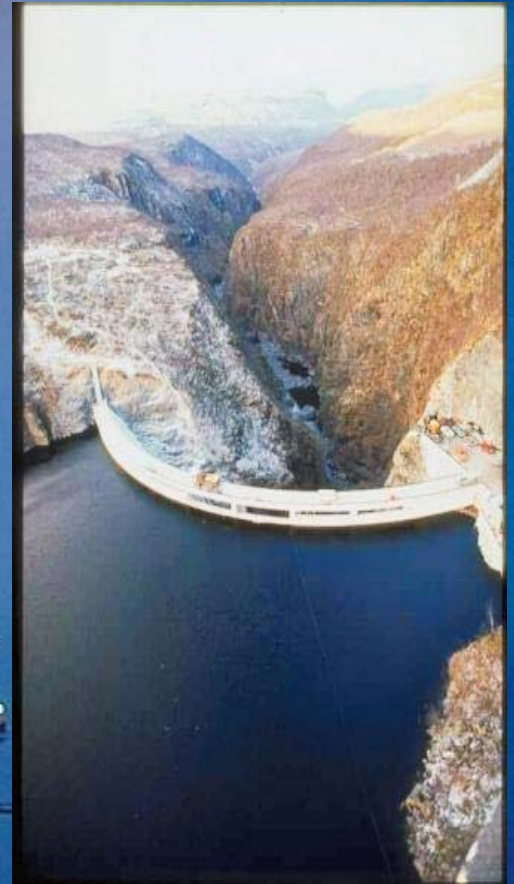


Norway - an energy nation.....

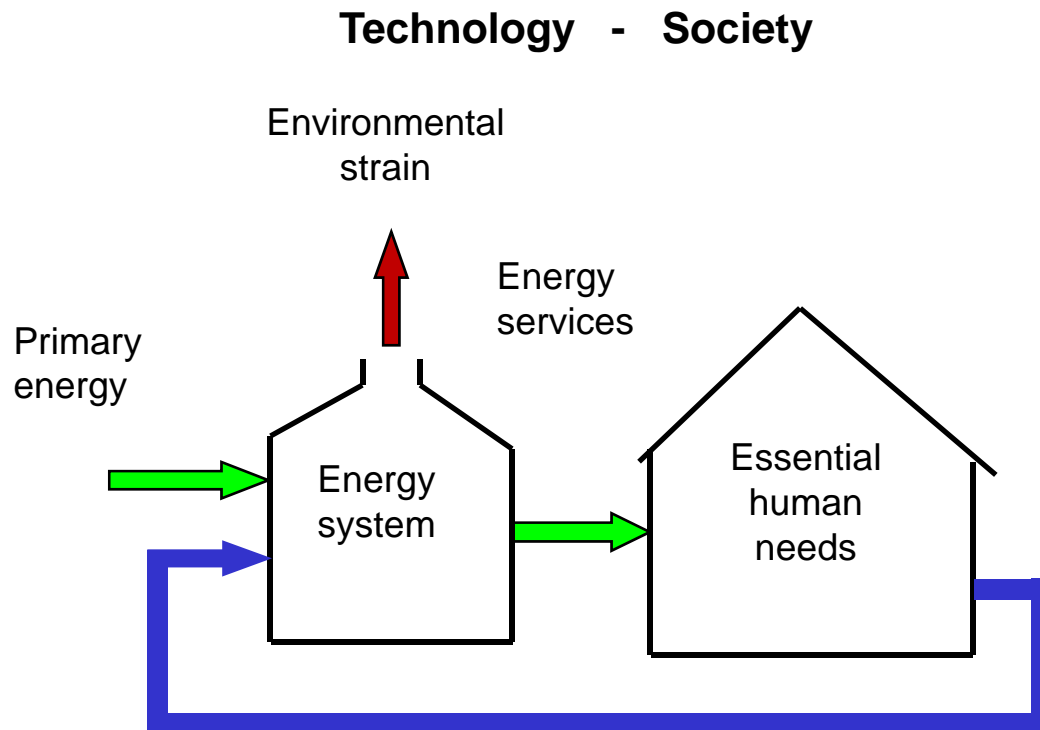


Norway's strategic response to the energy challenges

By Prof. Bjørn Hafskjold, Dean of Faculty of Natural Science and Technology, NTNU

