

Til medlemmene av Styret for **CREE - Oslo Centre for Research on Environmentally friendly Energy**

Einar Hope  
Oddbjørn Raaum  
Karine Nyborg  
Taran Fæhn  
Tor Kartevold  
Guro Børnes Ringlund

Fra: Snorre Kverndokk

Kopi: Tone Ibenholt og Einar Wilhelmsen, Forskningsrådet, styrets vararepresentanter. Lars Bergmann, HHS, Ellen Skaansar, NVE, Lars Svindal, Statnett, påtroppende styremedlemer fra 1.7.2015

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**Styremøte i CREE - Oslo Centre for Research on Environmentally friendly Energy**

Det innkalles med dette til styremøte

**9. mars 2015 kl 9.00-11.00**

I Forskningparken, Rom CIENS Terra, Gaustadalléen 21, 0349 Oslo.

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- Sak S-15/1 Godkjenning av innkalling og saksliste**
- Sak S-15/2 Godkjenning av referat fra forrige møte**  
Ett vedlegg
- Sak S-15/3 Presentasjon av nytt styre (fra juli 2015)**
- Sak S-15/4 Evalueringmøtet 4. mars - synspunkter?**
- Sak S-15/5 Orienteringssaker**  
- Seminar i Miljødirektoratet 24. mars  
- CREE workshop 14-15. september  
- Nye prosjekter og søknader  
- Medieseminar i august/september  
- EAERE 2017  
- Status økonomi
- Sak S-15/6 Strategiplan**  
Ett vedlegg
- Sak S-15/7 Årsrapport**  
Ett vedlegg

**Sak S-15/8** **Sammendrag på norsk**  
Ett vedlegg

**Sak S-15/9** **Bør vi ha en egen brukerkontakt?**

**Sak S-15/10** **Eventuelt**  
*Dato for neste møte*

## **Møtereferat - styremøte for CREE S-III.14**

(Sendes til godkjenning på styremøte mandag 16 mars. 2015)

Referat fra styremøtet i CREE - Oslo Centre for Research on Environmentally friendly Energy, kl. 9:00-11:00, 12. des. 2014 på Frischsenteret, Forskningsparken, Gaustadalléen 21, 0349 Oslo.

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Styrets medlemmer som var til stede:

Einar Hope  
Oddbjørn Raaum  
Karine Nyborg  
Taran Fæhn  
Guro Børnes Ringlund  
Tor Kartevold

Fra administrasjonen

Snorre Kverndokk (senterleder)  
Jørg M. Gjestvang (koordinator)

Fra Norges Forskningsråd (NFR)

Ingen

Referent

Jørg Gjestvang.

### **Sak S-14/14 Godkjenning av innkalling og saksliste**

Sak S-14/20 Orienteringssaker flyttet opp til etter sak-14/15

**Vedtak:** Godkjent

### **Sak S-14/15 Godkjenning av referat fra forrige møte**

- Vedlagt: Referat fra styremøtet 23 sep. 2014

**Vedtak:** Godkjent

### **Sak S-14/20 Orienteringssaker**

*Kverndokk informerte*

#### a. Framdriftsrapport 1. desember

- Vedlagt: Publikasjoner og foredrag 2014

Antall rapporterte tidsskriftartikler er relativt likt som i fjor, mens antall Working papers har gått ned. Dette er trolig pga. av at aktivitetsnivået på miljø- og energifeltet har gått ned. Vi ser at også andre samfunnsfaglige miljøer får færre midler på dette området.

b. EAERE-søknaden

Søknaden vil bli sendt fra Oslo 15 des. Styret ba om å få sendt søknaden i forkant av dette til eventuelle merknader.

c. Medieseminar sommer/høst 2015

I forkant av klimaforhandlingene i Paris 2015 vil CREE arrangere et medieseminar. Dette vil være et seminar rettet mot media, med utgangspunkt i CREEs forskning. Vi kommer til å invitere pressen og andre interesserte til noen relevante korte innlegg. Noe av hensikten er å få frem bredden i det vi jobber med og at økonomisk forskning kan gi konstruktive løsninger. Dette ble nevnt som en mulighet av Wilhelmsen i NFR på forrige styremøtet. Styret ga uttrykk for at dette er en god ide og ønsker å bli seg forelagt planer og opplegg på neste styremøte..

d. Andre arrangementer 2015

I tillegg til de normale arrangementer vil vi i 2015 også holde et eget seminar for Miljødirektoratet. Statoil nevnte at de også kan være interessert i et seminar i forbindelse med arbeidspakke 4.

e. Tilbakemelding brukerseminar

- Vedlagt: Respons CREE minibrukerseminar

Vi fikk gode tilbakemeldinger på brukerseminaret. Det ble ytret ønske om at det kunne vare litt lengre med litt større mulighet for å mingle.

**Vedtak:** Styret tar informasjonen til orientering.

**Sak S-14/16 Budsjetten for 2015**

- Vedlagt: Budsjetten 2015 med langtidsprognose

*Kverndokk informerte*

Det ble opplyst om at CREE vil få videreført FME midlene på 0,5 mill. pr. år fra UiO.

Siden NFR tillater oss det og ØI ikke ser et stort behov for flere Post Doc-er, foreslår administrasjonen å omprioritere midlene som var budsjettet til den neste post doc-en til faste forskere isteden. Samarbeidet med Sintef er avsluttet. Dette gir også noen innsparinger. I tillegg kommer det at to av II-erne ikke blir med hele veien til 2019.

Dette gjør at forskerpotten til SSB og Frisch kan økes med ca. 50 %. I tillegg foreslås det å øke tildelingen til ØI med 135.000, tilsvarende frikjøp for en forsker i en måned. SSB og Frisch foreslås å tildeles hver 100.000 til modellarbeid, og IFE vil få økt sin tildeling noe.

Det ble informert at Frisch har satt ned sine timepriser for 2015 etter at budsjettet ble laget. Budsjettet er også satt opp med 100 tusen til ØI, beløpet skal være 135.000. I budsjettet er stipendiaten satt opp med kostnadene ved ØI, de skulle vært ført med Frischsenterets kostnader, noe som tilsvarer NFRs tildeling for en stipendiat.

**Vedtak:** Styret godkjenner budsjettet med de endringer som er nevnt over.

#### **Sak S-14/17 Nytt styre fra neste sommer**

*Kverndokk informerte*

Hver styreperiode er på 4 år, den første går ut 30 juni 2015, dvs. at det skal oppnevnes et nytt styre fra 1 juli.

Styreleder Einar Hope har tidligere meldt sin avgang etter denne perioden. I styringsvedtektene står det:

*Styrelederen bør ikke komme fra de nasjonale forskningspartnerne eller fra brukerpartnerne, men bør framstå som uavhengig av deres interesser. Vedkommende utpekes av vertsinstitusjonen i samråd med de nasjonale forskningspartnere.*

Kverndokk informerte om tre aktuelle kandidater.

Representantene fra de tre forskningspartnerne SSB, ØI og Frisch utnevnes av forskningspartnerne selv. ØI har allerede utnevnt Nyborg til å fortsette, mens den nye vara blir Jon Vislie. Når det gjelder representanter for brukerpartnerne, ønsker administrasjonen å involvere noen av de partnerne som ikke hadde sittet i styret til nå.

**Vedtak:** Styret tar informasjonen til orientering.

#### **Sak S-14/18 Oppdatert strategiplan**

- Vedlagt: Ny strategiplan

Styret ønsket et avsnitt om hva man hadde lært til nå og hvordan man vil bruke lærdommen videre. Her kan spesielt nevnes hvordan man har jobbet med involvering av brukerpartnerne og deres opplevelse av dette. Statoil ønsker et møte om dette i begynnelsen av 2015. Tor Kartevold tar kontakt om dette.

Det bør også nevnes at pga. reduksjon i finansieringen til miljøene knyttet til CREE har aktiviteten gått ned. Det savnes en diskusjon av konsekvenser av dette og hva man kan gjøre for å forbedre situasjonen. Her kan man også nevne internasjonal finansiering.

Det bør også nevnes utfordringene med NFR sin satsing på Kompetanseprosjekter for næringslivet (KPN), dvs. prosjekter som krever finansiering av andre aktører. Bør også ha med at CREEs hovedfokus er vitenskapelige publisering.

En ide om at det også tas med hvordan vi tenker oss at fotavtrykket etter CREE skal være og hva vi ønsker å påvirke.

**Vedtak:** Styre ber administrasjonen utarbeide en revidert strategiplan hvor de overnevnte temaene er inkludert, til neste styremøtet.

#### **Sak S-14/19 Arbeidsplan 2015**

- Ettersendt: Arbeidsplan 2015

Kverndokk informerte om at han ikke hadde fått inn all informasjonen. At dette vil bli utarbeidet og sendt til NFR før 31 des.

Styret ga uttrykk for at det var en imponerende liste med faglige arbeider. De savnet en setning om finansiering i innledningen. Dette er en arbeidsplan for 2015, styret opplevde det som noe forvirrende at det også var tatt med hva som ble avsluttet i 2014. Bør tydeliggjøre skille mellom hva som er avsluttet og hva som skjer fremover

**Vedtak:** Styret tar den foreløpige arbeidsplanen til orientering og ber administrasjonen ta hensyn til de momenter og forslag som kom til uttrykk under styremøtet.

#### **Sak S-14/21 Skal vi skrive norske sammendrag?**

I forbindelse med et prosjekt på SUM ble det sendt ut et tosidert sammendrag. Bør CREE lage flere slike? Dette vil kunne gjøre CREEs forskning mye mere tilgjengelig for brukerne og andre.

Styret ga uttrykk for at dette ville være en god ide. Å fremstille skrevne forskningsartikler på norsk i en kort og populærvitenskapelig artikkel vil kunne være disiplinerende Det vil også kunne utvikle en lettere måte for brukerne og media å orientere seg om hva CREE driver med.

Dette kan gjøres i sammenheng med årsrapporten

**Vedtak:** Styret ber CREE administrasjonen om å gå videre med ideen.

#### **Sak S-14/22 Eventuelt**

Dato for neste møte:

Neste styremøte blir mandag 16 mars 2015 kl 9:00-11:00 på Frischsenteret.

Einar Hope

Oddbjørn Raaum

Karine Nyborg

Taran Fæhn

Guro Børnes Ringlund

Tor Kartevold

February 2015

## **Strategic Plan for CREE – Oslo Centre for Research on Environmentally friendly Energy: 2015-2019**

This strategic plan is intended as a long-term management document for CREE for the final five years of activity, i.e., from summer 2015 to summer 2019, given that CREE get funding for the last three years (2016-19). It is based on the Strategic Plan for 2011-2014 which is an appendix to this plan. The Strategic Plan for 2011-2014 is still the underlying document, and the board has extended this plan to summer 2015. The new plan will, therefore, mainly evaluate the first period, describe strategies for improvements and the changes in research organization and focus for the last years.

### **1. Vision**

As stated in the Strategic Plan for 2011-14, the centre has the following vision for its entire period:

- We want to be a leading international research centre within energy, environmental and resource economics.
- We will generate knowledge that can contribute to a cost-effective and sustainable exploitation of Norwegian and international energy resources by industry and governments, as well as an effective and fair climate and energy policy, both nationally and internationally.
- We will contribute to recruitment and training at the master, doctoral and post-doctoral levels in energy and environmental economics at the University of Oslo. Recruiting women to research will have a particular focus.

### **2. The footprint of CREE**

Based on the vision above, the plan is that CREE research will make footprints after 2019 both when it comes to the research community and for the society at large.

CREE researchers have published extensively in leading field journals as well in general economic journals. We hope that these contributions will have an impact on research also after 2019 by contributing to the future research agenda.

CREE participates broadly in the public debate on climate and energy issues. Our expectations is that this will have an influence on Norwegian energy and climate policy, and that we will contribute to a better understanding of energy and climate issues in the general public. We also believe that the novel insight achieved by our research will help industry in making better decisions for instance decisions that can help us in the transformation to a carbon free society, which is required at the end of this century if the two degree target should be reached (see the latest IPCC assessment reports).

### **2. Achievements of the first 3 years of CREE**

Since the start of the centre in 2011, we have made progress in several areas that we think are important for expanding the knowledge base in the field:

- Better collaboration between the research partners
- Better contact with users
- More multidisciplinary collaboration
- More media activity
- Made new contributions to PhD courses
- Improved the quality of research

The collaboration between the research partners has become very close since the start of the centre in 2011. The Norwegian research partners – and in several cases also the Dutch - collaborate on most research proposals, papers and seminars. The annual research workshop is a meeting place for all national and international researchers who are connected to CREE as partners and subcontractors. The collaboration with users is also much more organized, fruitful and concrete than before due to the regular meeting places. For instance, several Norwegian ministries and agencies have during the recent years made use of our competence.

As we have several subcontractors connected to CREE, we have also much more contact and collaboration with other disciplines, such as technology researchers (IFE and SINTEF Energy), social anthropologists (SUM) and law (University of Oslo). We have also given PhD courses at multidisciplinary research schools, and we are very active in the media, including interviews, debates and chronicles, as much of our research is policy relevant.

The quality of our research publications has increased measured by the quality of journal publications. While most research in energy- and environmental economics are published in field journals, we have been successful in publishing in general economic journals as well as the top 5 economic journals. Examples of the first category are *Scandinavian Journal of Economics*, *European Economic Review*, *Journal of the European Economic Association*, while examples of the latter category is *American Economic Review*, *Review of Economic Studies* and *Journal of Political Economy*. In addition we have also published several papers in the highest ranked field journals such as *Journal of Environmental Economics and Management*.

New models are developed that are important for our research. These include the energy market model LIBEMOD, the petroleum market model PETRO2, and a series of general equilibrium models SNoW.

Based on this, we think we are closer to the primary aims of providing better knowledge in the debate on climate and energy issues, and to be a leading international research centre. However, there are also areas of improvements, which will be the focus of this strategic plan.

### **3. Areas for strategic improvement and adjustments for the final period**

There are two areas that can be improved for the final period; user involvement and multidisciplinary cooperation.

#### *3.1 User partner involvement*

CREE has user partners from both governmental bodies and industry. The communication with the user partners takes place through different channels such as regular user partner conferences, seminars and workshops, the Model Forum where modelling of energy markets



and environmental/technological policy tools are discussed, meetings and joint research proposals. In addition to this, our research, media activity, seminars etc. are documented on our webpage ([www.cree.uio.no](http://www.cree.uio.no)).

The user partners are mainly involved in strategy work and annual work plans through the board of CREE, where two of the board members come from the user partners, and through input to our research at seminars and meetings.

User partners contribute to our research by supporting data and information that are implemented in our economic models, comment on the relevance of our research, and also hopefully through joint projects. The policy of the Research Council of Norway is to include user partners from industry and governmental agencies in Knowledge-building Projects for Industry (KPN) by letting industry fund parts of the project and also contribute to the research questions. This is one of the priorities for CREE in the coming years.

It is hard for user partners to be directly involved in our research as this requires experience with methodologies and knowledge of economic theory that most of our user partners do not have. Thus, we do not have mutual personnel mobility between user partners and research institutions.

Several users have access and actively use our research, methodology competence and analyses. They are not formal user partners, either because they do not want to be associated with single FMEs or because they establish and maintain relations with the CREE centre in other ways. Examples are ministries (FIN, KLD), Office of Auditor General of Norway and the statistical production at Statistics Norway.

Our experience for the first four years is that the contact between researchers and user partners has not been as good as expected. The communication channels may not be good enough, and we experience that the main channel of information about research, seminars and media activity, namely the webpage ([www.cree.uio.no](http://www.cree.uio.no)) is not often used by user partners. While some of the user partners have been quite active at seminars and meetings and have been interested in organizing CREE seminars, other user partners have been more passive. User partners have only to a small degree initiated joint projects or suggested research topics, and we have not been able to establish KPN projects.

The picture is not only negative. We have been successful in establishing fruitful connections and mutual gains with ministries and other public agencies. Our research is policy relevant and applicable for policymakers, as we contribute to Governmental reports, IPCC, hearings, meetings, seminars etc. However, we have not yet achieved the same level of mutual gains/synergies in relations with industry partner companies. One reason may be that a large part of the topical research ideas and knowledge gaps in social sciences are not particularly relevant for private companies. Examples of this may be policy choices from a social point of view and typically takes the perspective of policy makers. However, there are areas that should be relevant for industry partners, such as analysis of markets, decisions under uncertainty and effects of policy measures for different sectors.

### *3.2 Strategies to strengthen user involvement*

CREE has organized several seminars at the user partners and other stakeholders. However, most of these seminars have been organized for governmental bodies. In the final years the

aim is to give seminars for the user partners that have not been on the list yet. Thus, this also includes industry partners.

We will continue to have communication with the user partners at our regular user partner seminars and conferences. Our experience has been that user partners have been satisfied with these meeting places.

To improve the contact with user partners, one possibility is to establish a user partner contact at CREE, who has the main responsibility for the contact. So far, the responsibility for the user partner contact has been with the centre director, who also is responsible for all the other activities at the centre. A user partner contact may be able to spend more time on improving the contact between users and researchers.

In addition to this, one possibility could be that a CREE researcher visits the user partners for a certain time period. This will give possibilities for mutual exchange of ideas that may also lead to research projects.

One feedback from user partners is that our research is a bit hard to access. To improve this, from 2015 we have started to include a popular summary in Norwegian for all our working papers published in the CREE working paper series.

The information on new research should improve. The plan is to send out e-mails on new research four times a year to all followers of CREE research including user partners.

To improve user involvement in research, we think that the best way of doing this is to apply for funding from Knowledge-building Projects for Industry (KPN) at the Research Council of Norway (RCN). We have invested much effort in building networks and creating suitable projects for this purpose, and have involved users in many projects and project proposals, but so far we have not succeeded to establish a full KPN with 20% funding from users, whereof minimum 10% funding from a private company. We will continue working to try to involve industry in KPN projects in the future.

### *3.3 Multidisciplinary cooperation*

The second area that can be improved is the multidisciplinary cooperation. CREE has several user partners from different that contribute to the research in several of the research packages. In WP1, we have cooperation with political scientists at CICEP as climate negotiations and treatments are of special focus in both centres. The technology institutes have mainly contributed to the numerical modeling of energy markets (WP2 and WP5), while social anthropologists are involved in evaluation of policy measures (WP4). We have also been successful in starting a new cooperation with psychologists, particularly on experiments and behavioral economics. We also have lawyers as subcontractors, and we have got funding for a project (ENERGIX) where we will have close collaboration with them. Efforts taken to strengthen links between the different fields have mainly resulted in applications for joint research projects. Much effort has been spent on this the last few years.

When it comes to cooperation with other FMEs, our main contact is CICEP. This is mainly due to common research subjects as well as geographical proximity. We coordinate with CICEP our annual user conference that is held in April every year. Some research cooperation has been undertaken, and we have submitted several research proposals to the Research

Council of Norway. Further, we contribute to the research school of all the FME centres; NORREN, and we have organized several workshops with CenSES on numerical energy market models with the aim of establishing closer contacts. Note that our subcontractors IFE and SINTEF Energy are also partners in CenSES.

However, while we have a closer contact with other fields through our subcontractors, we still could improve our collaboration by writing joint papers.

