim is to provide an improved knowledge base and better tools for energy and environment authorities in their efforts to bring climate friendly energy from power plants to consumers.

OPTIPOL will:

- Develop systems for collecting data about wildlife near power lines – e.g. by using radar and advanced GIS analysis.
- Analyse bird mortality, habitat quality and other positive and negative ecological impacts from power lines.
- Define where and how new power lines can be built, and how existing lines can be adapted for optimal ecologic and economic outcome.
- Develop tools for EIAs, and mitigation procedures for power lines

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Photo: Kjetil Bevanger/NINA

Photo: Karl-Otto Jacobsen/NINA

Partners

SINTEF Energy Research focus on finding solutions related to power production and conversion, transmission, distribution and the end use of energy. We cover all the key areas from the indoor climate and energy use in buildings to gas technology, combustion, bioenergy, refrigeration engineering, market modelling, hydro and wind power production, water resources, environmental impacts and energy politics. SINTEF is the co-ordinator of CEDREN.

Norwegian Institute for Nature Research (NINA) is Norway's leading institution for applied ecological research. NINA is responsible for long-term strategic research and commissioned applied research to facilitate the implementation of international conventions, decision-support systems and management tools, as well as to enhance public awareness and promote conflict resolution.

The Norwegian University of Science and Technology (NTNU) is Norway's primary institution for educating the nation's future engineers and scientists. The university also has strong programmes in the social sciences, the arts and humanities, medicine, architecture and fine art. NTNU's cross-disciplinary research delivers creative innovations that have far-reaching social and economic impact

Other Norwegian research partners:
Freshwater Ecology and Inland Fisheries Laboratory (LFI)
International Centre for Hydropower (ICH)
Norwegian Institute for Water Research (NIVA)
UNI Research

Industry partners:
Agder Energi Produksjon AS
BKK Produksjon AS
E-CO Vannkraft
Eidsiva Vannkraft
Energi Norway
Norsk Hydro Produksjon AS
Sira Kvina kraftselskap
Statkraft
Statnett
TrønderEnergi Kraft AS

Management partners:
Norwegian Directorate for Nature Management (DN)
Norwegian Water Resources and Energy Directorate (NVE)

International participants:
The University of Life Sciences and Natural Resources (Austria)
Royal Institute of Technology (Sweden)
Swedish University of Agricultural Sciences
Stockholm Environment Institute (Sweden)
National Environmental Research Institute (Denmark)
Finnish Game and Fisheries Research Institute
University of Stuttgart (Germany)
University of Lyon (France)
HydroNet Project (Canada)

Norwegian hydro-power as a green battery for Europe

Norway is Europe's largest producer of clean, renewable hydropower. Our hydroelectric adventure dates more than 100 years back in time, and was a vital element in Norway's transformation from a backward society to become one of the world's most advanced countries.

Status as of today is almost 30 000 MW installed capacity, and an annual production of approximately 123 TWh. The system is characterised by a highly flexible capacity – i.e. which in only a few minutes, a hydropower plant is regulated from standstill to full load. In addition, we are well equipped with a large reservoir storage capacity of about 85 TWh, equivalent to half of the total capacity in Europe.

Both national and international climate goals generate a great demand for more renewable energy. Phasing in more unregulated renewables, such as on- and offshore windmills, creates a great need for more balancing power. Increased pumped storage capacity in Norway could be a significant solution: By pumping water up in the reservoir when the wind is blowing, and generate energy when the wind is gone.

A closer connection between wind power and hydropower by establishing a kind of "super-grid" in the North Sea is then necessary, and can give our modified hydropower plants a key role as a green battery for Europe!

In our opinion new and improved knowledge about the environmental consequences in this area is required in order to succeed. The power industry has longstanding traditions in cooperating with various research communities, both nationally and internationally. This tradition of interaction has been particularly elaborated with the research community in Trondheim. Consequently, Norway has some of the best hydropower plants in the world. Still, many of us think that they have a potential for improvement by expanding the installations!

In light of the climate challenge, we observe great opportunities, and through cooperation with dedicated researchers we feel confident that we together will be able to identify sustainable solutions to the challenges ahead.

Our common brainpower will enhance a better interaction between the different types of renewable energy, including hydropower and wind power!

Jan Alne
Chairman of CEDREN Board
Senior Vice President Statkraft Energi AS

Conferences:

June 7th - 8th, 2010 Trondheim, Norway

Renewable Energy Research Conference

Renewable Energy Beyond 2020

www.sffe.no/conference

Conference on
Wind energy and
Wildlife impacts

Photo: Jan Adde © Trondheim kommune

May 2-5 2011, Trondheim, Norway

www.cww2011.nina.no

www.cedren.no

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