Inaugural Opening of the Peder Sather Center at UC Berkeley, Oct 25, 2012

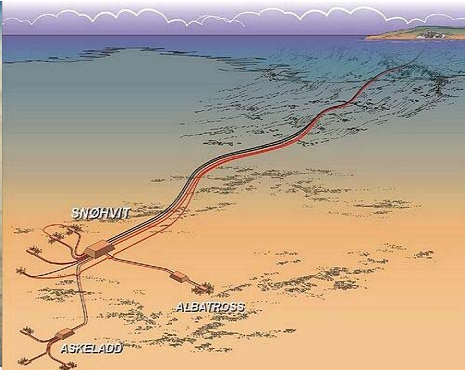
The Global Energy Challenge



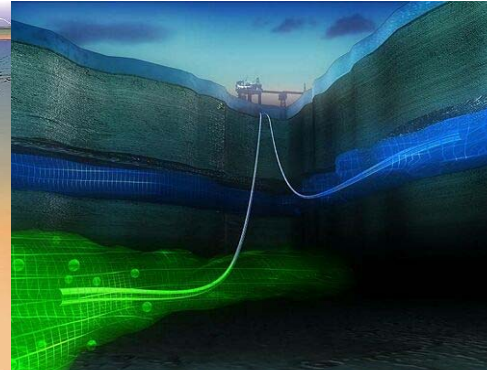
- We rely on energy to provide for essential human needs like FOOD, housing, clothing, transportation, health and recreation, in short what we need to live a good life on this planet.
- By the end of this century emissions of green-house gases needs to be curbed.
- At the same time several billion new citizens may join at the global dinner table.
- How to provide SUFFICIENT amounts of CLEAN energy for a future peaceful and sustainable society is the largest challenge facing humanity?