### *3.4 Strategies to improve multidisciplinary cooperation.*

Economics in itself is in many ways an interdisciplinary field as it uses methodologies from mathematics and statistics. In addition to this it also uses knowledge from different fields when studying for instance behavior, ethical questions and innovation. However, funding from RCN often requires multidisciplinary cooperation to be successful in research proposals, and not interdisciplinary approaches. This means that researchers from other fields than economics should also be included in the proposal to be successful.

Multidisciplinary research is a process that takes time. The best way of having a multidisciplinary cooperation is to involve subcontractors in research proposals, and this will be the strategy for the coming years. Being involved in a specific project requires much more direct contact than just presenting at the same seminars.

## **4. Challenges for the final period**

We see two main challenges for the final period; the potential tradeoff between **research that may be useful for users** and academic research, and the possibilities for funding.

### *4.1 The potential tradeoff between user relevant and academic research*

The first challenge is the potential conflict between internationally relevant social scientific knowledge gaps and the knowledge needs of domestic stakeholders. To be a leading international research centre, we need to show our competence by publishing in leading international research journals. This requires research that is quite general in its analysis and the methodologically used should be transparent. Also, this requires a lot of time to be spent on analyses that may not necessary change the conclusions of the work, for instance to make elegant formal proofs, to do many empirical tests and to run several sensitivity analyses. On the other hand, stakeholders often demand more detailed analysis that are not necessary interesting for a broader research audience, and may also not have the competence to go into detail about the methodology. They may not also be willing to fund the time that is necessary for good academic journals. Such reports may be harder to publish in good journals. There are of course exceptions to this. Econometric works are based on real data and may be useful to users. Top journals also publish a high number of econometric papers. Pure theoretical papers, on the other hand, are also published in these journals, but are probably of less interest to users.

### *4.2. Strategies to meet the potential tradeoff between user relevant and academic research*

As mentioned above, being a leading academic research institution may be hard to combine with doing applied research that may be considered relevant for users. The best way to meet

both requirements may be to divide our portfolio in different projects such as research projects, KPN and Governmental reports. Thus, this means that we should be active in applying from different sources of funding. We think that the strategies mentioned under paragraph 3.2 above may help to be successful in this.

#### *4.3 The possibilities for funding*

The main challenge for CREE is the external funding for the final period. Funding for environmental and resource economics (and in general funding for social science on environmental and energy projects) seems to follow cyclical fluctuations. Our external funding from the Research Council of Norway has decreased, and we experience that we have less success with our research proposals than we had when the centre started (from an acceptance rate of about 50% to 10-20%). This is particularly true for climate research, while the success rate has been higher for energy research. In our opinion this is not due to a lower relative quality of our research, rather the following aspects may be relevant:

- There has not been a real increase in funding of climate and energy research
- More disciplines than before compete for these funds
- Calls for research proposals are much more specific than before (e.g., ENERGIX)
- There has been much more focus on technology in the calls
- A larger proportion of the announced funds require co-funding from industry, which makes it harder for social science research
- One main objective of the research policy in Norway is that research should be industry relevant and increase industry competitiveness.

Based on the lack of external funding, the number of CREE working papers has been significantly reduced from 2013 to 2014. The lower activity follows from the fact that more time is devoted to writing research proposals, and that some of our researchers have also started working in other fields. Thus, a big challenge for the centre is to ensure a stable funding of our activities.

#### *4.4 Strategies to increase external funding*

As our funding from RCN has declined over the last few years, CREE should actively apply from funding from other sources. KPN has been mentioned already. In addition to this, we should search for international funding from for instance the EU and Nordic Energy Research. Important steps have already been taken in this direction as we will coordinate a proposal to HORIZON 2020 and has submitted a preproposal to the Nordic Energy Research Flagship projects. We will continue to work on this in the final period of CREE.

### **5. Strategies for the research subjects and work packages**

Much of the state-of-the-art of the research topics for the centre is described in the latest IPCC assessment report working group III: Mitigation of Climate Change, which was published in 2014, and where several CREE researchers were involved. In brief, this report states that we have a carbon budget if we want to limit the concentration of greenhouse gases (GHGs) at a level that fulfills the 2 degree target; we need to reach a carbon free society at the end of this century. One important challenge is that emissions are increasing fast in upper middle income countries, countries that so far have limited regulations on GHG emissions and are not included in the Kyoto Protocol. Global poverty reduction has led to higher GHG emissions.

However, 40-70 % reductions in GHG emissions are necessary by 2050 if we want to be on track for the 2-degree target, meaning that most fossil fuel reserves should stay in the ground. Model simulations with CGE models and other macroeconomic models show that this does not have to be expensive, but there are still barriers such as transition costs and distributional effects. Anyway, to reach this we need to have an increased electrification of the economy, a decarbonization of the power sector, possible land use changes, use CCS, be more energy efficient, and to plan infrastructure investments. Therefore, innovation and urban planning are important. Further, when it comes to climate agreements, game theoretical models are still pessimistic about the outcome of negotiations. Thus, there seem to be need for institutional changes to reach a significant agreement. Finally, ethical questions have received much more attention, especially in studies of climate agreements, the last few years.

Nationally, the research challenges we face are the same as for the international community. CREE researchers are on the research frontier in energy- and climate economics, and we want to follow up the challenges pointed out by IPCC. Our future research agenda will, however, be dependent on external funding. As the competition for funding is much harder than when the centre started, we expect to have less degrees of freedom in future research.

One main activity during the first four years has been to build our numerical models to make them available for studying important research questions. These models are now mostly available, and will be actively used in policy analyses during the last years of the centre funding.

WP1 (The International Politics of Climate and Energy) has been the working package with the largest activity during the first four years of activity. We still think that this will be the biggest working package for the last four years as most of our researchers are involved in climate issues, but the plan is that the funding and the use of resources on the different working packages will be more even after the first four years. Our experience the last three years is that it is harder to get funding for climate projects than for energy projects, and this will also lead to less focus on activities that fall under WP1. We do not intend to expand the number of working packages, but new ideas will always come up that will be included under the existing umbrella of working packages. Good communication with user partners and sub-contractors within the meeting places established by the centre, and the new strategies described above, will be important for the generation of research ideas.

## **Appendix**

### **Strategic Plan for CREE – Oslo Centre for Research on Environmentally friendly Energy**

This strategic plan is intended as a long-term management document for CREE. Below we describe the general vision, aims and strategy for the centre with an emphasis on the three first years of activity, i.e., from 2011 to summer 2014.

#### **1. Vision**

The centre has the following vision:

- We want to be a leading international research centre within energy, environmental and resource economics.
- We will generate knowledge that can contribute to a cost-effective and sustainable exploitation of Norwegian and international energy resources by industry and governments, as well as an effective and fair climate and energy policy, both nationally and internationally.
- We will contribute to recruitment and training at the master, doctoral and post doctoral levels in energy and environmental economics at the University of Oslo. Recruiting women to research will have a particular focus.

#### **2. Aims**

The centre's aim is to satisfy the Research Council's success criteria for the FME Centres for Social Science-related Energy Research (FME Samfunn). These criteria are documented in the governing documents from the Research Council ("Requirements and Guidelines" and "Information for applicants for the announcement of the Research Centres of green energy within the social sciences (FME Society)"). Thus, we adopt these criteria as CREE's long term aims:

##### **Research activity**

- The centre has a distinct research profile, conducts long-term, thematically relevant research of high international calibre in the field specified in the project description, and demonstrates this through its production of doctorates, scientific publications, papers for presentation at recognised international conferences and other measures of scientific excellence.
- The centre utilises a multidisciplinary approach in its research activities; i.e. it forges close links between various subject areas within the field of social science. The centre also strengthens the links between social science-related energy research and technology-related energy research.
- Researchers from the host institution and research partners participate actively in the centre's research.

##### **Relevance and benefit to users**

- The centre participates visibly in national and international arenas in which energy and climate-related questions are discussed.
- The centre has implemented measures to ensure that the expertise and results achieved by the research activity are effectively transferred to and utilised by the user partners, and actively disseminates research results to broader user groups and the public at large.

- The centre has achieved reciprocal mobility of staff between the centre's partners.
- The centre's user partners have increased their research commitments over time through participation in the centre's activities.

### **Internationalisation**

- The centre has been successful in achieving recognition at the international level (e.g. researchers associated with the centre have received awards or been invited to be keynote speakers at international conferences).
- The centre has been successful in international research cooperation, e.g. as a player under the EU's framework programme.
- The centre engages in active and binding collaboration with international research groups and has contributed in other ways to the internationalisation of Norwegian research. The centre has at least one recognised international partner.
- The centre attracts outstanding international researchers, including research fellows and senior staff, as visiting researchers.

### **Researcher training and recruitment**

- The centre has an effective framework in place for researcher training, and helps to train highly skilled personnel in the centre's areas of specialisation.
- The centre is actively engaged in education, especially at the master's and doctoral levels, and promotes recruitment to the centre's subject areas, including increased recruitment of women.

### **Partners and funding**

- The centre receives long-term funding from the host institution and partners.
- Active efforts are made to attract new partners.
- The centre has been successful in securing other external funding.

### **Organisation**

- The centre has a visible profile, a strong identity and a successful collaboration with its partners.
- The centre is organised in a manner that is well adapted to the host institution's organisation.
- The centre has a board and management which ensure that the intentions and plan for the centre are followed up.
- The centre has a common administration with a high degree of scientific and administrative autonomy.

## **3. Partners and cooperation**

A major aim of CREE is to facilitate cooperation between the research partners, as well as with researchers in other countries and in other disciplines. Such cooperation is essential for reaping economies of scale and scope and for realizing the research ambitions set out above. Establishing and maintaining cooperation between researchers across different institutions, different countries and, especially, different disciplines, is very demanding. It requires an institutional framework, a well-functioning administrative apparatus and sufficient funding for bringing researchers together. Below we detail how CREE will contribute to overcoming hurdles to successful cooperation, as well as bringing other benefits, such as more systematic contact with users and recruitment of researchers to the field.

The three national research partners of CREE constitute a large share of the researchers working in the field of environmental and energy economics in Norway. At the same time, each of the institutions has its own unique competence. The Department of Economics has its main strength in theoretical research and the Frisch Centre in modeling international energy markets, whereas the Research Department at Statistics Norway has long experience in developing large macroeconomic and energy market models. All the partners have considerable experience with empirical research, and both the Frisch Centre and the Research Department at Statistics Norway have built a strong competence in the analysis of Norwegian register and survey data. Also, the Frisch Centre and the Department of Economics run a laboratory for experimental economics.

While there is already cooperation among the Norwegian partners, CREE will facilitate a deepening of this by providing resources and an organizational structure for collaboration both within the community of economists and with the wider research community. The field of energy and climate is naturally multidisciplinary, making it important for CREE to be closely integrated with researchers in other social sciences, law and technology. As multidisciplinary research is more resource demanding than research within a given discipline, CREE will be an important factor for success in this respect.

CREE will be part of MILEN, the University of Oslo's interfaculty research network on environmental change and sustainable energy. To facilitate interfaculty and multidisciplinary research, MILEN aims to improve the competence of university researchers in working across disciplines, and will organize cooperation at workshops, seminars and conferences, as well as through the development of multidisciplinary courses at the PhD and master's level. We will work together with MILEN to organize seminars and workshops, and present our PhD students and researchers to the multidisciplinary environment and methods that MILEN represents.

Researchers from MILEN will also actively participate within CREE. From the network, we will draw on researchers from social anthropology, law and political science. From the discipline of social anthropology, SUM – the Centre for Development and the Environment, will participate. The centre has long experience on topics related to sustainable consumption, which is relevant for understanding behavior when evaluating policy instruments. In addition, we will work closely with the research group in Natural Resources Law at the Faculty of Law. The group's activities are multidisciplinary and comprise research on natural resources, energy, environment and property. Law expertise is crucial in gaining an understanding of topics studied at CREE such as international energy and climate policies, innovation and policy instruments. Further, to achieve a better understanding of politics, political science is important. Since the political scientists in the MILEN network are involved in CICEP (Strategic Challenges in International Climate and Energy Policy) another FME funded by the Research Council, we have agreed with CICEP to establish a formal cooperation between the two centres, which means arranging joint workshops, seminars and graduate courses. This may also lead to joint research papers. Lastly, we are also in contact with the Department of Psychology. We share a common interest in behavior economics, and hope that they will be a discussion partner on our future research in that field.

Collaboration with experts on technology is also important if we want to perform relevant energy research. Therefore, we have engaged SINTEF Energy Research and IFE (Institute for Energy Technology) as subcontractors. SINTEF Energy has a long experience in modeling electricity markets and IFE possesses a deep knowledge about different technologies, e.g.,



through their development and use of the energy system models MARKAL and TIMES, which have been developed in a cooperative multinational project over a period of almost two decades by the Energy Technology Systems Analysis Programme (ETSAP) of the International Energy Agency (IEA). SINTEF Energy, IFE and the University of Oslo are already involved in existing technology FME centres. Based on these channels, we will keep in contact with these centres to be informed about the latest international trends within technological development and the energy markets.

Tilburg Sustainability Centre (TSC), a new multidisciplinary centre hosted by Tilburg University, working on topics such as environmentally friendly energy, innovation and international environmental agreements, is engaged as our international partner. While the national partners have collaboration with researchers at TSC, CREE will strengthen and extend this contact, as well as give Norwegian researchers access to the multidisciplinary sustainability network in Tilburg and give Dutch researchers access to the Norwegian network. The ambition of TSC is to become a leading international centre for scientific expertise in the field of sustainability, in addition to providing support to companies, governments and other organizations. The cooperation with the Norwegian partners may help both centres to become internationally leading in their respective fields.

The resources and the organization of CREE will also make it easier to maintain better contact with the users of energy and environmental research. This requires resources in the form of regular meetings, conferences, and other interaction, all of which will be provided by CREE. The organizational structure of CREE will also establish a formal meeting point with our user partners. These represent industry and government and include Gassnova, Norwegian Climate and Pollution Agency, Norwegian Ministry of Petroleum and Energy, Norwegian Water Resources and Energy Directorate, Statkraft Energy, Statnett and Statoil. All the user partners possess knowledge on energy markets and climate issues that are very relevant for our research. The plan is to have a two-way communication with the user partners so that both user and research partners can gain.

An additional value added to the centre is that funding over an eight-year period allows for the possibility of long-term planning. This is particularly important when it comes to recruitment to the field.

#### **4. Organization of research**

CREE will focus on research mainly connected to renewable energy and climate issues. The aim is to have a broad research portfolio and to work with all of the issues mentioned in the announcement from the Research Council of Norway. This makes us more open to include good ideas that come up and to employ good people within the field.

The research is organized in five different working packages, for more details see the *Project Plan (revised proposal to the Research Council of Norway)* and the *Annual Work Plans*:

- Working Package 1: The International Politics of Climate and Energy
- Working Package 2: Innovation and Diffusion policy
- Working Package 3: Regulation and Market
- Working Package 4: Evaluation of Environmental and Energy Policy Measures
- Working Package 5: The Next Generation of Numerical Models

Our research will be based on a broad set of methodologies. We will conduct theoretical analyses and empirical studies. The partners have specialized expertise which will be merged within the various parts of the research. Both the theoretical and empirical studies will be anchored in microeconomics, but will also draw on perspectives from other social sciences. On the empirical side, the research will be based on numerical economic models, econometric studies in which we make use of our large datasets, qualitative analyses of different cases and laboratory experiments. We will bring together researchers from various fields, who will be engaged in multidisciplinary activities such as conferences and workshops in addition to working on projects.

The output from CREE will be directed at both the research community and potential users including user partners and a broader interested public. CREE will introduce a new working paper series in which our research partners will publish their works. Furthermore, all of our research partners have a long tradition in presenting research at international conferences and publishing papers in peer-reviewed journals, and we will continue this tradition. We will also focus on popular publications such as newspaper articles, policy notes and popular science journals, as communication with users is important for scientifically based policy making.

While the Frisch Centre is the host institution of CREE, all national research partners are involved in directing the different working packages to. For more details about the different working packages, see the project descriptions.

## **5. Strategies to obtain the aims of the centre**

### *5.1 Research activity*

CREE has a distinct research profile described in the *Project plan* and *Annual work plans*. The long-term funding ensures that we can plan large projects that build on each other. The multidisciplinary approach is taken care of via collaboration with our sub contractors.

While the main research profile of the centre is outlined in the above mentioned documents, more detailed projects will develop as a result of the general progress of research in the field, international collaboration, the competence of the researchers connected to the centre, discussions with user partners and political and industrial developments. This will require meeting places for researchers and also for researchers and user partners.

All research partners already encourage their researchers to participate in the international research community, to collaborate with other researchers nationally and internationally, to publish in international peer-reviewed journals, and to be active in popular and/or user-oriented dissemination. The centre has thus not established additional strategies for publishing, attending conferences etc. that go beyond those of the different research partners. We will encourage our researchers to attend relevant conferences such as those of the EEA, EAERE and IAEE. A main aim is to continue to publish in good international journals, in addition to other publications such as books. We do not, however, focus on quantitative goals for publications, as research quality is considered more important than output quantity. The quality will be ensured with extensive contact with the international research community via publications, conferences, workshops and collaboration.

To facilitate cooperation among the research partners and also among research partners and sub-contractors, we will organize several activities:

- An annual research workshop that includes presentations from researchers from the different research partners, subcontractors and other researchers connected to CREE. This will be held in September each year.
- A seminar series that will be coordinated with the seminar series at Department of Economics, Frisch Centre and Statistics Norway. This will be held continuously during the year.
- Exchange of researchers among research partners for longer or shorter periods of time.
- CREE has a web-page that is always updated on CREE activities.
- A CREE working paper series has been established electronically.
- Regular breakfasts and lunches where CREE researchers meet and exchange information.
- Social activities such as summer party and “julegløgg”.

## *5.2 Relevance and benefit to users*

One of the basic requirements of the centre is that the research must be relevant, both for our users, but also for the international research community on environmental and energy economics. While the latter is included in our research strategy, the first will be ensured through regular contact with user partners and other users. Increased communication will also provide an incentive to policy relevant research.

As mentioned above, the resources and the organization of CREE will make it easier to maintain better contact with the users of energy and environmental research. This means regular meetings, conferences, and other interaction where we can have a two-way communication with our users. CREE has a responsibility for research dissemination, both to users and to the public. We will use the following communication channels:

Communication to users:

- Dissemination of research through the Web
- Hold an annual user conference (April). This will be organized together with CICEP.
- Organize user activities such as meetings and seminars as required
- Organize a Model Forum (once or several times a year) where users together with researchers in other disciplines, can make contributions to economic modeling.
- Publish in Norwegian-language journals such as *Samfunnsøkonomen* and *Økonomiske analyser*.

Once a year we will organize a meeting with all user partners where we will present the different working packages, the new research findings as well as new plans. The user partners will then have an opportunity to comment on this. This could be a part of the annual user conference or as a user seminar.

In addition to this, researchers from CREE should be available for meetings with user partners to discuss relevant topics. User partners may also fund research projects directly that are of high relevance to them.

The research partners can also do analysis for the user partners, but these should primarily be based on the research activity in the centre.