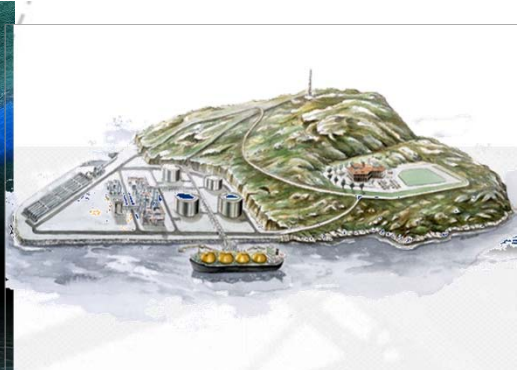
Multiphase flow



**Full subsea field/
remote operation**



Environmental technology



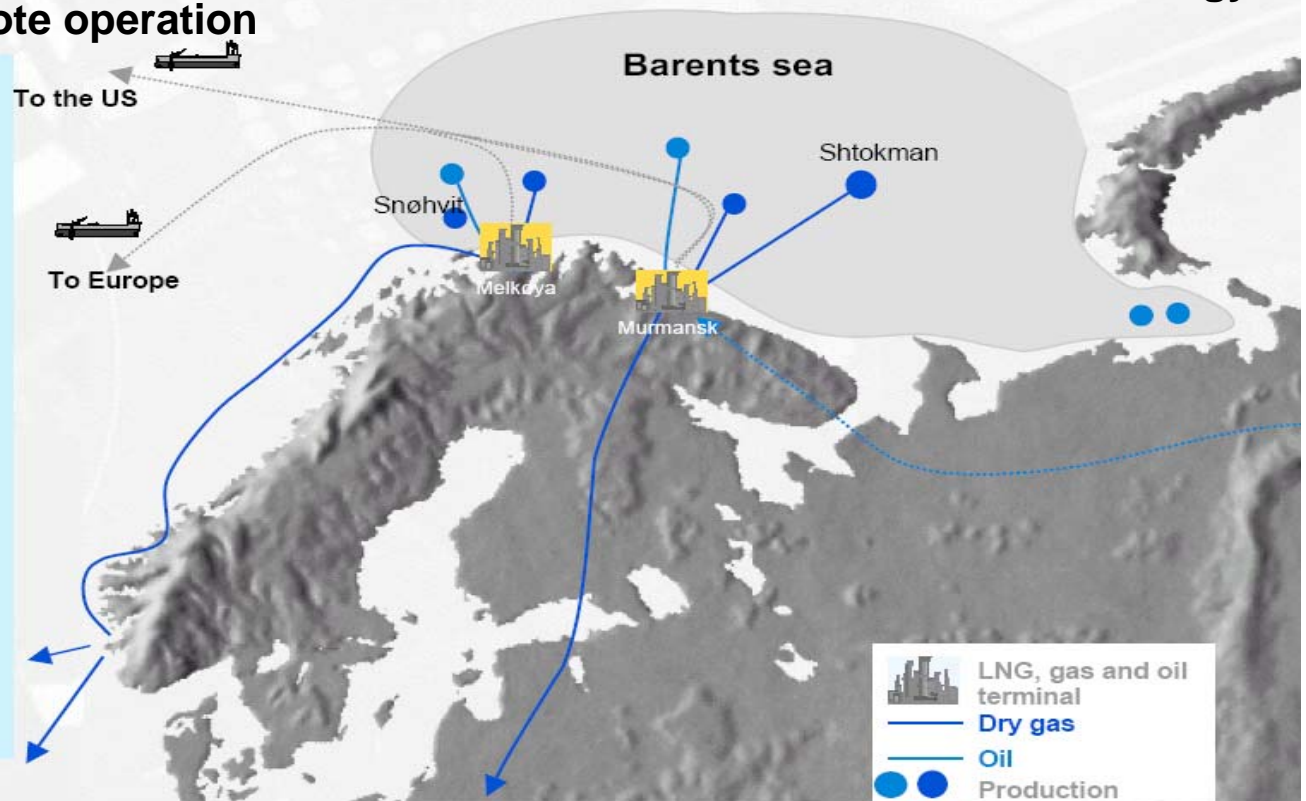
LNG technology

✓ **Barents Sea – the Main Hydrocarbon Province with significant**

- Production
- Field Developments
- Exploration

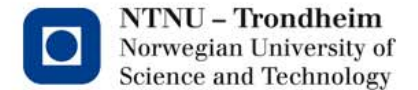
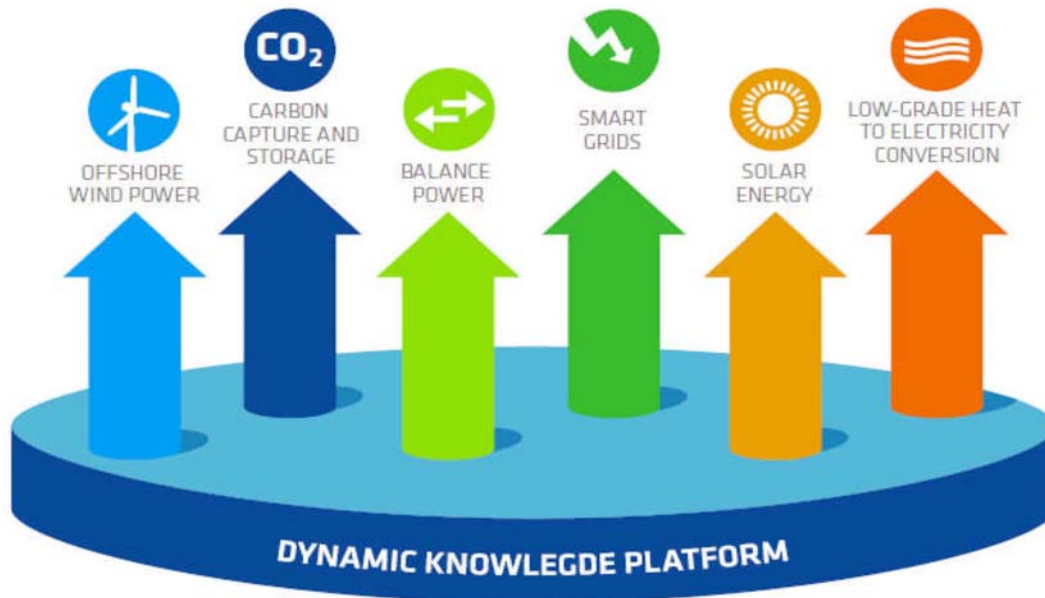
✓ **Oil and Gas export to Europe and US**

✓ **Significant utilisation of NCS transportation network**



National program:

Technology Target Areas



5

Energy research and education at NTNU – Structure

Strategic area: Energy and Petroleum – Resources and Environment

STRATEGIC COUNCIL

MANAGEMENT

CENTRES

Strategic Initiatives

Associated activities

CENTER FOR ENERGY AND SOCIETY

**PETROLEUM
CENTER FOR
BETTER
RESOURCE
UTILIZATION
NTNU-SINTEF**

**GAS
TECHNOLOGY
CENTER
NTNU-
SINTEF**

**CENTER FOR
RENEWABLE
ENERGY
NTNU-
SINTEF-
IFE-UoO**

**CENTER FOR
ELECTRIC
ENERGY AND
ENERGY
SYSTEMS
NTNU-
SINTEF**

**CENTER FOR
SUSTAIN-
ABLE
BUILDINGS
NTNU-
SINTEF**

Carbon Capture and Storage

Hydrogen

Industrial ecology

Study programmes (more than 300 specialists for the energy sector graduate each year)



NTNU – Trondheim
Norwegian University of
Science and Technology



SFFE - Centre for renewable energy

Senter for fornybar energi

NTNU

SINTEF

IFE

UiO



The goal of SFFE:

Increase the quality, efficiency and scope of education, research, development and innovation within renewable energy in Norway.

The strategy of SFFE:

Influence: The Centre participates in the public debate on renewable energy research and innovation and the framework conditions in Norway.

Networking and coordination: The Centre is a platform for national and international cooperation, and coordinates the competence within renewable energy at the member institutions NTNU, SINTEF, IFE and UiO.

Dissemination and information: The Centre is an information resource on renewable energy research in Norway, and works to increase the common knowledge on the subject.

Recruitment: The Centre works to strengthen the educational facilities on renewable energy in Norway, and to recruit young people to renewable energy research and industry.

SFFE coordinates the Norwegian Research School for Renewable Energy (NorRen) www.norren.no

Making key competence and PhD courses available nationally

Exchange of personnel between universities, research institutes and industry

Hydropower

Wind energy

Ocean energy

Solar energy

Bioenergy

Geothermal energy

Energy use and efficiency

Transport

Energy storage

Societal aspects

Energy for development



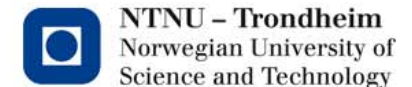
NTNU – Trondheim
Norwegian University of
Science and Technology

Centres for Environment-friendly Energy Research (FME)

Established in 2009 by the Research Council Norway
 Each centre has a total budget of ~ 300 mill. NOK (~52 mill USD)
 over 8 years, (25 % from industry). 175 new PhD and PostDoc started up