The user partners can contribute to the research activities by, e.g.,

- Contribute with data

- Contribute with funding
- Contribute to discussions around modeling (e.g., in the Model Forum)
- Comment on research and suggest research tasks for instance at meetings and other user activities
- Participate at seminars and conferences organized by CREE

The user partners will also contribute to the governance of the centre as two representatives in the board should come from user partners (see under organization below).

Communication to the public:

- We will publish opinion pieces, feature articles, interviews and policy commentaries on our website under "CREE in the media". These can be in Norwegian or English.
- We will contribute to hearings in the Parliament and public debates.

CREE will make a *Dissemination plan* that goes more into detail on this topic.

### 5.3 Internationalization

In addition to the usual research channels such as collaboration on projects, publishing, presentations at conferences, etc., CREE formalizes its international contacts through

- An international research partner (Tilburg Sustainability Centre). We will aim for collaboration, discussions and exchange of researchers for short time periods.
- Employing internationally recognized researchers in part time positions at all three national research partners (see also the Project Plan)
- Invite renowned researchers to our workshops and to hold PhD courses.
- Actively participate in applications for EU funding.

CREE will participate in EU-projects as a partner. However, we do not intend to lead EU-projects as this requires a much larger administration than what we have established. Studies based on our numerical models are particularly relevant for EU-projects.

### 5.4 Researcher training and recruitment

CREE will fully fund two PhD students and two post-doctoral researchers over an eight year period. This means that we will recruit a PhD student in 2011 and 2015 respectively, as well as post-doctoral researchers in 2012 and 2016. These research recruits will be employed by the Department of Economics. In addition, the other research partners will also employ research assistants and research recruits. The research recruits will be given supervision by their supervisors and project leaders and will be invited to the ordinary CREE activities.

CREE will contribute to an interest in environmental and energy economics by providing up to three scholarships annually to students who want to write a master thesis in the field.

Researchers from CREE will teach at the master's and doctoral program at the Department of Economics as well as the summer school at the University of Oslo, and supervise master students and doctoral candidates.

CREE supports MILENs Research School, an multidisciplinary research school at the University of Oslo in environment and energy, both financially and through organizing and

teaching courses and seminars.

CREE supports the national research school in renewable energy for all the FME centres; NorRen. This means that we help organizing courses and seminars.

CREE also want to contribute to the exchange of PhD candidates among our research partners and also with other international collaborators.

### *5.5 Partners and funding*

CREE will actively work to increase funding for the centre's activities through

- User Partner Funding
- Search external research funding from the Norwegian Research Council and other external sources such as the EU's framework program.

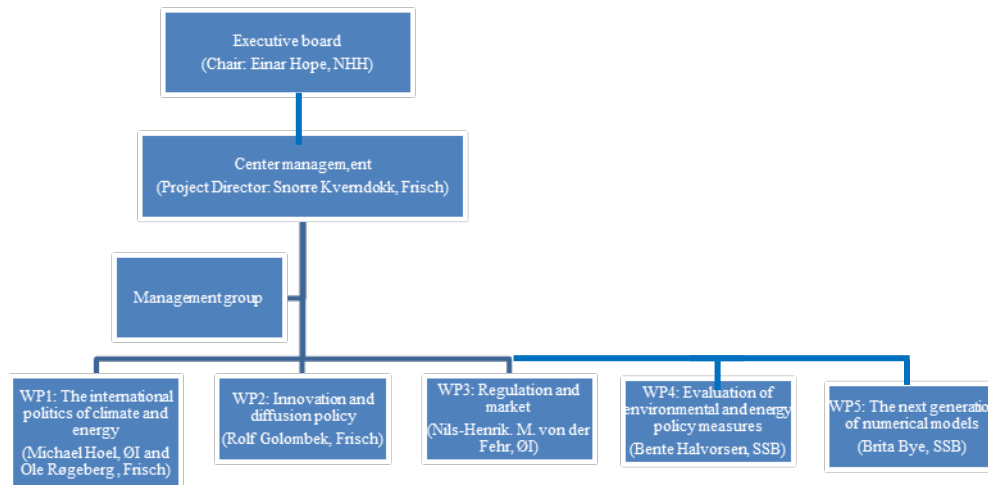
### *5.6 Organization*

The organization of the centre in 2011 is as shown in the figure below. It is also described in a separate document in Norwegian (*Styringsstruktur – CREE*).

The chair of the executive board should not represent any of the research partners, user partners or sub-contractors, and is therefore independent of the partners in CREE. The board also consists of one member from each of the three Norwegian research partners, while the user partners should be represented by two members, one from industry and one from government.

The board has the overall responsibility for the direction of future research activities, including adoptions of research issues and potential modifications of the working packages. The board is also responsible for constructive interaction between the centre, the host institution and partners in the consortium. More precisely, the board is responsible for ensuring that the Centre's vision and activities formulated in the Strategy document, are followed up in key documents such as project and work plans as well as budgets. This means adoption of the strategic plan, annual work plan, annual report, progress reports, budget, and to recommend the accounts.

The administration of CREE is located at the Frisch Centre. It should have regular meetings with the management group consisting of all the working package leaders to discuss matters of importance for the centre.



## 6. Focus the first three years, 2011-14

The centre will continuously work to meet the vision and aims of this strategic plan, also during the first three years of the centre's activity.

However, in the beginning we will particularly focus on getting the organization in place, such as all the formal contracts and documents, creating collaborative relationships, set up a seminar series, workshops and conferences, work to create a centre identity, and to ensure a stable funding.

CREE is working to improve centre identity through

- Regular lunches / breakfasts
- Seminar series and other professional events
- Own website
- Social events
- Opportunities for exchange of scientists for shorter or longer periods
- Visits to the user partners.

When it comes to funding, the “fixed costs” of running the centre such as administration, PhD students, post docs, sub contractors and external part time positions, take a large part of the base funding from the Research Council of Norway. Thus, the aim is to increase external funding to be able to ensure a stable funding of the research activity of the senior researchers. We do not aim to expand the centre much, but we plan to keep up a steady recruitment to the field of energy and environmental economics.

When it comes to research, one main activity during the first three years is to build our numerical models to make them available for studying important research questions. As a mean to do this, we have set aside NOK 1,000,000 each year for numerical modeling. We also have a large activity on WP1 (The International Politics of Climate and Energy) in the first phase of the centre, which is mainly due to existing funding from research council programs. The plan is that the funding of the different working packages will be more even after three years. We do not intend to expand the number of working packages, but new ideas will

always come up that will be included under the existing umbrella of working packages. Good communication with user partners and sub-contractors within the meeting places established by the centre will be important for the generation of research ideas.

The main challenge for the first phase of the centre activity is to make the different research partners and subcontractors work together, and to ensure a useful multidisciplinary relationship with our subcontractors. They are now involved in different projects, and we will have an annual internal evaluation of the cooperation in order to make the projects work smoothly.

It is important to include user partners in a way that is to a mutual advantage of both the research and user partners. A good communication with the user partners through meetings, seminars and conferences is required to make this happen. During to 2012 the Project Director and researchers will have meetings with all user partners to discuss their needs and their involvement in the centre. Based on feedbacks from user partners, we will revise communication plans.

This strategic plan will be revised after three years.



**Oslo Centre for Research on Environmentally friendly Energy**

# Annual Report 2014





## **Executive Summary**

CREE – Oslo Centre for Research on Environmentally friendly Energy was established in 2011 as a social science based energy research centre funded by the Research Council of Norway (FME Samfunn) with an annual grant of NOK 8 million for 5 years, with a possible 3 years extension. The centre started its activities in August 2011. The midterm evaluation takes place the spring 2015, and the decision whether the centre will get funding for the period 2016-2019 will be made before summer 2015.

The main focus is on economic research as the research partners include the Frisch Centre, Department of Economics (ØI) at the University of Oslo (UoO), the Research department at Statistics Norway (SSB), and Tilburg Sustainability Center, the Netherlands. Cooperation with Centre for Development and Environment (UoO), Faculty of Law (UoO), SINTEF Energy Research and Institute for Energy Technology broadens the research perspective. 2014 was the last year of the subcontractor contract with SINTEF. The user perspective is ensured by several partners from industry and government.

The main aim of the centre is to collect and develop knowledge on the effects of regulatory conditions in the energy market and how these affect technological improvements such as innovation in and diffusion of technology for renewable energy, energy efficiency and carbon capture and storage. The centre provides a basis for better regulatory strategies and for policy instruments designed to reach energy and climate goals established nationally and internationally. CREE will also strive to develop methodological frameworks appropriate for achieving these goals.

Our portfolio is divided into five working packages that cover international climate and energy policy, innovation and diffusion, markets and regulation, evaluation of policy measures, and development of numerical models.

2014 has been the third full year of CREE activities. The activities have been concentrated on the research in the different working packages, the annual research workshop, CREE seminars, model forums and several user activities including the annual user conference. In 2014 we published 28 papers in international peer reviewed journals, 6 articles in books, 20 working papers and 7 popular science articles. The CREE scientists have held about 80 conference and

seminar presentations in 2014, and they have been mentioned numerous times in the media. While the number of published papers in international peer reviewed journals has increased significantly from 2013, the numbers of working papers, popular science articles and presentations have gone down. This reflects the funding situation at CREE, where we have been less successful in our research proposals the last few years, and more time is spent on writing proposals. Thus, CREE researchers need to get involved in other topics where the funding situation is better, and less time is devoted to research in environmental and energy economics. However, this also reflects that the quality of our research has increased measured in the quality of the journals that we publish in. A higher quality publication requires more time.



## **1 CREE**

There is increasing evidence that the global climate is changing, and that this change is mainly due to human activities. As has been stressed by the latest IPCC assessment report published in 2014, climate change can have a substantial impact on the economy, ecosystems and human welfare, and may have catastrophic impacts for parts of the world. Thus, there is a need to reduce greenhouse gas emissions as well as to adapt to inevitable changes. Technology improvements are widely held to be essential if we are to achieve the required emission cuts and to transform our economy to a carbon free society at the end of this century.

However, there are several challenges beyond the purely technological. The research and development effort, as well as diffusion and utilization of new, environmentally friendly energy sources, require appropriate incentives. Another important challenge is to design climate and energy treaties that will help achieving a better social outcome. In this respect effective policy instruments and fair outcomes are important. The aim of CREE, Oslo Centre for Research on Environmentally friendly Energy, is to provide a solid base for policy making on these questions. CREE will also contribute to the collection and establishment of

knowledge on how different regulations affect both the energy market and technological development. The centre studies policy instruments designed to reach the goals established in national and international energy and climate policy, while also examining how international treaties could be designed differently to better achieve broad participation and deep abatement.

The research of the centre is primarily grounded in economics, as reflected by the main research partners: Department of Economics at the University of Oslo, the Research Department at Statistics Norway, the Frisch Centre and the Tilburg Sustainability Centre. In addition, in 2014 the centre has drawn on other disciplinary perspectives through cooperation with researchers from other disciplines within the social sciences, law and technology.

The centre has the following vision which is stated in our Strategic Plan for 2011-14:

- We want to be a leading international research centre within energy, environmental and resource economics.
- We will generate knowledge that can contribute to a cost-effective and sustainable exploitation of Norwegian and international energy resources by industry and governments, as well as an effective and fair climate and energy policy, both nationally and internationally.
- We will contribute to recruitment and training at the master, doctoral and post doctoral levels in energy and environmental economics at the University of Oslo. Recruiting women to research will have a particular focus.

This report summarizes the activities and the achievements of the centre in 2014.

## **2 Research plan and strategy**

CREE organizes its research into five different working packages:

### ***Working Package I: The International Politics of Climate and Energy***

***(Research Directors: Michael Hoel, Department of Economics, University of Oslo, and Mads Greaker, Statistics Norway)***

The research questions in this working package focus on the following issues:

- Improving the current climate regime – increase incentives to join and comply

- Alternative treaty forms – sector based treaties; research and development (R&D) treaties
- Dealing with non-signatories – preventing carbon leakage
- Equity issues – intergenerational vs. intragenerational
- Implications of the above for energy market policies

***Working Package II: Innovation and Diffusion policy***

***(Research Director: Rolf Golombek, Frisch Centre)***

Important research questions in this working package are:

- What is the optimal mix of policy instruments to achieve innovation of environmentally friendly technologies?
- What is the optimal R&D policy for a small country with limited demand for carbon capture and storage (CCS), but with good technological competence?
- What types of market failures may arise in the application and diffusion of environmentally friendly technologies and how can we overcome them?

***Working Package III: Regulation and Market***

***(Research Director: Nils-Henrik M. von der Fehr, Department of Economics, University of Oslo)***

This research package focuses mainly on the electricity markets:

- Is there a contradiction between the policy to develop more green energy and regulations that will provide more efficiency in the energy market?
- Which policies can provide a sustainable use of energy?
- What is a reasonable level of energy security and how can we ensure that it is achieved?

***Working Package IV: Evaluation of Environmental and Energy Policy Measures***

***(Research Director: Bente Halvorsen, Statistics Norway)***

This is an empirical part of the project and studies the success of environmental and energy policy measures so far. Important questions are:

- What amount of energy savings is eaten up by increased consumption (rebound-effect)
- Can regulation of a good have unintended effects on close substitutes?
- What are the effects of soft policy measures?

- Focus on transportation: Does CO<sub>2</sub> taxation lead to higher demand for energy efficient vehicles? How does the increase in cars that run on biofuels and electricity affect emissions from road traffic?

### ***Working Package V: The Next Generation of Numerical Models***

***(Research Director: Brita Bye, Statistics Norway)***

This working package focuses on developing our numerical models by updating the data, improving the modeling of new technologies, and making innovation processes endogenous. The models will be used to study research questions in the other working packages. We use and develop

- The energy market model LIBEMOD
- Computable general equilibrium (CGE) models at Statistics Norway; the MSG-TECH model, the ITC (Induced Technological Change) model, and the SNoW-models (Statistics Norway World models).
- The new petroleum market model PETRO2

Our strategy is to follow the plans put down in the annual research plans, see <http://www.cree.uio.no/projects.html>. The research will benefit from close contact with subcontractors and user partners. For the vision and strategy of the total CREE activity, see the CREE strategy

plan [http://www.cree.uio.no/adm/Strategi\\_Komunikasjon/CREE%20strategic%20plan%20March%202013.pdf](http://www.cree.uio.no/adm/Strategi_Komunikasjon/CREE%20strategic%20plan%20March%202013.pdf), which was finalized in 2013. A new plan for 2015-19 is being prepared.

## **3 Centre organization**

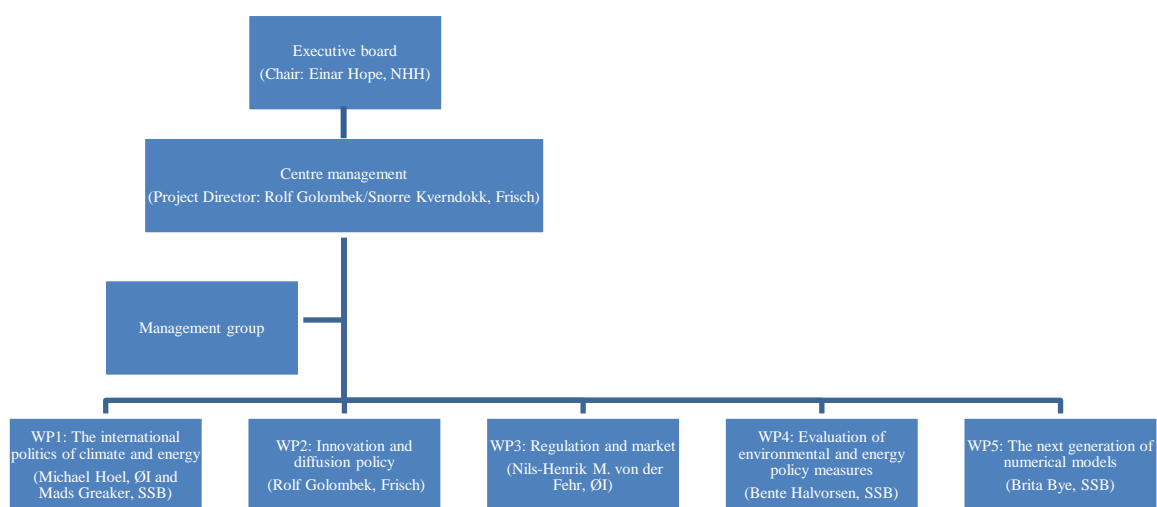
The organization of the centre in 2014 was as shown in the figure below.

The chair of the executive board (Einar Hope, The Norwegian School of Economics - NHH) does not represent any of the research partners, user partners or sub-contractors, and is therefore independent of the partners in CREE. The board also consists of one member from each of the three Norwegian research partners (Oddbjørn Raaum, Frisch; Taran Fæhn, SSB; Karine Nyborg, ØI), while the user partners are represented by two members, one from industry (Tor Kartevold, Statoil) and one from Government (Guro Børnes Ringlund, The

Norwegian Environment Agency). The board had three meetings in 2014, see [http://www.cree.uio.no/board\\_meetings.html](http://www.cree.uio.no/board_meetings.html).

The administration of CREE is located at the Frisch Centre. Dr. Rolf Golombek served as the temporarily Centre Director from 1 January to 31 March. In the remaining part of 2014, Dr. Snorre Kverndokk was the Project Director. Jørg Gjestvang was the Centre Manager.

The administration has regular meetings with the management group consisting of all the working package leaders to discuss matters of importance for the centre.



The partners of CREE are divided into research partners and user partners. The research partners are:

Ragnar Frisch Centre for Economic Research (Frisch Centre), Oslo (host institution)  
Research department, Statistics Norway, Oslo  
Department of economics, University of Oslo  
Tilburg Sustainability Center, Netherlands

CREE has seven user partners:

Gassnova SF  
Norwegian Environment Agency  
Norwegian Ministry for Petroleum and Energy  
Norwegian Water Resources and Energy Directorate  
Statkraft Energy AS  
Statnett SF  
Statoil ASA

The user partners of the centre contribute with funding and with members on the board, but also to the research with detailed knowledge about markets, technologies and politics.

Like in earlier years, we have a CREE luncheon about every second month that brings together the CREE network and contributes to unify the Norwegian CREE research institutions.