- **ZEB** - Research Centre on Zero Emission Buildings, led by NTNU
- **CenSES** – Centre for Sustainable Energy Studies, led by NTNU
- **BIGCCS** – International CCS Research Centre, led by SINTEF Energy Research
- **CEDREN** - Centre for Environmental Design of Renewable Energy, led by SINTEF Energy Research, NINA (Norwegian Inst. for Nature Research), and NTNU.
- **CenBio** - Bioenergy Innovation Centre, led by UMB (The Norwegian University of Life Sciences) and SINTEF Energy Research
- **NOWITECH** - Research Centre for Offshore Wind Technology, led by SINTEF Energy Research
- **Solar United** - The Norwegian Research Centre for Solar Cell Technology, led by IFE (Inst. for Energy Technology)
- **NORCOWE** - Norwegian Centre for Offshore Wind Energy, led by CMR (Christian Michelsen Research)
- **SUCCESS** - SUBsurface CO₂ storage – Critical Elements and Superior Strategy, led by CMR
- **CICEP** - Strategic Challenges in International Climate and Energy Policy , led by CICERO, Fritjof Nansen Inst., and Univ. of Oslo
- **CREE** - Oslo Center for Research on Environmentally friendly Energy, led by the Frisch Centre, Oslo



ZEB - The Research Centre on Zero Emission Buildings

Is led by NTNU, and will develop buildings that emit no greenhouse gases, by studying the entire life-cycle of the building, from its components and materials to its operation.

The centre is involved in a broad range of activities from materials research to research on the building as a whole and its systems, and will develop new materials and components where existing ones are inadequate. Core personnel at ZEB has a long-term cooperation with Lawrence Berkeley National Lab.

WP-1: Advanced materials technologies

WP-2: Climate-adapted low-energy envelope technologies

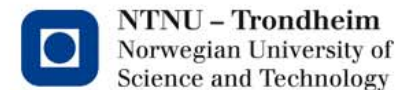
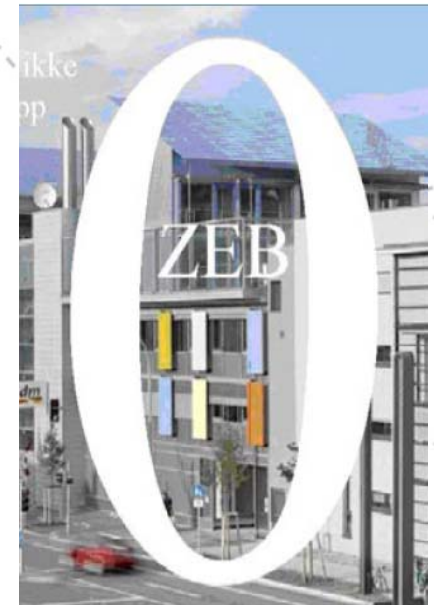
WP-3: Energy supply systems and services

WP-4: Energy efficient use and operation

WP-5: Concepts and strategies for zero emission buildings

<http://www.zeb.no/>

Contact: Centre Director **Arild Gustavsen**
email: arild.gustavsen@ntnu.no



CenSES

Centre for Sustainable Energy Studies

Is led by NTNU, and focus on studies and decision-support systems that will underpin the development of a new sustainable energy system.

CenSES integrates insights from energy economics, energy systems analysis, political science, sociology, innovation studies, technology and scientific studies. UiO is a partner.

1. Policy making and transition strategies
2. Energy systems and markets
3. Economic analysis
4. Innovation, commercialization and public engagement
5. Scenario development

<http://www.ntnu.no/censes>

Contact: Centre Director, Asgeir Tomasgard,
email: asgeir.tomasgard@iot.ntnu.no



BIGCCS

International CCS Research Centre

led by SINTEF Energy Research, and its main objective is to contribute to the ambitious targets in the Climate Act, adopted by the Norwegian Parliament in February 2008.

BIGCCS will enable sustainable power generation from fossil fuels, based on cost-effective CO₂ capture, and safe transport and underground storage of CO₂. NTNU and UiO are partners.

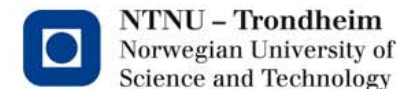
Sub projects:

1. CO₂ Capture
2. CO₂ Transport
3. CO₂ Storage
4. CO₂ Chain
5. Academia

<http://www.sintef.no/projectweb/bigccs/>

NTNU contact: Professor Truls Gundersen

email: truls.gundersen@ntnu.no



The banner features the CEDREN logo in white on a dark blue background. To the right of the logo, there is a decorative graphic of green and blue concentric circles and lines on a lighter blue background.**CEDREN**

Centre for Environmental Design of Renewable Energy



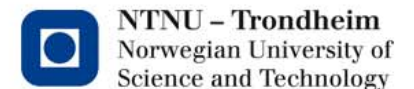
is jointly led by SINTEF Energy Research, NINA (Norwegian Inst. for Nature Research) and NTNU, will further develop hydropower, adapting it to the more flexible energy systems of the future to function in concert with other renewable energy sources.

It is an interdisciplinary research centre for technical and environmental development of hydro power, wind power, power line rights-of-way and implementation of environment and energy policy. UiO is a partner.

<http://www.cedren.no/>

NTNU contact: Vice Director Ånund Killingtveit

email: anund.killingtveit@ntnu.no



CenBio

Bioenergy Innovation Centre



led by UMB (The Norwegian University of Life Sciences) and SINTEF Energy Research. CenBio address the entire value chains of virgin biomass and biodegradable waste fractions, including their production, harvesting and transportation, their conversion to heat, power and biogas, and the handling and upgrade of residues to valuable products.

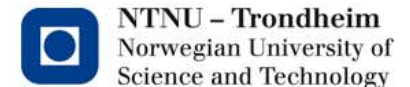
1. Biomass supply and residue utilization
2. Conversion mechanisms
3. Conversion technologies and emissions
4. Knowledge transfer and innovation
5. Sustainability assessments

CenBio researchers will develop effective, environmentally sound ways of utilizing more biomass and waste for energy purposes. NTNU is a partner.

<http://www.sintef.no/Projectweb/CENBIO/>

NTNU contact: Professor Anders Hammer Strømman

email: anders.hammer.stromman@ntnu.no



NOWITECH

Norwegian Research Centre for Offshore Wind Technology

Is led by SINTEF Energy Research. Its objective is to lay a foundation for industrial value creation and cost-effective offshore wind farms.

Emphasis is on “deep-sea” (+30 m) including bottom-fixed and floating wind turbines. NTNU is a partner.

WP1: integrated numerical design tools

WP2: new energy conversion systems

WP3: novel substructures

WP4: grid connection and system integration

WP5: operation and maintenance (O&M) strategies and tech.

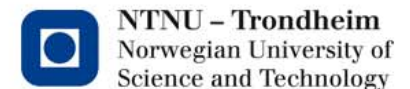
WP6: novel concepts for offshore wind turbines

NTNU is a partner.

<http://www.sintef.no/projectweb/nowitech/>

NTNU contact: Associate professor Trond Kvamsdal

email: trond.kvamsdal@math.ntnu.no



The Norwegian Research Centre for Solar Cell Technology



Solar United - The Norwegian Research Center for Solar Cell Technology, led by IFE (Inst. for Energy Research), joins the major Norwegian scientific and industrial players in the field of PV technology.

WP1: Mono- and multicrystalline silicon

WP2: Next gen. modelling tools for silicon crystallization and subsequent cooling

WP3: Solar cell and module technology

WP4: New materials for next generation solar cells

WP5: Solar cell material and device characterization methodology development

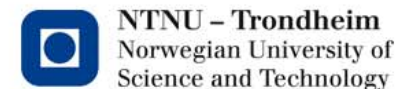
WP6: Value chain demonstration project.

The Centre aims at further developing the strong, Norwegian PV industry and substantially contributing towards making solar energy a significant renewable energy source. NTNU and UiO are partner universities.

<http://www.solarunited.no/>

NTNU contact: Associate professor Turid Worren Reenaas

email: turid.reenaas@ntnu.no





norcowe

Norwegian Centre for Offshore Wind Energy

Is led by Christian Michelsen Research (CMR) in Bergen, and is an interdisciplinary resource centre for exploitation of offshore wind energy as a natural sustainable energy source.