## **4 Funding**

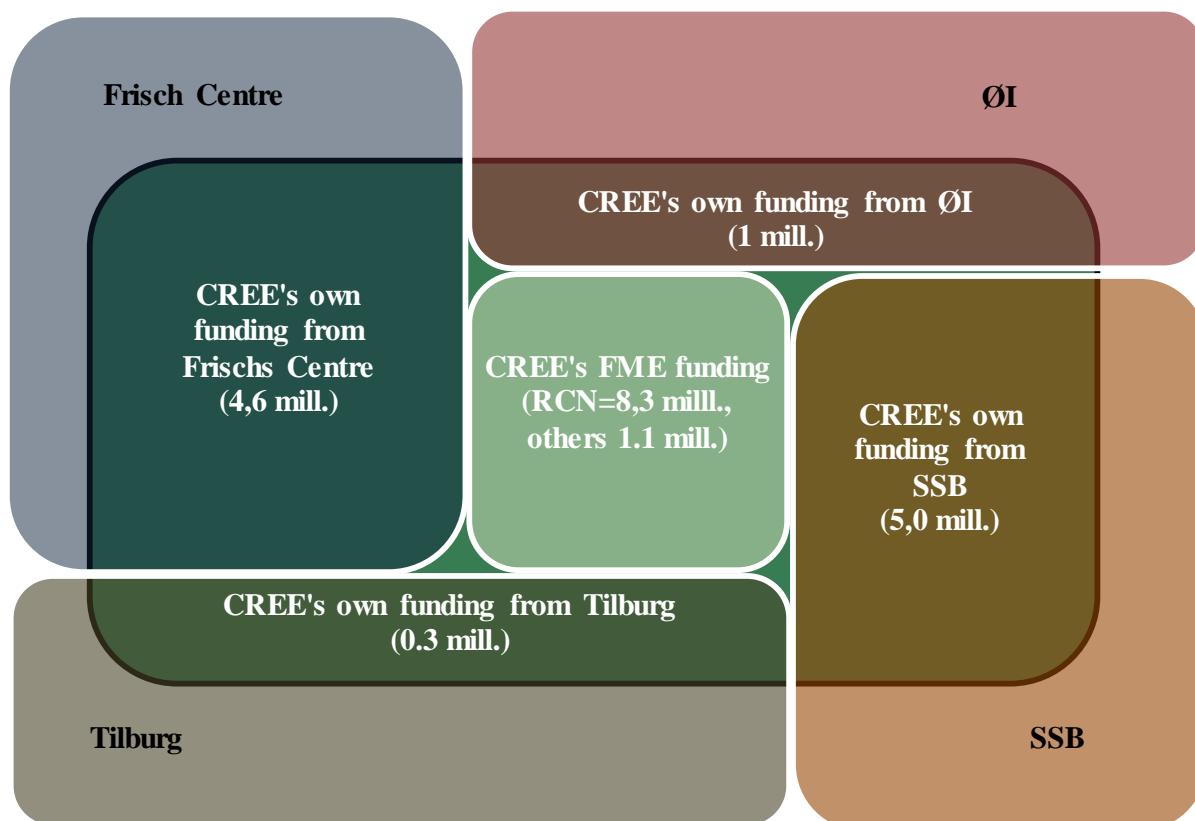
The funding of CREE in 2014 comes from various sources. The centre has an annual contribution from the Research Council of Norway (RCN) of NOK 8 millions, user partner funding of NOK 600.000, and funding from the University of Oslo (UoO) of NOK 500.000. In addition, the centre has secured its own funding through other programs under RCN and international research programs. The figure below gives an overview of the total funding in 2014. Note that in the figure, the funding from RCN is NOK 8,3 million, which is more than the annual grant. The reason is that some of the money is transferred from 2013. For more



detailed information, see Appendix A2, which also shows the distribution of costs by CREE research partners and other units affiliated to the centre. Note that costs cover activities directly funded by RCN as well as activities financed by own funding, for example, funding through other research council programs.

### CREE funding in 2014

Total CREE centre funding incl. own funding. (20,2 mill.)



Own funding = professional work that is beneficial to the CREE centre, but is not part of CREE's direct funding from The Research Council of Norway. Own funding should be at least 25% of the total budget of CREE.

#### FUNDINGS

The Research Council of Norway	8,3
Others	1,1
<i>Public funding (UoO)</i>	0,5
<i>Privat funding (User partners)</i>	0,6
Own funding	10,9
<i>Frisch</i>	4,6
<i>SSB</i>	5,0
<i>ØI</i>	1,0
<i>Tilburg</i>	0,3
<b>Sum total funding</b>	<b>20,2</b>

## 5 Professional activities and results

The professional activities in 2014 have been concentrated on the research in the different working packages described above, the research workshop, CREE seminars, a common workshop with the other FME-S centres and several user activities including the user conference.

The CREE workshop took place in Oslo (Lysebu hotel) on 22-23 September. About 35 people attended the workshop, mainly researchers from the research partners and sub-contractors in CREE, but also from our international network. Presentations covered research from all our work packages, and on subjects related to the work packages. The program is available at [http://www.cree.uio.no/Workshop\\_Sem\\_Conf/4th\\_research\\_workshop.html](http://www.cree.uio.no/Workshop_Sem_Conf/4th_research_workshop.html).

A joint workshop was organized for all the FME-S centres (CREE, CICEP and CenSES). The workshop was held in Trondheim in November and the topic was uncertainty and investment risk in the energy sector.

The CREE seminar series included 17 seminars in 2014, among them 5 international visitors. The seminars were given at Statistics Norway, Frisch Centre and University of Oslo. For a list of all seminars, see [http://www.cree.uio.no/seminars\\_earlier\\_years.html](http://www.cree.uio.no/seminars_earlier_years.html).

We did not hold any model forum meetings in 2014 as we had to forums in 2013, and because the work package leader of WP 5 who is responsible for the model forums were abroad in the fall 2014. However, a new model forum is planned for 2015.

The user conference was held in April and was co-organized with CICEP, another social since FME centre. The conference was in Norwegian and the topic was the EU climate and energy policy towards 2030. About 50 people attended the conference. For more information about the conference, see [http://www.cree.uio.no/Workshop\\_Sem\\_Conf/Brukerkonferanse\\_CREE\\_CICEP\\_240414.html](http://www.cree.uio.no/Workshop_Sem_Conf/Brukerkonferanse_CREE_CICEP_240414.html). CREE also organized a half-day seminar with all its user partners; see [http://www.cree.uio.no/Workshop\\_Sem\\_Conf/minibrukerseminar\\_141110.html](http://www.cree.uio.no/Workshop_Sem_Conf/minibrukerseminar_141110.html), as well as seminars for the Ministry of the Environment and the Norwegian Environment Agency.

When it comes to publications, we had 28 papers published in international peer reviewed journals, see the Publications table below and Appendix A3. We have also published 6 articles in books and produced 20 CREE working papers. Further, we have published 7 popular science articles and 2 other publications. The CREE scientists have also held about 80 conference and seminar presentations. They have also been mention at least 23 times in the media.

As seen from the table, the number of published papers in international peer reviewed journals has increased significantly from 2013, while the numbers of working papers, popular science articles and presentations have gone down. This reflects the funding situation at CREE, where we have been less successful in our research proposals the last few years, and more time is spent on writing proposals. Thus, CREE researchers need to get involved in other topics where the funding situation is better, and less time is devoted to research in environmental and energy economics. However, this also reflects that the quality of our research has increased measured in the quality of the journals that we publish in. A higher quality publication requires more time.

#### **Publications 2011-2014**

	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>
Journal papers:	8	16	21	28
Books and article in books:		2	7	6
Working Papers:	9	21	30	20
Popular scientific articles:	4	10	12	7
Other publications:		5	3	2
Conference and seminar presentations:		100	100	74
CREE in the media:	9	41	31	23

Below we give an overview of the research in the five different research packages in 2014.



## **5.1 The International Politics of Climate and Energy (WP I)**

The main question in this work package is how international climate treaties best can achieve greenhouse gas (GHG) abatement. This raises questions regarding how treaties should be structured to raise participation rates, abatement targets and policy implementation, and how abatement efforts will influence other important goals – such as global equity issues, as well as how equity principles may affect treaties.

Abatement treaties are the type of international climate treaties mostly studied in the literature. However, other designs like sectorial treaties, regional treaties or “topical” treaties focusing, for example, on R&D efforts are also possible. The increasing pessimism regarding prospects for a single, UN-led, ambitious “top-down” abatement treaty with global coverage has raised the question of whether such smaller, partial treaties could be coordinated and gradually integrated with each other, thereby addressing the climate problem “bottom-up”.

We are also concerned about how climate policies both directly and indirectly through for instance technical change affect global energy markets.

The research activities in this work package spans from theoretical studies to numerical models and experimental studies using laboratory participants.

### **I.1 Pareto-improving climate policies**

Future generations will be richer than us, but may have a more inferior environment. While mitigation today will increase the quality of the future environment, it implies costs to the current generation. However, by transferring resources from the future to the present

generation there may be possibilities for improving the welfare of all generations. This can be done by compensating mitigation today by fewer investments so that the present generation does not have to reduce consumption.

This is a numerical project where we do simulations with the RICE model. The project started in 2013, but most of the work has been done in 2014. A first draft is written and is presented at several workshops and seminars. This will be finalized, published as a CREE Working Paper and submitted to a journal in 2015.

We have applied KLIMAFORSK for a continuation of this project, but did not get funding.

*Project leader: Snorre Kverndokk, Frisch*

## **I.2 Border Tax Adjustment**

A standard result in the literature on international climate agreements is that few countries will sign an abatement agreement due to the free rider problem: all countries benefit from abatement activities of other countries whereas cost of abatement is born entirely by the country itself. In several studies, the equilibrium number of coalition members is two or three, and even if it is possible to construct bigger coalitions the effect on aggregate abatement is typically modest.

This subproject examines whether the introduction of a border tax on the carbon content of goods that are traded internationally may make participation in an international climate agreement more attractive and thereby increase the equilibrium number of signatories. The basic idea is that a border tax imposed on imports of carbon-intensive goods to the group of signatories may increase the revenues to this group and/or change the relative prices of goods in favor of the signatories. In 2014, the model was refined and a draft of a working paper was produced. In 2015, the working paper will be finalized. This is a joint project between the Frisch Centre and the University of California at Berkeley.

*Project leader: Rolf Golombek, Frisch*

## **I.3 Climate treaties with reciprocal preferences**

Research in behavioral and experimental economics indicate that reciprocity, that is, a preference to repay mean intentions by mean actions and kind intentions by kind actions, is

widespread in many cultures. If voters or individuals in power have reciprocal preferences, states may conceivably act as if they have such preferences too.

A reciprocal person is not generally kind. Rather, reciprocity is about anger and gratitude, retaliation and reward. Although reciprocity may help secure cooperation, it can also be very destructive.

The present project develops a simplified theoretical analysis of participation in international environmental agreements if countries behave as if they have reciprocal preferences. It is shown that when few others are expected to abate, reciprocal countries are even less willing to abate than countries with standard preferences.

However, if all countries have strong preferences for reciprocity, the grand coalition of all countries can be stable as well. The reason is that others' abatement increases the individual country's motivation to contribute. Moreover, if not all countries are reciprocal, a large (but less than full) coalition can be stable if the share of reciprocal countries is strictly more than half, and if these countries are sufficiently strongly reciprocal.

In addition, a stable minority coalition can exist which is larger than the maximum coalition size with standard preferences. In this situation, each coalition member is disappointed with others' behavior and is willing to sacrifice own material welfare to punish them. In spite of this, the minority coalition is stable, for the following reason: Each coalition member knows that if it leaves, the coalition will dissolve. It will then choose to stay, because this is the only way it can keep a small island of kindness in a world of meanness; if it leaves, the world becomes universally mean.

In 2014, a discussion paper has been published:

*Nyborg, K.: Reciprocal Climate Negotiators: Balancing Anger against Even More Anger, Memorandum, 17/2014, Department of Economics, University of Oslo.*

In 2015 the paper will be revised to include a more systematic discussion of results in light of empirical findings from behavioral and experimental economics, possibly also an extension of the formal results to include the case of heterogeneous country size.

*Project leader: Karine Nyborg, ØI*

#### **I.4 Participation and duration of climate agreements**

Theoretical contributions to the formation of international environmental agreements often analyze either participation in abatement agreements or participation in an R&D partnership

that aims to develop environmentally friendly technologies that will lower costs of abatement. However, abatement and R&D efforts are interrelated. If a country manages to lower its costs of abatement through successful R&D in environmentally friendly technologies, its future bargaining position may be weakened as other countries may claim that this country should abate more because its costs have been reduced (the hold-up problem). In the present project we therefore analyze participation in international environmental agreements in a dynamic game where countries pollute and also invest in green technologies.

We show that if complete contracts are feasible, participants eliminate the hold-up problem associated with their investments; however, most countries prefer to free-ride rather than participate. If investments are non-contractible, countries face a hold-up problem every time they negotiate; but the free-rider problem can be mitigated and significant participation is feasible. Participation becomes attractive because only large coalitions commit to long-term agreements that circumvent the hold-up problem. Under well-specified conditions even the first-best outcome is possible when the contract is incomplete. Since real-world IEAs fit in the incomplete contracting environment, our theory may help explaining the rising importance of IEAs and how they should be designed.

In 2014, a paper has been accepted for publication:

*Battaglini, M. and B. Harstad: Participation and duration of environmental agreements, forthcoming in Journal of Political Economy.*

*Project leader: Bård Harstad, ØI*

## **I.5 Reducing carbon leakage**

A key challenge for unilateral policy initiatives, even for a big coalition like the EU, is carbon leakage and competitiveness concerns. In 2013 we have analyzed economic and emission effects of introducing carbon taxes combined with output-based rebating and also how second-best optimal rebate rates interact with carbon policies in other regions. We are especially concerned about the development of second-best optimal rebating rates for large versus small regions/countries in a world where a considerable share of global carbon emissions is still not regulated. We use both theoretical and numerical methods, the last one exemplified by the global CGE model SNoW.

In 2014 the project finalized a discussion paper:

*Böhringer, C., B. Bye, T. Fæhn and K. E. Rosendahl: Output-based rebating of carbon taxes in the neighbor's backyard - Competitiveness, leakage and welfare, CREE WP 06/2014.*

In 2014/2015 the carbon leakage project work with another paper that concerns possibilities, limitations, and implications of various border carbon adjustment (BCA) systems designed particularly for targeting the emission intensities of foreign producers. Succeeding to design and implement such systems would improve the efficiency and effectiveness of BCAs. The final working paper will be submitted to an international journal by March 2015. This project is part of the ENTRACTE-project and the WILL project financed by the RCN through its Klimaforsk program. The results will also be included in a synthesis report from the ENTRACTE project, together with ZEW (Mannheim) by May 2015. See also WP5 for more information on this.

*Project leader: Brita Bye, SSB*

## **I.6 Inequality aversion and trade**

Widespread skepticism towards tradable emission quotas is apparent in surveys and political debates. One potential explanation is that opponents see markets as rigged and favoring “rich countries.” In a laboratory experiment we allow resource owners and buyers to trade at *given* prices, and examine the effect on trading volumes of high prices (that distribute most of the gains from trade to sellers), low prices (that distribute most of the gains to buyers) and “fair” prices that give both parties the same payoffs.

A lesson often drawn in the experimental economics literature is that social preferences like inequity aversion are not triggered in market settings. Our experiment tests whether people willingly “leave money on the table” rather than trade at inequality increasing terms. The results indicate that, in a simple two-person trade game with fixed prices, a significant amount of trade is withheld when it creates strong inequality, in spite of trade being Pareto-improving in monetary outcomes. This behavior is consistent over 10 rounds of experience for the favored and disfavored player compared with the neutral treatment when no inequality is created by trading resources. We conclude that fairness concerns may affect outcomes in a fixed price trade setting, even when there are no strategic or retaliation motives present for restricting trade.

This project is part of Alice Ciccone’s PhD project and will be finalized in 2015.



*Project leader: Ole Røgeberg, Frisch*

### **I.7 Is it wrong to buy a right to do a wrong?**

An alternative hypothesis to the one explored in I.6 is that opposition to tradable emission quotas stems from a view that sees emissions as moral bads. Philosopher Michael Sandel from Harvard has made several arguments in this vein over the years. The project has run a laboratory experiment to see if a market in “bads” (taking from a common resource pool to benefit oneself despite hurting others even more) would trigger negative attitudes towards market trade. Results showed no effects on neither attitudes towards markets, trading volumes in markets, nor prices in markets relative to a control treatment with trade in a non-harmful good.

A paper by Kjell Arne Brekke, Ragnhild Bråten and Ole Røgeberg will be published as a CREE WP and is now to consideration in a journal.

*Project leader: Kjell Arne Brekke, ØI*

### **I.8 Earned pies and outside options in structured bargaining**

Bargaining is central to many economic applications and certainly a key to an international climate agreement. To better understand bargaining, Alice Ciccone and Kjell Arne Brekke at UiO/CREE together with Leif Helland and Tom-Reiel Heggedal at BI have conducted a series of experiment. The experiments are designed to test the effect of earning either an outside option or earning a share of the pie, prior to alternating offer bargaining. We have solved for the subgame perfect equilibrium with loss-aversion preferences and the model prediction is that earning an outside option should not matter, unless the option is binding, while subjects who earned a larger share of the pie should also end up with a larger share. This latter prediction is contrary to most other models of bargaining, but supported by the experimental results. We are in the process of collecting more data and testing our model rigorously

This is part of Alice Ciccone’s PhD project and will be finalized in 2015.

*Project leader: Kjell Arne Brekke, ØI*

## **I.9 Natural resources and the climate**

We will write a chapter on climatic change in a Norwegian book on natural resource economics; the book is aimed for undergraduate students. In our contribution, we first go through the history of research and policy on climatic change, and then explain institutional factors. Then we go through the facts we have about climate change today and what we expect will happen in the future. In the analysis we first introduce a dynamic model that shows how we can determine the optimal emission reductions. We then turn to a simpler model and show how to implement the optimal emission reductions by means of direct regulation and economic instruments such as tradable permits and taxes. Game theory is then used to explain why it is difficult to reach a binding and comprehensive climate agreement. The chapter concludes with what a small country like Norway can do, as well as some thoughts about the future.

This project finished in 2014 and is now published as:

*Kverndokk, S. and C. Hagem (2014): «Klimaendringer» (Climate change), chapter 8 in O. Flåten and A. Skonhoft (eds.): Naturressursenes økonomi (Natural resource economics), Gyldenda Akademisk.*

*Project leader: Snorre Kverndokk, Frisch*



## **5.2 Innovation and diffusion (WP II)**

Atmospheric greenhouse gas stabilization targets as low as 450 ppm CO<sub>2</sub> equivalents could be needed in order to avoid dangerous anthropogenic interferences with the earth's climate system. Such targets may require more than twice as much carbon-free power by the middle of this century than we now derive from fossil fuels - this is the technological challenge of the century.

Environmentally friendly R&D is a tale of several market failures. First, there are environmental externalities which need to be internalized through appropriate environmental policy measures. This is essential since it is the internalizing of the environmental externalities that create the demand for the new environmental technology. Second, there may be market failures in the innovation and diffusion processes. Research creates new knowledge which benefits other firms, and thus entails a positive externality. On the other hand, competing research firms may duplicate each other and/or exhaust the pool of good ideas, thereby negatively affecting other research firms.

Economists have realized that there are market failures also in the adoption and diffusion of new technologies. For a number of reasons, the value to a user of a new technology may depend on how many other users have adopted the technology. This type of “increasing returns” may be created by learning-by-using, learning-by-doing or network externalities. When the qualities of a product are hard to assess, consumers may assess it by observing the number of other people who are purchasing the product, inducing informational cascades which creates a scope for advertising. Similarly, the responsibility to act in an

environmentally friendly manner is shaped by observing others, although this may cause market failures with multiple equilibria. The adoption of new technologies may also be hindered by principal-agent problems and cognitive costs. In this work package we address a broad set of topics which are of interest from both a research and political perspective.

## **II.1 Strategic technology policy as supplement to renewable energy standards**

Renewable energy standards have been introduced in several countries as a supplement to climate policy. Some countries have also subsidized the use of renewable energy or the producers of renewable energy capital. In this subproject we examine the rationale for such policies.

Our point of departure is that a renewable energy standard creates new profit opportunities for firms that supply renewable energy capital. With imperfect competition among technology suppliers, technology policy could be used strategically. We consider both downstream subsidies to renewable energy suppliers and upstream subsidies to renewable energy capital producers. To the extent that there is imperfect competition upstream, subsidies may improve welfare both globally and nationally. Moreover, upstream subsidies are preferred over downstream subsidies from a national perspective. Finally, we show that strategically chosen subsidies by individual countries could in fact be optimal from a global perspective, given that the shadow price of emissions is correct from a global perspective.

This paper will be published in 2015 in a book on climate and technology policy, funded by the World Bank. A working paper will be published parallel with the book chapter.

*Project leader: Mads Greaker, SSB*

## **II.2 Carbon leakage: Pay or not pay the polluter?**

Asymmetric regulation of a global pollutant between countries can alter the competitiveness of industries and cause emissions leakage. For most types of pollution, abatement technologies are available, but the markets for these technologies are not competitive, particularly when emissions regulations and advanced technologies are new. In this context of

twin market failures, we consider the relative effects and desirability of subsidies for abatement technology.

We find that downstream subsidies tend to increase global abatement technology prices, reduce pollution abatement abroad and increase emissions leakage. In contrast, upstream subsidies reduce abatement technology prices, and hence also emissions leakage. Whereas downstream subsidies may weaken the position of domestic abatement technology firms, upstream subsidies may provide domestic abatement technology firms with a competitive advantage.

A working paper has been published:

*Fischer, C., M. Greaker and K. E. Rosendahl: Robust Policies against Emission Leakage: The Case for Upstream Subsidies, CESifo Working Paper No. 4742.*

This paper has also been submitted to an international journal in 2014. The work in 2015 will be to follow up review comments.

*Project leader: Mads Greaker, SSB*

### **II.3 How should CCS technologies be supported?**

Carbon capture and storage (CCS) technologies have the potential to bridge the gap between the current carbon-based society and a future low-carbon society. Using CCS electricity technologies, either with coal or natural gas as the fuel, may reduce emissions by as much as 90 percent relative to standard fossil-fuel based technologies.

One main disadvantage of CCS is high cost. These may, however, be lower through continued R&D. An important question is then whether CCS should be prompted through subsidizing the producers of CCS technology (upstream subsidy) or through subsidizing the use of CCS technology (downstream subsidy). In a combined theoretical-empirical subproject we first study optimal design of CCS subsidizes within a simple model of imperfect competition where CCS technology producers are divided into two groups according to whether they are owned by EU citizens/member countries. We show that upstream subsidizes to EU producers outperform downstream subsidizes.

We then use the numerical equilibrium model of the European energy market LIBEMOD, combined with a new model block with non-competitive supply of CCS technologies, to study how the CCS subsidy should be designed. Although LIBEMOD encompasses many effects not captured in the simple theoretical model used in the first part of the subproject, for example, terms-of-trade effects, we obtain the same type of result as in the theoretical part of the subproject; upstream subsidies to EU producers are preferable, though in some cases these should be combined with downstream subsidies.

In 2014 a robustness analysis of the numerical part of the paper was undertaken. Here we focus on the importance of i) number of suppliers within the EU and outside the EU, ii) the importance of whether CCS suppliers offer two technologies – CCS coal and CCS gas – or only one type of CCS technology, and iii) the range of variation in upstream and downstream subsidies. A draft paper has been written and will be published in the WP series. It will also be submitted to an international journal in 2015.

*Project leader: Rolf Golombek, Frisch*

#### **II.4 Environmental R&D instruments**

There are several reasons to support environmental R&D: knowledge spillovers that make future R&D more efficient, commitment problems with respect to future environmental policy and globally insufficient environmental policies due to lack of international environmental agreements on global pollutants. We will study the optimal use of three technology push policies 1) Patent systems, 2) Innovation prizes and 3) Subsidies to R&D projects under various circumstances: i) Global environmental policies are too weak in the near and intermediate future, and ii) Governments cannot commit to future environmental policy goals. In particular, we are interested in to what degree there are systematic differences between market goods R&D and environmental R&D that suggest that different support programs should be offered.

This topic has also funding from EU's seventh framework program (ENTRACTE), which will last until 2015. In addition, we have applied ENERGIX for means to extend the study. The project was started in 2013 but on a very low activity level. In 2015 a draft paper will be written that covers topics described above.

*Project leader: Michael Hoel, ØI*

## **II.5 Optimal timing of clean energy policies**

Should technology subsidies be used as a climate policy instrument in addition to imposing a price on GHG emissions, or is pricing of GHG emissions sufficient in order to obtain a socially desirable outcome? If also technology subsidies should be offered, how should the path of subsidies be designed? A paper that examines these questions within a theoretical model where abatement requires use of environmentally friendly technologies and R&D makes these technologies more productive were published in JEEM in 2014.

*Gerlagh, R., S. Kverndokk and K. E. Rosendahl (2014): «The Optimal Time Path of Clean Energy R&D Policy When Patents Have Finite Lifetime», Journal of Environmental Economics and Management, 67(1): 2-19.*

*Project leader: Reyer Gerlagh, Tilburg*

## **II.6 Innovation in clean energy as a commitment device**

The starting point of this project is how the present generation can make future generations reduce their GHG emissions. The basic idea is that by developing and installing environmentally friendly capital and technologies, for example, cheap solar power or insulation of buildings, costs of obtaining low GHG emissions will be reduced for future generations, thereby fulfilling the aim of the present generation to lower future GHG emissions.

In the first part of the project, researchers at the Tilburg Sustainability Centre (TSC) set up and studied a model where concerns for future climate change introduce a time-inconsistency in policy-making. The study shows a regular pattern where a regulator prefers a tight climate target, but also prefers to delay costly tasks. Over time, targets are weakened as a natural outcome of the preferred delay.

In the model the government is naïve as it mistakenly assumes that it can control future governments. In a refinement, a recursive Integrated Assessment Model is specified. This model can be used to study innovations as a commitment device for climate policy by deriving

the Markov equilibrium, that is, the current government correctly anticipates the response of the future governments. In 2014, the main task has been to calibrate and test the model.

In 2015 the model will be extended in collaboration with Mads Greaker from Statistics Norway to include innovations. The expected result is an assessment of the usefulness of policies that stimulate cost-reducing innovations in clean energy technologies as a mechanism that induces deep emission reductions in the future. This model will also be used in an EU project (Entracte) where both TSC and CREE participate.

*Project leader: Reyer Gerlagh, Tilburg*

## **II.7 Can non-market regulations spur innovations in environmental technologies?**

This project provides new evidence on the role of direct (“command-and-control”) regulations in relation to innovations in environmental technologies. While pricing is generally considered the first-best policy instrument, direct regulations, such as technology standards and non-tradable emission quotas, are common when a regulator faces multiple emission types and targets, heterogeneous recipients, or uncertainty with regard to marginal damages. Using a unique Norwegian panel data set that includes information about the type and number of patent applications, technology standards, non-tradable emission quotas, and a large number of control variables for Norwegian incorporated firms, we are able to conduct a comprehensive study of the effect of direct regulations on environmental patenting. Unlike previous studies that are typically conducted at the industry level, we are able to take firm heterogeneity into account, and thereby reduce the common problem of omitted variable bias in our analysis. We empirically identify strong and significant effects on innovations from implicit regulatory costs associated with the threat that a firm will be sanctioned for violating an emission permit.

An earlier version of this paper is published as:

*Klemetsen, M. E., B. Bye and A. Raknerud: Can non-market regulations spur innovations in environmental technologies? A study on firm level patenting , CREE WP 16/2013.*

A revise-and-resubmit based on the earlier version of this paper has been submitted to Scandinavian Journal of Economics.

This project is part of Marit Klemetsen’s PhD project at SSB.



*Project leader: Brita Bye, SSB*

## **II.8 Technology agreements**

Most of the literature on international climate agreements focuses on treaties that directly regulate emissions. In contrast to these papers, the present project analyzes an agreement between a group of countries that implement a joint R&D effort to reduce abatement costs. Even without an explicit agreement on emission reductions, a technology agreement leading to lower abatement costs as a consequence of the agreed upon R&D expenses might result in a broad reduction of emissions. There may exist an equilibrium with a group of countries participating in a coalition that undertakes R&D in order to reduce abatement costs, and another group of countries (generally differing but overlapping with the first group) that uses the new technology to reduce their emissions. The paper gives an extensive analysis of the special case in which there are only two types of countries; some with “high” willingness to pay to avoid emissions, others with “low” willingness to pay. It is demonstrated how total emissions depend on the number of countries with high willingness to pay: It may be the case that as the number of such countries increases, emissions may first decline, then rise, and then again increase. The paper was published as a chapter in a book in 2014.

*Hoel, M. and de Zeeuw, A. (2014): Technology Agreements with Heterogeneous Countries, in Todd L. Cherry, Jon Hovi and David McEvoy (editors): Toward a New Climate Agreement: Conflict, Resolution and Governance. Routledge.*

As indicated in the 2013 CREE work plan, the level of activity will depend on whether this subproject obtains external funding. So far no funding has been available. Potential future activity will be related to research questions like: i) How do the equilibrium amount of emissions depend on the distribution of willingness to pay across countries? ii) What is the effect of introducing a subsidy to users of the new technology?, and iii) Under what circumstances will an agreement of this type outperform an agreement focusing only on emission reductions?

*Project leader: Michael Hoel, ØI*

## **II.9 Obstacles to dissipation of environmentally friendly technology**

In 2014 the literature survey, within the fields of behavioral and experimental economics, on energy efficiency investment was published in *Samfunnsøkonomen*:

*Hauge, K. E. (2014): Når Viljar, Egil og Rasmus skal investere i energibesparende teknologi. Samfunnsøkonomen, Nr 1/2014.*

The starting point of the review is the so-called energy paradox: several studies claim that it is possible to save between 10 and 25% of our total energy consumption through profitable investment. This claim is discussed within the framework of behavioral economics.

*Project leader: Karen Hauge, Frisch*

## **II.10 Innovation policies, patenting and technological quality**

Note that this project is changes from what was reported last year, and so is the title of the project.

The contribution of this paper is to examine the magnitude of the effect of the Norwegian R&D tax credit program, known as SkatteFUNN, on firm patenting as well as on patent quality measured using patent citations. We are also interested in investigating whether the R&D tax credit is sufficient in order to reduce the externalities and create incentives for patenting of environmental technologies. Concerns have been raised that R&D support must be specifically targeted towards clean technology development as innovations in clean technologies are exposed to more externalities than innovation in general. Innovation in general faces knowledge externalities from R&D, whereas environmental innovation in addition faces the environmental externality exerted by dirty input producers. Acemoglu (2012) thus finds that an optimal policy involves directing R&D towards clean technologies. We investigate whether the R&D tax credit scheme – which is generic in the sense that it offers the same R&D support for any type of technology (clean, dirty or other) – thus has the same effect on environmental and non-environmental technology patenting. We will also investigate the effects of R&D support specifically targeted towards environmental technology development. Through this study we seek to contribute to the policy discussion on the effectiveness of the various R&D support alternatives. We have access to a detailed Norwegian firm level patent data set including both domestic and foreign patent citations where we identify the patenting firms through official organizational numbers, allowing a

better match with other important firm level data. We are thus able to control for firm size, the education level of each firm's employees, capital intensity, economic performance, industry affiliation, and more.

This project is part of Marit Klemetsen's PhD project in SSB.

A draft paper will be written in 2015.

*Project leader: Brita Bye, SSB*

### **II.11 Should environmental R&D be prioritized?**

There are at least two reasons to support private R&D: First, the R&D process generates knowledge spillovers from which all future innovators will benefit. Second, even if the innovator succeeds to patent her new idea, she will not be able to appropriate the full social benefit of her innovation. This project focuses on the appropriability problem for supporting R&D.

The point of departure is two innovations of equal social value; one lowers the cost of producing an ordinary market good that has no particular impact on the environment, whereas the other reduces the cost of pollution abatement. In the market good case, demand for a patented technology is given from the underlying preferences of consumers or the technology of firms. Governments seldom interfere with demand for a standard market good even if society could benefit from such an intervention. In contrast, in the environmental technology case the government is bounded to interfere with demand for the new technology through its environmental policy. No research has so far investigated whether this asymmetry implies that environmental R&D should be prioritized in public R&D budgets.

In order to analyze this question we apply a game theoretic model. In the first stage of the game an innovator invests in R&D under uncertainty. If the innovator succeeds, she obtains a patent and can market her idea as a technology improvement. If the new idea is a new production process for some market good, the government does not intervene and the innovator simply maximizes profit. To the extent that the realized increase in social surplus exceeds the value of the patent, there will be too little R&D and hence R&D should ideally be subsidized.

On the other hand, if the innovation is a new pollution abatement technology the government will want to change its environmental policy since the cost of reducing emissions has become smaller. Thus, the government affects demand for the innovation, and our research question is whether this intervention makes the discrepancy between the social value of the innovation and the private value of the patent larger than in the market goods case. A larger discrepancy implies that environmental R&D should receive a higher subsidy.

*Project leader: Mads Greaker, SSB*

## **II.12 Transitions to clean technologies**

Jointly funded by the EU Entracte project and CREE, researchers at the TSC have set up a series of lab experiments to study the effect of various instruments on the transition from a benchmark to a clean technology. The lab experiments have been carried out in 2014. An early assessment of outcomes suggest that both communication and the availability of commitment mechanisms support the transition, while a first-mover leadership is less effective as support. Framing the transition as ‘green’ increases overall support but makes subjects also less responsive to feedback from other group members.

In 2015, TSC will analyze the experiment outcomes and produce a working paper to be submitted to a journal. The research question is whether communication, commitment devices, leadership, and framing can support a transition to a clean energy system. The underlying structure of the problem is that the transition is costly, and the payoff for support by individual members is risky.

*Project leader: Reyer Gerlagh, Tilburg*

## **II.13 Effective climate policies with trade and international technology spillovers**

TSC has studied the consequences of international innovation spillovers between open economies when countries have heterogeneous environmental preferences. A key result is that the size of a coalition (both in terms of its number of researchers as well in terms of its market for demand) determines whether it is optimal to stimulate foreign clean production and

innovation, or to follow a protective policy for domestic clean production and innovation. In 2014 a paper was submitted to a journal.

*Project leader: Inge van den Bijgaert, Tilburg*

## **II.14 The market potential of new clean energy technologies**

In the future, electricity supply may be dominated by carbon-friendly technologies like floating windmills, solar power and Carbon Capture and Storage (CCS) electricity technologies. Governments are currently involved in the development of these technologies, and support basic research, demonstration facilities and market diffusion. It is hard for governments to know what role these technologies might play in the future, and hence to allocate their support optimally; there are plenty of different Carbon Capture on Storage power technologies, see, for example, Golombek et al. (2011), and also a number of renewable electricity technologies (floating wind mills, thermal solar, tides, stationary batteries, etc.).

According to standard economic theory, the social value of a new technology can be approximated by the area under the demand curve that exceeds the price of the technology. If the demand curve for a new technology is flat, the social value will typically be low, and vice-versa if the demand curve is steep. In general, the social value depends on a number of factors, in particular the price of GHG emissions. LIBEMOD determines investments in the energy industry for all European countries under uncertainty, including investment in climate-friendly technologies. By running Libemod with different sets of capital investment costs for climate-friendly technologies and prices of GHG emissions, we can estimate a system of demand functions for these technologies (one system for each price of emissions), and thus identify the social value of each technology. This project is funded by ENERGIX. See also WP5 for information.

*Project leader: Mads Greaker, SSB*



### **5.3 Regulation and Market (WP III)**

In this work package, the main question is how regulation of energy markets affects the development of green energy, and how measures to promote green energy impact the functioning of energy markets. It is of particular interest to study the implication of regulation across national borders, especially with respect to infrastructure, since an international regulatory framework is crucial for the exploitation of Norwegian energy and environmental resources, both in traditional areas and in new areas like capture and storage of CO<sub>2</sub>. The work is planned mainly as theoretical and empirical studies, but will also utilize numerical models, either already existing or developed in other work packages. As such, part of the work within this package will be conducted in cooperation with or as part of Working Packages 4 and 5.

#### **III.3 Integration of Intermittent Power in Northern-European Power Markets**

Wind power, on-shore as well as off-shore, and solar power has been identified as a key technologies for renewable energy, where the EU has an ambition that Europe should become a global leader and where countries like Denmark, the United Kingdom, Sweden and Germany already invest heavily, or have concrete plans to do so. Short-term variation in the availability of wind and solar power makes it difficult to integrate these technologies on a large scale in conventional energy systems, but with access to sufficient amounts of storable hydropower, the potential for wind is substantially larger. The idea that Scandinavia may become an electric battery - a "blue battery" - for Europe has therefore attracted considerable interest, both academically and politically. In this project, we ask to what extent the existing hydro capacity can accommodate a large-scale expansion of intermittent power in and around

the North Sea, taking account of the possibility of building pumped storage and the cost of constructing large international interconnectors that will provide back up and balancing capacity for the countries both inside and outside of the Nord Pool area.

Work on this project is documented in CREE Working Papers no 6/2012 and 14/2012. These papers will be prepared for journal publication. In addition, the book *Hydropower Economics* is being revised, where, in addition to extensions and improvements of existing chapters, two new chapters will be included, based on the above-mentioned working papers.

*Project leader, Finn Førsund, ØI*

### **III.4 Green Certificates and Competition in Electricity Markets**

A number of studies have analyzed how green certificates affect the functioning of electricity markets, both with respect to short-term price formation and long-term investment. One result is that green certificates may undermine the efficiency of energy markets by increasing price volatility. In addition, green certificates may provide market participants with the possibility of exploiting market power by imposing so-called "margin squeezes". In this project we study the importance of green certificates for electricity markets, and analyse how potentially negative effects may be counteracted by suitable regulation.

Work on this project was documented in 2013 in Nils-Henrik M. von der Fehr and Stephanie Ropenus, *Green Certificates, Vertical Relations and Market Power*. The paper is currently being revised for publication in a scientific journal.

*Project leader: Nils-Henrik von der Fehr, ØI*

### **III.5 Effects of Reduced Nuclear Capacity in Europe**

Following the Fukushima accident in 2011, some EU member states decided to phase out nuclear power. We explore the impact of an EU-wide nuclear phase out provided the proposal of the EU Commission to reduce GHG emissions by 40 percent in 2030 relative to 1990 is implemented. Using a numerical simulation model of the European energy industry (LIBEMOD), we find that a complete nuclear phase out in Europe by 2030 has a moderate impact on total production of electricity and only a tiny impact on total consumption of energy. Lower nuclear production is to a large extent replaced by more renewable electricity production, in particular wind power and bio power. More generally, the equilibrium

composition of electricity technologies reflects the stringency of the climate target, which climate instruments that are imposed and whether some technologies are being promoted, either directly through subsidies or indirectly through a tailor-made policy goal.

A draft paper suitable for submission to a journal has been written.