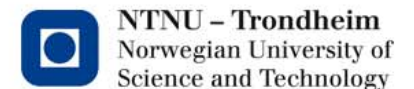
- Met/ocean measurements,
- Wind resource assessment and optimal wind farm layout,
- Models for energy yield predictions,
- Offshore wind energy standards and design criteria,
- Marine operations,
- Operations and maintenance

The vision is to provide innovative and cost efficient solutions and technology for large water depths and harsh offshore environments. UiB, UiA and UiS are partners.

<http://www.norcowe.no/>

Contact: Director, Kristin Guldbrandsen Frøysa

email: kristin@cmr.no





The SUCCESS centre is led by CMR, Bergen, and addresses several important areas for CO₂ storage in the subsurface: storage performance, sealing properties, injection, monitoring and consequences for the marine environment. The “CO₂-School” is in addition a major educational program. UiB and UiO are core educational partners.

WP1: Characterization and response

WP2: Reservoir modelling

WP3: Sealing properties

WP4: Monitoring

WP5: The marine component

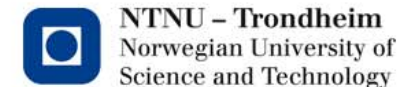
WP6: Operations (INJECT)

WP7: CO₂ School

<http://www.fme-success.no/>

Contact at UiO: Per Aagaard; per.aagaard@geo.uio.no

Contact at UiB: Ivar Aavatsmark; Ivar.Aavatsmark@uni.no



CICEP - Strategic Challenges in International Climate and Energy Policy



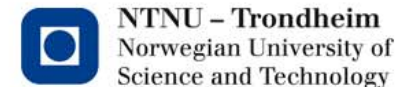
The centre is led by the research center CICERO in Oslo, and will help identify and design realistic international policy options and strategies that can effectively drive the transition towards a low-carbon energy future.

Second, the centre will help determine the consequences of plausible policy options and trajectories for global and European energy and energy technology markets, for major Norwegian industries, and for government strategies. UiO is a partner.

<http://www.cicep.uio.no/english/>

Contact: Research Director: Knut H. Alfsen

email: k.h.alfsen@cicero.uio.no





Oslo Centre for Research on Environmentally friendly Energy



CREE is led by the Frisch Center in Oslo. The main focus is on economic research will collect and develop knowledge on the effects of framework conditions in the energy market and on technological development, including innovation and the diffusion of technology for renewable energy, energy efficiency and carbon capture and storage.

The centre provides a basis for better framework conditions and policy instruments designed to reach the energy and climate goals established nationally and internationally. UiO is a partner.

<http://www.frisch.uio.no/cree/index.html>

Contact: Center Director, Snorre Kverndokk

email: snorre.kverndokk@frisch.uio.no



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Outlook

From NTNU's strategy on internationalization:

- ***Participate in the global knowledge society***
- ***Contribute to the international mobility***
- ***Offer international master- and PhD training***

This implies:

- Establish international strategic alliances, and
- Develop a systematic integration of research, education, and innovation in international partnerships

The Peder Sather Center at UC Berkeley and NTNU seem like a good strategic match.

From the speech by Pro-Rector for Research, Kari Melby (May 2012, Oslo), based on a mapping of possibilities and interest at NTNU's faculties: "Most of our faculties have a large and unexplored potential to develop cooperation with groups at Berkeley. Several groups at NTNU have already a well established cooperation, which goes years back in time. We realize that it is important to support and strengthen these ties, to optimize the potential mutual benefit of the cooperation.

However, another aim for the center is that it should also contribute to investigate and support activities in new fields where we don't have a relation yet. One way to carefully explore new areas of cooperation could be through exchange of high-potential graduate students."

Personally, I think a joint response to the global challenge of providing sustainable energy services to the society would be a very good candidate for cooperation!




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Thank you for the attention!



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