*Project leader: Rolf Golombek, Frisch*

### **III.6 Natural Resources and Sovereign Expropriation**

An important question for governments of countries endowed with large natural resources is how to govern these resources, including choice of ownership structure and rights to exploitation. An example is the Norwegian hydro resources, which, since the introduction of the "panic laws" in the early 20th century, have been governed by a regime in which "national" ownership is combined with leasing of exploitation rights to third parties. Questions of ownership and governance are inherently political and policies may change abruptly, following changes in government, changes in the value of the resources or other events. At the same time, the type and quality of governance is crucial for the efficient exploitation of natural resources. In this project we study such issues, including how the regime governing natural resources depend on political and economic factors, as well as how such factors, through their influence on the regime, affect the efficiency of resource exploitation.

During 2014, we have continued work on building a suitable theoretical model to study some of the relevant questions. This is a challenging process, given the inherent dynamic feature of the problem, which requires use of sophisticated mathematical techniques, and has taken more work and a longer time than originally envisioned. As planned, we have during 2014 developed a suitable model and finalized a first draft of a paper (Fridrik Baldursson and Nils-Henrik von der Fehr, Natural Resources and Sovereign Expropriation). In 2015, the paper will be further developed, with the aim of publication in a scientific journal. The project will also be extended in various directions, including studies of underlying issues concerning political economy.

Another part of this subproject is undertaken by Daniel Spiro who is a Post Doc at UiO funded by CREE. He studies how resource owners will behave with a risk of losing their resource due to nationalization, how this in turn affects the incentives for governments to nationalize such resources and how world prices for resources may be affected by such



interaction. The central result in this work is that nationalization in one country will be closely linked to nationalization in other countries. The analysis shows that if one country nationalizes its resource then resource prices will rise making it worthwhile for others to nationalize too, thus raising the price further. This way the model predicts waves of nationalization in correlation with price surges. The novelty of this paper is that it would be one of the first to analyze the interaction between political processes and world prices. While the main mechanism is in place, the remaining work relate to analyzing alternative equilibria and some extensions of the model.

*Project leaders: Nils-Henrik von der Fehr, ØI/Daniel Spiro, ØI*

### **III.7 Should Foresters Forecast?**

Growth dynamics of forests will likely be altered by climate change. As these shifts are hard to predict, this paper asks whether forecasting them is necessary for profitable management. While unpredictability of climate change makes it hard to calculate expected profit losses of not forecasting, by using Monte Carlo simulations we can obtain an upper bound of these losses. We show that an owner following a rule of thumb, which completely ignores future changes and only observes changes as they come, will closely approximate optimal management. If changes are observed without too much delay, profit losses and errors in harvesting are negligible. This has implications for the effort foresters should devote to long-run forecasting. It also implies the argument that boundedly rational agents may behave as if being fully rational has traction in forestry.

This has been published as a CREE WP:

*Gars, J. and D. Spiro: Should Foresters Forecast?, CREE WP 11/2014.*

Still, some work will be done to publish this in a journal.

*Project leader: Daniel Spiro, ØI*

### **III.8 The Hveding Conjecture: Optimal Operation of Hydro Power**

The thinking about how to operate hydro generation facilities in an integrated system has developed considerably over time, with ideas from economics gradually becoming more

influential. In this project this history will be revisited, with particular emphasis on the relevance and success of the so-called Hveding Conjecture.

This has resulted in a CREE WP in 2014:

*Førsund, F. R.: Hveding's Conjecture: On the Aggregation of a Hydroelectric Multiplant – Multireservoir System, CREE WP 17/2014.*

Still, some work will be done to publish this in a journal.

*Project leader: Finn Førsund, ØI*

### **III.9 Integration of, and Competition between, Electricity Market Places**

A new phase in the integration of the European electricity industry has been initiated with the coupling of physical trade on different regional market places. Some developments have already taken place, mostly based on bilateral agreements between regional players, but a more comprehensive approach is currently being taken by regulators in North-Western Europe, with the aim of subsequently extending the process to the rest of Europe. The coupling of trade not only raises question about how to harmonize market places and efficiently utilize physical interconnectors, but also how to handle competition between different market places. Such competition is already present in the UK, as well as in certain regions of Germany, but further integration may increase the extent of rivalry between market places. In this project, we study challenges raised by market coupling.

*Project leader: Nils-Henrik von der Fehr, ØI*

### **III.10 Flexibility in Electricity Markets**

Consumption and demand of electricity must be balanced at all times. Achieving this balance requires a high degree of flexibility, either on the supply side, on the demand side or both. Achieving the warranted flexibility has become more challenging with the increased share of intermittent and distributed generation. A fundamental question is whether this requires new ways of organizing and governing the electricity market, including the availability of contracts and market places to allow market participants, as well as system operators and other decision makers, to operate efficiently. In this project we aim to study such questions.

A preliminary analysis (Nils-Henrik von der Fehr: Market Time Unit) was developed in 2014 and presented at various conferences. In 2015, the work will be developed.

*Project leader: Nils-Henrik von der Fehr, ØI*

### **III.11 Conflicts and price contagion on resource and energy markets**

Whether the world market will make the transition to renewable energy sources and clean technologies by itself, largely depends on long-run prices of fossil energy and mineral inputs such as silicon and lithium which are needed in the new technologies. Likewise, to be able to analyze the efficiency of various policy measures curbing climate change or directed at renewable technology it is central to understand the long-run workings of fossil energy markets. Now, exhaustible resource markets are notoriously politicized. Yet there is virtually no literature on how world markets for these resources interact with national and international political incentives. The current project on contagious resource conflict aims to take a step in bridging this gap.

A well-known feature of many of these markets is that property rights are either not defined or not practically upheld. This is in particular the case for many minerals which are abundant in non-stable countries and which are necessary for production of renewable energy technologies. This would also be true for renewable energy resources such as wood in some countries. How does this feature of the world market affect global supply and prices? This is essential to understand when thinking about a future market for renewable energy relying on technologies whose supply is unpredictable. This project intends to study theoretically how world prices of such resources affect the prevalence of violence and conflict in unstable countries, how this feeds back to affect world prices and how this in turn may lead to conflict in other countries or regions. Apart from the theoretical part, the project intends to test the predictions using a new dataset of reserves and production of all resources in all countries over the last 20 years.

*Project leader: Daniel Spiro, ØI*

### **III.12 Finders keepers**

Related to the ongoing projects on Natural Resources and Sovereign Expropriation is the question of public policy and taxation. Governments do not only have the possibility to

expropriate the resource but can also change the tax schedule. Few governments can make promises on behalf of future governments several decades into the future, hence this is a real concern for private investment.

But what is the optimal tax scheme incentivizing exploration and investments that will provide the government with a large share as possible of the profits? Investments in hydropower, solar power installations and new resource deposits of oil and gas typically create incentives for a government to increase taxation after a major investment has been made. This in turn may lead to underinvestment. Another complication is that, normally, investments are made in the most profitable projects first. Then, if the tax scheme remains the same over time, projects with lower expected profits, but which are still profitable enough to warrant investment, may remain undeveloped due to the distortionary tax.

This project analyses theoretically what the optimal taxation will be in such a case of limited commitment to future taxes, how the tax will change after findings have been made and how it will change over time as investments become less and less profitable. It also aims to study how this depends on the type tax used (royalty, profit tax, etc).

*Project leader: Daniel Spiro, ØI*

### **III.13 Systems for refunding emission payments**

We analyze two mechanism designs for refunding emission payments to polluting firms: Output Based (OB) and Expenditure Based (EB) refunding. In both instruments, emissions fees are returned to the polluting industry, typically making the policy more politically acceptable than a standard tax. The crucial difference between OB and EB is that the fees are refunded in proportion to output in the former, but in proportion to the firms' expenditure on abatement equipment in the latter. We show theoretically that to achieve a given abatement target, the fee level in the OB design exceeds the standard tax rate, whereas the fee level in the EB design is lower. Furthermore, the use of OB and EB refunding may lead to large differences in the distribution of costs across firms. Both designs imply a cost-ineffective provision of abatement as firms put relatively too much effort into reducing emissions through abatement technology compared with reducing output or improving management. However, maintaining output may be seen as a political advantage by policymakers if they seek to avoid activity reduction in the regulated sector. A first version of this paper is about to be finalized

(Hagem, C. Hoel, M. Holtmark, B. and Sterner, T., Refunding emission payments), and we will soon submit it to an international journal.

*Project leader: Cathrine Hagem, SSB*



#### **5.4 Evaluation of Environmental and Energy Policy Measures (WP IV)**

In the first three years, the activities in WP4 have focused on four research topics:

- a) Rebound and adverse effects of energy efficiency measures.
- b) The households' response to soft policy measures.
- c) Environmentally friendly transportation.
- d) Indoor temperature and energy consumption in families with children.

The work on WP4 is undertaken in four research communities: economists from Statistics Norway (SSB), social anthropologists from Centre for Development and the Environment (SUM), and economists from the Frisch Centre/University of Torino and the Department of Economics at the University of Oslo (ØI). The different research communities will apply a variety of methods to analyse the research questions listed above. The economists at SSB apply micro econometric analysis to estimate how policy tools affect household energy demand based on micro data from the Norwegian Survey of Consumer Expenditure. The social anthropologists from SUM apply social practice theory to describe how energy is a part of daily tasks, and how policy measures affect habits and the interrelation between household members, and through this its effects on household energy consumption. The economists at

Frisch/Torino/ØI will build a micro simulation model for car purchases based on estimations on vehicle purchase data. Simulations will be done to analyse how the goals for a reduction in CO<sub>2</sub> emissions in 2020 may be achieved. In addition, economists from the Frisch Centre will use experimental economics method to perform a field experiment, aiming to explain more in depth some specific aspects of the households' decisions.

In 2014, analysis of the effects of energy efficiency and soft policy measures on household energy consumption has continued both at Statistics Norway and at SUM. Some of these studies were finished in 2014, and some will continue into 2015. The work package also includes the works on three PhD-theses (Dalen, Klemetsen and Ciccone).

#### **IV.1 Rebound and adverse effects of energy efficiency measures**

In quantitative studies by SSB Norway, a rebound effect has been detected after households have installed a heat pump. In this paper we use an interview sample with 28 households to attempt to identify and interpret changes in practices that may have contributed to rebound in electricity consumption after a heat pump is taken into use. The results show that a comfort rebound effect (direct rebound) is at work in two specific senses. First, people expand the time period in which they heat the home (both daily and seasonally). Second, users expand the total space of the house heated after heat pumps are taken into use. We point to a general attitude among many of the respondents that these changing practices were justified because of their investments in and anticipated savings from the heat pump. Finally, the study found that people did not keep a close accounting of money saved by the heat pump nor could they associate any particular investment or purchase with the savings. This lack of accounting by the users makes it difficult to pin down indirect rebound effects. See:

*Winther, T. and H. Wilhite (2014): An analysis of the household energy rebound effect from a practice perspective: spatial and temporal dimensions, Energy Efficiency, 7(5). DOI 10.1007/s12053-014-9311-5.*

Several ongoing studies on this topic will be completed in 2015. First, researchers at Statistics Norway have analyzed the effects of heat pump ownership on household energy consumption (reported last year). This paper will be processed further for publication in an international in 2015.

In addition, economists at Statistics Norway have conducted an analysis of the main drivers for the sharp increase in the proportion of households that have acquired heat pumps in

Norway. This development has occurred very rapidly and almost without public subsidies. We have not seen similar structural changes in heating technology in Norwegian homes since the transition from wood and oil to electricity in 1970 - and 80's. We study the characteristics of households that have acquired a heat pump. Preliminary results indicate that this increase is largely driven by economic conditions to reduce fuel costs, and a change in heating technology appears to have occurred in all walks of life. This paper will be finished and submitted for international publication in 2015. The paper will also be published in CREE's working paper series.

In an interdisciplinary paper, economists and anthropologists study the perplexing case of the Norwegian heat pump ownership, a technology that theoretically should reduce household heat consumption by up to 25%, but when taken into use results in little or no change in electricity consumption. Our two coordinated studies find a major change in how households heat their residences after acquiring a heat pump. The anthropological study shows that many households increase the heated living area and no longer turn down the heat at night and when away. The economic study quantifies large effects of heat pump ownership on the consumption of all energy sources. On average, households with and without a heat pump use approximately the same amount of electricity, implying that the changes in behavior discussed in the anthropological study completely offsets the savings potential of the heat pump. However, total energy consumption is lowered and energy efficiency is increased since the consumption of firewood and fuel oils are reduced. A first draft of this paper is finished, and invited to be submitted to a special issue of *Journal of Indoor and Built Environment*. The paper will also be published in CREE's working paper series.

*Project leaders, Bente Halvorsen, SSB/Tanja Winther, SUM*

#### **IV.2 The households' response to soft policy measures.**

Anthropologists at SUM, in collaboration with economists at CICERO, have tested how households adapt to visual in-home displays of their electricity consumption. The displays were tested out in 26 homes at a housing cooperative at Røverkollen in Oslo. The study analyzed how the different members of the household reacted and interacted with the new technology, and recorded how they used it to monitor and control their consumption of electricity. The study found that many households were surprised by how much (or little) electricity different appliances used. Several of the households changed their habits based on

the new information, by changing electric ovens or light bulbs. The collection of empirical material has been completed, and the work will result in two international scientific papers in 2015. A summary in Norwegian has been published on our webpage under [http://www.cree.uio.no/publications.html#Other\\_publications](http://www.cree.uio.no/publications.html#Other_publications).

*Project leader: Tanja Winther, SUM*

### **IV.3 Environmentally friendly transportation.**

As part of Alice Ciccone's PhD project funded by CREE, she analyzed the impact of the purchase tax on new cars; this reform was announced in connection with the Government Budget in October 2006 (effective from 1 January, 2007). Sales data revealed there was a strong increase in the sales of cars with high CO<sub>2</sub> emissions during the fall of 2006. Thus the announcement of the new policy had an impact on CO<sub>2</sub> emissions in the fleet of cars after October 2006. But it also seems that the total sales of cars were not changed very much. Thus cars that otherwise would have been bought with somewhat lower CO<sub>2</sub> emissions in the fall of 2006 were replaced by bigger cars with higher potential CO<sub>2</sub> emissions. Sales in 2007 did not drop. For that reason the policy implemented since January 1<sup>st</sup> 2007 had a lasting impact on CO<sub>2</sub> emissions in the fleet of new cars after this date.

This has resulted in the following publication:

*Ciccone, A.: Is it all about CO<sub>2</sub> emissions? The environmental effects of a tax reform for new vehicles in Norway, CREE WP 9/2014.*

In 2015 we will work to get this published in a journal.

Reyer Gerlagh and Inge van den Bijgaart (jointly with Hans Nijland and Thomas Michielsen,) at Tilburg Sustainability Center have studied the effects of fiscal personal vehicle policies on the CO<sub>2</sub> emissions-intensity of new bought cars in the EU. They find clear empirical evidence that CO<sub>2</sub> sensitive registration taxes and fuel taxes shift the car fleet additions to more fuel-efficiency. A manuscript will be submitted for a WP before December 2014. The plan is to extend the research on the effects of fiscal policies on new car sales in 2015, looking more closely to the response by car manufactures, in terms of their price setting. One result so far is that there is evidence that car prices excluding taxes are structurally different between countries in response to fiscal measures.

*Project leaders: Alice Ciccone, ØI/Reyer Gerlagh, Tilburg*



#### **IV.5 Residential end-use electricity demand**

It is costly and difficult to meter electricity consumption for different end uses, e.g. space heating, lighting and household appliances. We deduce a model for using cross-sectional data for total annual electricity consumption for a sample of households, together with information from energy surveys, to estimate the end uses within an econometric demand model conditional on appliance ownership. By applying a consistent method to Norwegian data for 1990, 2001 and 2006 (repeated cross-sections), we compare results over time and detect possible trends. We find that electricity consumption for many end use necessities such as washing, water heating and refrigeration varies somewhat from year to year, but they show no trend. We find a steady increase in electricity used for more untraditional end uses and newer types of appliances. Total energy consumption for heating purposes is quite stable over the time period. See:

*Dalen, H.M. and B.M. Larsen (2013): "Residential end-use electricity demand: Development over time". Discussion papers 736, Statistics Norway, forthcoming in Energy Journal.*

*Project leader, Bodil M. Larsen, SSB*

#### **IV.11 Which policy instrument induces the best environmental performance in firms?**

We study the effects of various environmental regulations on environmental performance measured as emission intensity. Moreover, we aim to test whether any such effects are persistent or only temporary. Conventional theory predicts that indirect regulations as opposed to direct regulations provide continuous dynamic incentives for emission reductions. Our unique Norwegian firm level panel data set allow us to identify effects from different types of regulations such as environmental taxes, non-tradable emission quotas and technology standards. The data includes information of different environmental regulations, all kinds of polluting emissions, and a large number of control variables for all polluting incorporated firms. Empirically we identify positive and significant effects from both direct and indirect policy instruments. We also investigate whether the regulations provide continuous dynamic incentives that lead to persistent effects. In contrast to what the literature suggests, we find evidence that direct regulations promote persistent effects. Indirect regulations will, on the other hand, only have potential persistent effects if environmental taxes are increasing over time. See:

*B. Bye and M.E. Klemetsen (2014): The impacts of alternative policy instruments on environmental performance: A firm level study of temporary and persistent effects, CREE WP 14/2014.*

This is part of Marit Klemetsen's PhD project, and the paper is submitted to *Energy Journal*.

*Project leader: Brita Bye, SSB*

#### **IV.13 Agent based modelling**

In Dalen's PhD-thesis, the construction of a simulation model based on the agent based modeling framework is planned for 2015. The model will be used to analyze the diffusion and consumption of energy efficient household cooling appliances. The model is further complemented with econometric analyses of the effect of energy labeling and standards for cooling appliances on household electricity consumption. The results from these analyses will be presented in Dalen's PhD-project that is planned finished in 2015. The results are further planned to be presented in two articles intended for international publication.

*Project leader: Hanne Marit Dalen, SSB*

#### **IV.14 Development in the households' stock of heating equipment**

As many policy instruments are attached to household energy consumption for heating purposes, information about what heating equipment the households own and how they use it, is of greater importance. On request from the Norwegian Water Resources and Energy Directorate, Statistics Norway have documented data describing the development of the stock of heating equipment and the use of this equipment, based on the Consumer Expenditure Surveys of 1993, 1994, 1995, 2001, 2004, 2006, 2009 and 2012. It also includes a literature study, describing the main results from various Norwegian studies on related topics. The tables will be documented in Statistics Norway's Notater series. See:

*A.C. Bøeng, B. Halvorsen and B.M. Larsen (2014): «Kartlegging av oppvarmingsutstyr i husholdningene - En dokumentasjon av data fra Forbruksundersøkelsen», forthcoming as Notater, Statistics Norway.*

*Project leader: Bente Halvorsen, SSB*



## **5.5 The Next Generation of Numerical Models (WP V)**

To analyze policies that stimulate innovation and diffusion of new environmentally friendly technologies, integrated economy-energy-environment models are necessary tools. At CREE we have the energy market model LIBEMOD, the petroleum market model PETRO2, and the new family of integrated macroeconomic Computable General Equilibrium (CGE) models; the SNoW-models (Statistics Norway World models).

Development and updating of numerical models are very resource-intensive activities. Outputs from these activities will materialize as papers under the other work packages. Below we concentrate on projects that are not part of other WPs.

### **LIBEMOD**

In 2014 the activities to update and upgrade the numerical model LIBEMOD were finalized. Building on economic theory, this model provides a detailed modeling of the energy markets in 30 European countries. It encompasses all activities in the energy markets: investment, extraction of fossil fuels, production of bioenergy and electricity, trade in energy and consumption of energy. LIBEMOD produces a consistent set of quantities and equilibrium prices.

In the new version of the model more countries have been added (13 East-European countries); the end-user sectors have been refined (the service and public sector has been

separated from the household segment); the modeling of wind power has been changed and more renewable technologies have been included (run-of-river hydro and solar power); the modeling of natural gas has been refined; bioenergy has been split into biomass and biofuel; all data have been updated (the data year has been changed from 2000 to 2009) and the complete model has been recalibrated. A detailed documentation of the new version of LIBEMOD is now available at <http://www.frisch.uio.no/ressurser/LIBEMOD/>

The new version of LIBEMOD has been converted into a stochastic model. Here we build on stochastic programming where a crucial distinction is made between decisions made before the uncertainty is revealed, and decisions made afterwards. To this end the stochastic LIBEMOD has two periods. In period 1, some actors make decisions under uncertainty, that is, to determine their future capacities through investments. In the beginning of period 2, the uncertainty is revealed and all actors learn the true state of the economy, that is, which scenario that has materialized. Then all actors make decisions; producers determine how much to produce (given the predetermined capacities), arbitrators determine how much to trade, and consumers determine how much to consume.

For each realization of the uncertainty, the model determines supply of, and demand for, all goods from all agents and the corresponding vector of prices that clears all markets. In fact, the stochastic equilibrium model determines simultaneously all quantities (investment, production, trade and consumption) and all market clearing prices for all possible future states. The determination of quantities and prices are based on the assumption that all actors have rational expectations, that is, when investment decisions are taken in the first period actors take into account the probability distribution over the scenarios and the equilibrium prices of all scenarios. So far, the source of uncertainty is future climate policy – political uncertainty – but more applications are planned, see below.

*Project leader: Rolf Golombek, Frisch*

## **SNoW models**

In 2014 we have continued to develop our new family of integrated macroeconomic Computable CGE models for energy and environmental policy analyses; the SNoW-models (Statistics Norway World models). SNoW\_No is our new CGE model for Norway with 41 industries, based on the GTAP database structure (a global database on trade, environmental and energy) and programmed in GAMS. The model is continuously being developed to make

the model more like SSB's earlier version of a computable general equilibrium model for Norway, the MSG-model, which has been used by the Ministry of Finance for decades. Many of these new properties have not been implemented in GTAP-based models before, and examples are modelling of process emissions and a more detailed consumer system.

*Project leader: Taran Fæhn/Orvika Rosnes, SSB*

## **The petroleum market model – PETRO2**

PETRO2 is a dynamic simulation model that analyses how market conditions and/or climate-/energy-policies affect the oil market. PETRO2 models oil as a non-renewable resource implying that the oil price contains a scarcity rent. PETRO2 further models OPECs degree of market power. The main outputs from the model are short and long run oil prices and production/consumption.

PETRO2 has seven demand and supply regions: OPEC, Western Europe (EU/EFTA), USA, Rest-OECD, Russia, China and Rest of the World. In each region there are seven sectors demanding oil: Industry, Household, Other sectors (private and public services, defense, agriculture, fishing, other), Electricity, Inland transport (road and rail), Aviation and domestic and International shipping. This division into demand regions and sectors permits us to consider more closely developments for example in the transport sector in some selected regions. PETRO2 includes six energy commodities: Oil (which is an aggregate of different oil products), Gas, Electricity, Coal, Biomass and Biofuels for transport. The oil price is endogenous and the other energy prices are exogenous. This feature of the model permits users to study how changes in demand and/or price of these five non-oil energy goods may influence the oil market. A crucial feature of the model is that it makes both short and long term adjustments to supply and demand taking into account that responses to changes in the oil market often are delayed or sluggish.

Non-OPEC regions (the fringe) are modeled as perfect competitors and OPEC has market power. OPEC may be modeled to either include all OPEC countries OR to include just the OPEC-core (the Gulf States: Saudi Arabia, Kuwait, Qatar, UAE). OPEC maximizes profit over time and takes into account that demand is price sensitive and therefore produces less than a perfect competitor would do.

PETRO2 has a rich data foundation from multiple sources and is calibrated to match the New Policies price scenario of the International Energy Agency. The start-year is 2007 and the time-period is one year.

*Project leader: Kristine Grimsrud, SSB*

### **Policy analyses on the SnoW models**

In 2014 Snow-No has been used to analyze emission scenarios for Norway dependent on different assumptions on important exogenous variables as international oil-price, international business cycles, and population forecasts. The scenarios are documented in an article submitted to *Samfunnsøkonomen*.

*Greaker, M. and O. Rosnes (2014): Robuste norske klimamålsetninger (revised version submitted to Samfunnsøkonomen).*

*Project leader: Mads Greaker, SSB*

In another project we use the dynamic version of the SNoW\_No model to analyze environmental and economic efficiency effects of climate- and energy efficiency policies. This is part of the EU project ENTRACTE. We model energy efficiency measures and technology costs based on a report by IFE on long-term scenarios for energy efficiency investment costs in buildings. This continues our cooperation with IFE on energy efficiency investments. The project is going to be presented at a workshop in Milan in February 2015, and synthesized in a report with FEEM (Milano) in May 2015.

*Bye, B., T. Fæhn og O. Rosnes (2014): Energy efficiency and European carbon policies: A CGE-analysis with endogenous investments in new technologies, Manuscript.*

*Project leader: Brita Bye, SSB*

The global model has been used in two different projects analyzing policies to curb carbon leakage, see project I.5 above. The first paper investigates how carbon taxes combined with output-based rebating (OBR) in an open economy perform in interaction with the carbon policies of a large neighboring trading partner. This paper is submitted to an international journal. The other paper concerns possibilities, limitations, and implications of various border carbon adjustment (BCA) systems designed particularly for targeting the emission intensities of foreign producers. Succeeding to design and implement such systems would improve the

efficiency and effectiveness of BCAs. The final working paper will be submitted to an international journal by March 2015.

*Böhringer, C., B. Bye, T. Fæhn and K.E. Rosendahl (2014a): Output-based rebating of carbon taxes in the neighbor's backyard: Competitiveness, leakage and welfare, CREE Working Paper 6/2014. Submitted to Canadian Journal of Economics.*

*Böhringer, C., B. Bye, T. Fæhn and K.E. Rosendahl (2014b): Targeting border carbon adjustments: Welfare and leakage effects of firm specific tariffs, Manuscript.*

*Project leader: Brita Bye, SSB*

## **6 International cooperation**

Each of the Norwegian research partners in CREE has a large international network and it will be difficult to give a comprehensive and detailed report of all the collaboration with foreign researchers. Below we give some examples of this activity.

There is an international research partner in CREE, Tilburg Sustainability Center, and we also have contracts with several foreign researchers who have part-time positions paid by CREE:

Fridrik Baldursson, Reykjavik University

Christoph Böhringer, Oldenburg University

Jared Carbone, University of Calgary.

CREE organizes an annual research workshop where we invite our international research partners, those having a part-time position in CREE, as well as other relevant researchers from our network.

Our seminar series also has presentations by foreign scholars; see our website <http://www.cree.uio.no/seminars.html>, and our researchers are active presenting their research at seminars at different international research institutes and universities, and at conferences and seminars. We also have an exchange of researchers as our researchers and PhD students regularly visit foreign universities for shorter and longer stays, and foreign researchers visit our institutions.

We have ongoing collaborative projects with foreign researchers in CREE. Some of these projects are reported in the CREE working paper series, while others have been reported in other series and in international publications. We also have cooperation that has not yet resulted in publications, for example through the CESifo network where several of our researchers are research fellows (Michael Hoel is also area director of Energy and Climate Economics at CESifo), both under projects that are directly funded by CREE, and also under projects that count as our own funding (ENERGIX, MILJØ2015 and NORKLIMA).

CREE is part of the ENTRACTE project (Economic iNsTRuments to Achieve Climate Targets in Europe) funded by the seventh EU Framework Programme. The project group consists of a consortium of nine European applied research centers, and is headed by Zentrum für Europäische Wirtschaftsforschung (ZEW). CREE heads one of the work packages and three research tasks, which involve collaboration with researchers from the other research centers. CREE further has achieved funding from the Research Council of Norway to deepen the collaboration with the ENTRACTE network. We are also involved in other international consortiums that are planning proposals for HORIZON2020 and Nordic Flagship Projects (Nordic Energy Research).

Climate change is the underlying factor of all the research in CREE as this creates the need for environmentally friendly technology, and IPCC (Intergovernmental Panel on Climate Change) is setting the agenda for most debate and policy making on this issue. CREE researchers have been involved in the IPCC process since the second assessment report (published in 1995). In the fifth assessment report (published in 2013 and 2014), CREE researchers have been involved in working group III (Mitigation of Climate Change). Reyer Gerlagh (Tilburg Sustainability Center) has been a coordinating lead author, Annegrete Bruvoll (Vista Analyses/Statistics Norway) has been a lead author, and Snorre Kverndokk (Frisch Centre) has been a review editor. In addition, Gerlagh also contributed to the Synthesis Report. These researchers have also been active in the media activity following the publications of the reports.

An important arena for our research is the European Association of Environmental and Resource Economists (EAERE). One CREE researcher - Karine Nyborg - at the University of Oslo was the president of the European Association of Environmental and Resource Economists (EAERE) in 2012 and 2013, and CREE researchers have received international prizes for their research by EAERE the last few years (Hoel, Harstad, Nyborg). Due to the



importance of this conference for our researchers, CREE (together with CICEP and UiO Energy) has applied for organizing the EAERE conference in 2017.

As most of our researchers have an international network, we do not have a coordinated policy on internationalization, apart from helping PhD students to get contacts abroad.

## **7 Recruitment**

The overall aim for CREE has been to recruit three PhD students and one post-doc researcher over the lifetime of CREE. Originally the plan was to recruit two post-doc researchers, but due to lack of external funding as well as satisfactory funding of post docs at the Department of Economics, University of Oslo, we decided to only fund one post doc directly. Two PhD students were recruited in 2011 and one in 2014, while we recruited one postdoc researcher in 2012. The research recruits are studying at the PhD program at the Department of Economics, University of Oslo. The Post Doc is also employed at the same department. In addition, we contribute to the funding of one PhD student at Statistics Norway and one Post Doc at Tilburg University.

CREE gives a master scholarship of NOK 20.000 to up to three master students annually. These are offered an office at one of the Norwegian research partners, supervision by one or two of the CREE researchers, access to all CREE arrangements, and the possibility to publish their thesis in the CREE Working Paper series.

In connection with the recruitment of candidates, we are also engaged in research training through teaching and supervising at the Tilburg University and the University of Oslo, both at the masters and PhD level. Further, we were involved in MILEN's research school, an interdisciplinary research school for PhD candidates in energy and environment at the University of Oslo that existed until 2014. At this research school, we gave seminars, lectures, and also organized a one-week PhD course on integrated assessment models in 2013. In 2014, we have also financially supported a PhD course at SUM (Centre for Development and the Environment, University of Oslo) called 'Consumption, Capitalism and Everyday Life: Understanding the Social Dimensions of the Growth Imperative'. Finally, we contributed to the research school of all the FME centers; NORREN, by providing lecturers.

When it comes to recruitment of women, two out of three PhD students funded by CREE have been women. Also, the majority of students receiving a master scholarship has been women. At the moment no special attention is needed to recruit women, as a significant part of PhD

students in economics are women. For instance, at the Frisch Centre, six out of seven PhD students are women. When it comes to permanent research positions, the situation is different, however, environmental and energy economics seems to be one of the most attractive fields for women within economic research. Due to the difficult funding situation at the CREE partners, we have not been able to employ permanent researchers within this field the last few years.

## **8 Cooperation with other FME centres**

CREE has a close collaboration with CICEP, one of the other social science-related energy research centers (FME Samfunn) funded by the Research Council of Norway. CICEP has many overlapping projects with CREE as both have a large interest in international climate negotiation and agreements. Every spring CREE and CICEP organize a user conference together for our research partners and other interested institutions. We also organize research workshops together, write joint research proposals and have some joint research projects. CREE and CICEP have also sent an expression of interest to organize the EAERE conference in 2017 together with UiO Energy. EAERE is the European Association of Environmental and Resource Economists.

In addition, we have some common interests with CenSES, the third FME Samfunn, in numerical modelling of energy markets, and we organize workshops and Model Forums together. In 2014 a joint workshop was organized for all the FME-S centres (CREE, CICEP and CenSES). The workshop was held in Trondheim in November and the topic was uncertainty and investment risk in the energy sector.

When it comes to the technological FME centers, we do not have any formalized cooperation as we work in quite different fields, use very different methodologies and address quite different research questions. However, we do have regular meetings with them, both during the RCN contact meetings for FME centers and also by inviting them to CREE seminars. In addition, our technological subcontractors, IFE and SINTEF Energy, are partners in some of these FME centers, and we, therefore, have input from the technological research through them.

## 9 Communication and dissemination

The main users of CREE are, in addition to the research community, industry, Government and the general public. The communications to users are mainly through the following channels:

- Dissemination of research and media activity through our webpage ([www.cree.uio.no](http://www.cree.uio.no))
- Hold an annual user conference (April). This is organized together with CICEP. In addition we give a seminar for all users every fall (November)
- Organize user activities such as meetings and seminars
- Organize a Model Forum (once or several times a year) where users together with researchers in other disciplines can make contributions to economic modeling.
- Publish in Norwegian-language journals such as Samfunnsøkonomen and Økonomiske analyser.
- We contribute to hearings in the Parliament and public debates.

CREE has invested heavily in communication, for instance through an internal reward system for communicating through the media. We have dedicated a website for news on CREE research, see [http://www.cree.uio.no/CREE\\_in\\_the\\_news.html](http://www.cree.uio.no/CREE_in_the_news.html), and had more than 25 reports in the media in 2014. Researchers from CREE have been involved in key debates in the media over the past year on subjects such as global warming, electric vehicles and the effect of reduced extraction of oil as climate policy.

When it comes to user-oriented communication measures, we usually give about 80-100 presentations each year. This includes meetings with all user partners, seminars, workshops and conferences. In addition to the two regular user arrangements in the spring and the fall, we organize seminars for users that are interested in certain topics. In 2014 we organized a seminar at the Ministry of Climate and Environment.



## **CREE - Oslo Centre for Research on Environmentally friendly Energy**

**Name:** CREE

**Address:** Frisch Centre, Gaustadalléen 21, 0349 Oslo, Norway

**Phone:** 22 95 88 10

**E-mail:** [cree-admin at frisch.uio.no](mailto:cree-admin@frisch.uio.no)

**Web:** [www.cree.uio.no/](http://www.cree.uio.no/)

**Annual report: CREE**  
**Appendix: A1 Personnel**

**Key Researchers**

<b>Name</b>	<b>Institution</b>	<b>Main research area</b>
Golombek, Rolf	Frisch Centre	Environmental Economics, Energy Economics, Applied Game Theory
Hallre, Hilde	Frisch Centre	Environmental Economics
Hauge, Karen	Frisch Centre	Environmental Economics
Kittelsen, Sverre	Frisch Centre	Production theory, Efficiency measurement, Regulation, Health Economics, Energy Economics
Kverndokk, Snorre	Frisch Centre	Environmental and Resource Economics, Health Economics
Nævdal, Eric	Frisch Centre	Resource Economics, Economic management of ecological systems, dynamic optimization, modeling of the risk of disasters, animal behavior
Røgeberg, Ole	Frisch Centre	Welfare analysis, endogenous preferences, rational addiction theory, consumer theory
Strøm, Steinar	Frisch Centre	Microeconomics
Asheim, Geir	Department of Economics, University of Oslo	Game theory, intergenerational justice, green national accounting
Brekke, Kjell Arne	Department of Economics, University of Oslo	Behavioral Economics, Experimental Economics, Resource and Environmental Economics, Real options and stochastic analysis
Førsund, Finn	Department of Economics, University of Oslo	Resources, energy, environment, production theory, productivity
Framstad, Nils Christian	Department of Economics, University of Oslo	Stochastic optimization
Harstad, Bård	Department of Economics, University of Oslo	Political Economics, Public Economics, Contract Theory, Environmental Economics
Hoel, Michael	Department of Economics, University of Oslo	Energy and climate economics, environmental economics, resource economics
Lund, Diderik	Department of Economics, University of Oslo	Resources, energy and environment, economics
Nyborg, Karine	Department of Economics, University of Oslo	Environmental economics, economic analysis of social and moral norms, behavioral economics.
Vislie, Jon	Department of Economics, University of Oslo	Microeconomics, environmental economics, incentives, public economics
Von der Fehr, Nils	Department of Economics, University of Oslo	Microeconomics, Industrial Economics, Regulation, Competition Policy.
Aune, Finn Roar	Research Department, Statistics Norway	Energy and environmental economics
Bye, Brita	Research Department, Statistics Norway	Macroeconomic
Fæhn, Taran	Research Department, Statistics Norway	Macroeconomic
Greaker, Mads	Research Department, Statistics Norway	Energy and environmental economics
Grimsrud, Kristine M.	Research Department, Statistics Norway	Energy and environmental economics
Hagem, Cathrine	Research Department, Statistics Norway	Energy and environmental economics
Halvorsen, Bente	Research Department, Statistics Norway	Energy and environmental economics
Holtmark, Bjart	Research Department, Statistics Norway	Energy and environmental economics
Isaksen, Elisabeth	Research Department, Statistics Norway	Energy and environmental economics
Thuestad		
Larsen, Bodil Merethe	Research Department, Statistics Norway	Energy and environmental economics
Rosnes, Orvika	Research Department, Statistics Norway	Energy and environmental economics
Storrøsten, Halvor B.	Research Department, Statistics Norway	Energy and environmental economics
de Zeeuw, Aart	Tilburg Sustainability Center	Sustainability, Dynamic game theory, Environmental economics, Environmental policy, Mathematical economics
Gerlagh, Reyer	Tilburg Sustainability Center	Climate Change, Economics, Energy economics, Environmental economics
van der Heijden, Eline	Tilburg Sustainability Center	Risk behaviour and time preferences, behavioral economics

**Associated Researchers**

Baldursson, Fridrik	Reykjavik University	Financial Economics, Industrial Economics, Environmental and Resource Economics
Böhringer, Christoph	University of Oldenburg	Energy Economics
Carbone, Jared	University of Calgary	Environmental and Resource Economics
Eyckmans, Johan	Hogeschool-Universiteit Brussel	Economics of climate change, emissions trading, applications of game theory to the formation of international environmental agreements, cost benefit analysis, general equilibrium and integrated assessment modeling, evaluation of environmental policies, economics of waste management, industrial organization and normative economic theory
Green, Richard	Imperial College London	Energy markets
Liski, Matti	Aalto University School of Economics	
Rosendahl, Knut Einar	Research Department, Statistics Norway	Energy and environmental economics

**Post Doc students with financial support from the Centre budget**

Name	Funding	Nationality	Period	Sex M/F	Topic
Spiro, Daniel	CREE	Swedish	2012-2016	M	Energy and environmental economics
Okullo, Samuel Jovan	CREE	Dutch		M	Energy economics, resource economics, climate economics, and firm behavior

**PhD students with financial support from the Centre budget**

Name	Funding	Nationality	Period	Sex M/F	Topic
Ciccione, Alice	CREE	Italian	2011-2015	F	Economic of the climate change with econometric
Klemetsen, Marit	CREE	Norwegian	2011-2015	F	Innovation in energy- and environmental technology industries: Identifying knowledge externalities and effects of policies
Wahlquist, Henning	CREE	Norwegian	2014-2018	M	Energy markets and uncertainty.

**PhD students working on projects in the centre with financial support from other sources**

Name	Funding	Nationality	Period	Sex M/F	Topic
Midttømme, Kristoffer	Department of Economics, University of Oslo	Norwegian	2011-2014	M	Technology diffusion
Dalen, Hanne Marit	Research Department, Statistics Norway	Norwegian	2009-2014	F	The use of multiple instruments in energy and environmental policy.
Mideksa, Torben	Department of Economics, University of Oslo	Swedish	2012-2016	M	Primary Concentration: Contract Theory Secondary Concentrations: Environmental Economics and Political Economics
Holtsmark, Katinka Kristine	Department of Economics, University of Oslo	Norwegian	2012-2016	F	Development Economics, Natural Resource Economics, Microeconomics
van den Bijgaart, Inge M.	Tilburg Sustainability Center	Dutch	2012-2016	F	Innovation, technological change, environmental policy

## A2 Statement of Accounts

(All figures in 1000 NOK)

### Funding

	Amount
The Research Council	8 309
<b>Research Partners (own funding)</b>	
Frisch Centre (Host Institution)	4 569
Statistics Norway	5 039
Department of Economics,UoO	1 000
Tilburgs Sustainability Center	250
<b>User partners</b>	
Statkraft Energy AS	100
Statnett	250
Statoil ASA	250
<b>Public partners</b>	
University of Oslo	500
<b>Total</b>	<b>20 267</b>

### Costs

<b>Research Partners</b>	
Frisch Centre (Host Institution)	8 878
Statistics Norway	6 609
Department of Economics, UoO	2 421
Tilburgs Sustainability Center	500
Centre for Development and the Environment, UoO	530
The Faculty of Law - Natural Resources Law, UoO	155
Institute for Energy Technology (IFE)	200
SINTEF	974
<b>Total</b>	<b>20 267</b>

## A3 Publications

### Journal papers

([http://www.cree.uio.no/publications.html#Scientific Journals](http://www.cree.uio.no/publications.html#Scientific_Journals))

**Barrett, S., T.M. Lenton, A. Millner, A. Tavoni, S. Carpenter, J.M. Anderies, F.S. Chapin III, A.-S. Crépin, G. Daily, P. Ehrlich, C. Folke, V. Galaz, T. Hughes, N. Kautsky, E.F. Lambin, R. Naylor, K. Nyborg, S. Polasky, M. Scheffer, J. Wilen, A. Xepapadeas and A. de Zeeuw (2014):** Climate engineering reconsidered, *Nature Climate Change* 4, 527–529.

**Böhringer, C., B. Dijkstra and K.E. Rosendahl (2014):** Sectoral and regional expansion of emissions trading, *Resource and Energy Economics*. Volume 37, August 2014, Pages 201–225

**Böhringer, C., C. Fischer and K.E. Rosendahl (2014):** Cost-Effective Unilateral Climate Policy Design: Size Matters, *Journal of Environmental Economics and Management*. Volume 67, Issue 3, May 2014, Pages 318–339

**Böhringer, C., K.E. Rosendahl and J. Schneider (2014):** Unilateral Climate Policy: Can OPEC Resolve the Leakage Problem?, *The Energy Journal* 35 (4), 79-100.

**Braaten, R. H. (2014):** Land Rights and Community Cooperation: Public Goods Experiments from Peru, *World Development Volume 61*, September 2014, Pages 127–141

**Braaten, R. H. (2014):** Testing deontological warm glow motivation for carbon abatements, *Resource and Energy Economics*, Volume 38, November 2014, Pages 96-109, ISSN 0928-7655

**Castagneto-Gissey, G. and R. J. Green (2014):** Exchange Rates, Oil Prices & Electricity Spot Prices: Empirical Insights from EU markets, *Journal of Energy Markets*, vol. 7, no. 2, pp. 3-33

**Eggert, H. and M. Greaker (2014):** Promoting Second Generation Biofuels: Does the First Generation Pave the Road?, *Energies* 7: 1-16

**Framstad, N. C. (2014):** When can the environmental profile and emissions reduction be optimised independently of the pollutant level?, *Journal of Environmental Economics and Policy*, Volume 3, Issue 1, 2014 , Pages 25-45

**Gerlagh, R. S. Kverndokk and K. E. Rosendahl (2014):** The optimal time path of clean energy R&D policy when patents have finite lifetime, *Journal of Environmental Economics and Management*, 39, Volume 67, Issue 1, January 2014, Pages 2–19

**Greaker, M. and C. Hagem, 2014:** Strategic investment in climate friendly technologies: The impact of global emissions trading, *Environmental and Resource Economics* 59, 65-85.

**Greaker, M., M. Hoel and K. E. Rosendahl (2014):** Does a renewable fuel standard for biofuels reduce climate costs? *Journal of the Association of Environmental and Resource Economists* 1: 337-363

**Green, R.J., I. Staffell and N. Vasilakos (2014):** Divide and conquer? k-means clustering of demand data allows rapid and accurate simulations of the British electricity system *IEEE Transactions on Engineering Management*, Vol:PP, Issue: 99, page: 1-10



- Hoel, M., B. Holtsmark and K. Holtsmark (2014):** Faustmann and the climate. *Journal of Forest Economics*, Vol 20, Issue 2, Pages 192-210
- Holtsmark, B. (2014):** A comparison of the global warming impact of wood fuels and fossil fuels taking albedo effects into account. *GCB Bioenergy*
- Holtsmark, B. and A. Skonhoft (2014):** The Norwegian support and subsidy policy for electric cars. Should it be adopted by other countries? *Environmental Science & Policy*, Vol 42, Pages 160-168
- Kverndokk, S., E. Nævdal and L. Nøstbakken (2014):** The Trade-off between Intra- and Intergenerational Equity in Climate Policy, *European Economic Review*, vol 69, pp. 40-58.
- Nyborg, K. (2014):** Do responsible employers attract responsible employees? *IZA World of Labor*
- Nyborg, K. (2014):** Project Evaluation with Democratic Decision-making: What Does Cost-Benefit Analysis Really Measure? *Ecological Economics*, 106, 124-131.
- Rosnes, O. (2014):** Subsidies for Renewable Energy in Inflexible Power Markets. *Journal of Regulatory Economics* 46, pp. 318–343.
- Spiro, Daniel (2014) :** Resource prices and planning horizons, *Journal of Economic Dynamics and Control*, vol. 48, November, pp. 159-175
- Staffell, I. and R.J. Green (2014):** How does wind farm performance decline with age?, *Renewable Energy*, vol. 66, June, pp. 775-786
- Storrøsten, H. B. (2014):** Prices Versus Quantities: Technology Choice, Uncertainty and Welfare. *Environmental and Resource Economics*, Vol 59 - Issue 2
- Strbac, G., M. Pollitt, C.V. Konstantinidis, I. Konstantelos, R. Moreno, D.M. Newbery and R.J. Green (2014) :** Electricity transmission arrangements in Great Britain: Time for change? *Energy Policy*, Vol 73, Pages 298-311
- Troell, M., R.L. Naylor, M. Metian, M. Beveridge, P.H. Tyedmers, C. Folke, K.J. Arrow, S. Barrett, A.-S. Crépin, P.R. Ehrlich, Å. Gren, N. Kautsky, S.A. Levin, K. Nyborg, H. Österblom, S. Polasky, M. Scheffer, B.H. Walker, T. Xepapadeas, and A.J. de Zeeuw (2014):** Does aquaculture add resilience to the global food systems?, *PNAS* (Early Edition) Vol 111, no 37 13257-1326
- Vogelsang, T.J. and M. Wagner (2014):** Integrated Modified OLS Estimation and Fixed-b Inference for Cointegrating Regressions, *Journal of Econometrics*, 39, Volume 178, Issue 2, February 2014, Pages 741–760
- Voigt, C. (2014):** Equity in the 2015 climate agreement: Lessons from differential treatment in multilateral environmental agreements, 4 *Climate Law* 2014, 50-69.
- Winther, T. and H. Wilhite (2014):** An analysis of the household energy rebound effect from a practice perspective: spatial and temporal dimensions, *Energy Efficiency*, 7(5).

## Books and article in books

[http://www.cree.uio.no/publications.html#Other\\_publications](http://www.cree.uio.no/publications.html#Other_publications))

**Green, R.J., Y. Mulugetta and Z.X. Zhang (2014):** Sustainable Energy Policy, in (eds) G. Atkinson, S. Dietz, E. Neumayer and M. Agarwala, Handbook of Sustainable Development, 2nd Edition, pp. 532-550, Cheltenham, Edward Elgar, ISBN 978-1-78254-469-2.

**Hoel, M. (2014):** Supply Side Climate Policy and the Green Paradox, In Pittel, K., van der Ploeg, R. and Withagen, C. (eds.): Climate Policy and Nonrenewable Resources. The Green Paradox and Beyond. MIT Press, 2014.

**Hoel, M. and A. de Zeeuw (2014):** Technology Agreements with Heterogeneous Countries, in Todd L. Cherry, Jon Hovi and David McEvoy (editors): Toward a New Climate Agreement: Conflict, Resolution and Governance. Routledge, 2014.

**Kverndokk, S. and C. Hagem (2014):** Klimaendringer, chapter 8 in O. Flåtén and A. Skonhoft (eds.): Naturressursenes økonomi, Gyldendal, 2014.

**Ulfstein G. and C. Voigt (2014):** Rethinking the Legal Form and Architecture of a New Climate Agreement, in: T. L. Cherry, J. Hovi, and D. McEvoy (eds.) 'Toward a New Climate Agreement: Conflict, Resolution and Governance' (Routledge) 183-198

**Voigt, C.(2014):** Delineating the Common Interest in International Law, in: W. Benedek, K. De Feyter, M. Kettemann, Ch. Voigt (eds.) 'Common Interest in International Law' (Cambridge: Intersentia) 9-27.

## CREE working papers

[http://www.cree.uio.no/working\\_papers.html](http://www.cree.uio.no/working_papers.html))

**Aakenes, S.(2014):** From Moon walking towards Moon landing: How might CCS leave the Launch Pad?, CREE working paper no 13

**Andersen J. J. and Greaker M.(2014):** The Fiscal Incentive of GHG Cap and Trade: Permits May Be Too Cheap and Developed Countries May Abate Too Little, CREE working paper no 8

**Brekke, K. A., Braaten R. H. and Røgeberg, O.(2014):** Buying the right to do wrong - An experimental test of moral objections to trading emission permits, CREE working paper no 19

**Bye B. and Klemetsen M. E.(2014):** The impacts of alternative policy instruments on environmental performance: A firm level study of temporary and persistent effects, CREE working paper no 14

**Böhringer C., Bye B., Fæhn T. and Rosendahl, K. E.(2014):** Output based rebating of carbon taxes in the neighbor's backyard Competitiveness, leakage and welfare, CREE working paper no 6

**Ciccone A.(2014):** Is it all about CO<sub>2</sub> emissions? The environmental effects of a tax reform for new vehicles in Norway., CREE working paper no 9

- Eggert H. and Greaker M.(2014):** Promoting second generation bioethanol: Does the first generation pave the road?, CREE working paper no 7
- Framstad, N. C.(2014):** The effect of small intervention costs on the optimal extraction of dividends and renewable resources in a jump diffusion model, CREE working paper no 18
- Fæhn T. and Isaksen, E. T.(2014):** Diffusion of climate technologies in the presence of commitment problems, CREE working paper no 1
- Førsund F. R.(2014):** Hveding's Conjecture: On the Aggregation of a Hydroelectric Multiplant – Multireservoir System, CREE working paper no 17
- Gars J. and Spiro D.(2014):** Should Foresters Forecast?, CREE working paper no 11
- Gars J. and Spiro D.(2014):** Uninsurance through trade, CREE working paper no 10
- Hauge K. E. and Røgeberg, O.(2014):** Contributing to Public Goods as Individuals versus Group Representatives: Evidence of Gender Differences, CREE working paper no 16
- Jemsek, M(2014):** Heat Pumps and Household Energy Consumption in Norway An actor network and practice theory approach, Thesis for the Masterdegree, CREE working paper no 3
- Nyborg, K.(2014):** Reciprocal climate negotiators: Balancing anger against even more anger, CREE working paper no 20
- Spiro D.(2014):** Resource prices and planning horizons, CREE working paper no 12
- Tanja, T and Wilhite, H.(2014):** The use of heat pumps in Norwegian homes: Accounting for the comfort rebound effect. The use of heat pumps in Norwegian homes: Accounting for the comfort rebound effect., CREE working paper no 2
- Valseth, A. S.(2014):** Competing Climate Policies, Thesis for the Masterdegree, CREE working paper no 4
- van den Bijgaart I. (2014):** The Unilateral Implementation of a Sustainable Growth Path with Directed Technical Change, CREE working paper no 15
- Weidle, M. K.(2014):** Is low carbon taxation optimal climate policy for a developing country? A numerical simulation of technology adoption, Thesis for the Masterdegree, CREE working paper no 5

### **Popular scientific articles**

[http://www.cree.uio.no/publications.html#Popular\\_scientific\\_articles](http://www.cree.uio.no/publications.html#Popular_scientific_articles))

**Fæhn, T. (2014):** Den vriene klimapolitikken. Finnes det råd for et lite land med god råd?  
*Samfunnsøkonomen*, Nr 3 2014

**Gavenas, E. and K.E. Rosendahl (2014):** Hva påvirker CO2-utslippene på norsk sokkel?  
*Samfunnsøkonomen*, Nr. 8 2014, 22-31.

**Hagem, C., B. Holtsmark og T. Sterner (2014):** Om den norske politikken for reduksjon av utslipp av NOx. *Samfunnsøkonomen*, Nr 2 2014

**Hagem, C., B. Holtsmark og T. Sterner (2014):** NOx-fondet gir ikke en kostnadseffektiv løsning *Samfunnsøkonomen*, Nr 5 2014

**Hauge, K. E. (2014):** Når Viljar, Egil og Rasmus skal investere i energibesparende teknologi. *Samfunnsøkonomen*, Nr 1 2014

**Kverndokk, S., E. Nævdal og L. Nøstbakken (2014):** Rettferdige klimaavtaler. *Samfunnsøkonomen*, Nr 2 2014

**Rosendahl, K.E. (2014):** Elektrifisering og klimapolitikk, *Samfunnsøkonomen Nr. 5 2014*, 14-17.

## Other publications

[http://www.cree.uio.no/publications.html#Other\\_publications](http://www.cree.uio.no/publications.html#Other_publications))

**Bråten, J.(2014):** En kostnadseffektiv og virkningsfull klimapolitikk *Norsk Klimastiftelse*, Rapport nr. 04/2014

**Winther, T., H. Wilhite and K. Standal (2014):** Strømbruk i husholdninger: Effekter av display. CICERO

## Conference and seminar presentations

Bye, B. (2014): Direct vs. Indirect regulations: A firm level study of the policy impacts on environmental performance. Seminar i Finansdepartementet, 25. August.

Fæhn, T. (2014): En norsk klimapolitikk i samsvar med togradersmålet – global vs. unilateral gjennomføring. Seminar i Miljødirektoratet, May 8., 2014

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Førsund, F. R. (2014): Economics of Pumped-Storage Hydroelectricity. 3rd Annual Advanced Hydropower Generation and Pumped Storage Forum, Berlin 4th – 6th November 2014

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- Golombek, R. (2014): Virkninger av Europakommisjonens forslag belyst med modellen LIBEMOD. CICEP-CREEs brukerseminar: EUs klima- og energipolitikk i 2030, 24. april.
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- Hagem, C. (2014): Hvilken rolle kan økonomiske virkemidler spille i klimapolitikken? Innlegg på SVs landsseminar 25.01.2014
- Hagem, C. (2014): Oil, climate and GPF. Presentation for the expert group on investments in coal and petroleum companies, 18.06.2014.
- Hagem, C. (2014): Veien mot lavutslippssamfunnet- klimapolitikk i et lite land. Klima og miljødepartementet, 31. Mars.
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- Hoel, M. (2014): Good and Bad Climate Policy Instruments. The BI seminar on green economics, May 22, 2014
- Hoel, M. (2014): Pareto Improving Climate Policies: Distributing the benefits across generations and regions. CREE 4th Research Workshop, Lysebu, Oslo, September 22-23, 2014
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- Hoel, M. (2014): Pareto Improving Climate Policy. Workshop on Climate Change and Public Goods, FEEM, Venice, June 9-10, 2014
- Kittelsen, S.A.C(2014): Promoting CCS in Europe: A case study for green strategic trade policy?. 14th IAEE European Energy Conference, Rome, Italy, October 28-31
- Klemetsen M. (2014): Direct vs. Indirect regulations: A firm level study of the policy impacts on environmental performance. WCERE i Istanbul, 28. June – 2. July
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Kverndokk, S. (2014): Climate Change 2014: Mitigation of Climate Change. Presentasjon av IPCC-rapporten, Finansdepartementet, 12. mai.

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Kverndokk, S. (2014): Rettferdighet i klimapolitikken. Diskusjon mellom Karen O'Brien, Asuncion Lera St.Clair og Snorre Kverndokk, Frokostseminar om innføring i nye rapporter fra FNs Klimapanel, Miljødirektoratet, 7. mars.

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- Midttømme, K. (2014): On the dynamics of cooperation. 4th CREE research workshop, September
- Nyborg, K. (2014): An economist's view on moral responsibility, social norms and environmental behavior. BENN (Behavior, Economics and Nature Network) Workshop, Beijer Institute of Ecological Economics, Royal Swedish Academy of Sciences, Stockholm June 2-4.
- Nyborg, K. (2014): Reciprocal Climate Negotiators. Environmental and Energy Economics Seminar (joint initiative of Université Paris 1-Paris School of Economics, Université Paris Ouest Nanterre la Défense, Université Paris Dauphine, Agro ParisTech, Ecole Polytechnique, Ecole des Mines, Ecole des Ponts, CEA, CIRED, Climate Economics Chair and IFP School), Paris, 13.03.14.
- Nyborg, K. (2014): Reciprocal Climate Negotiators: Balancing Anger Against Even More Anger. Research seminar, Grantham Institute, London School of Economics, May 28.
- Nyborg, K. (2014): Reciprocal Climate Negotiators: Balancing Anger Against Even More Anger. World Congress of Environmental and Resource Economists, Istanbul, July 1.
- Nyborg, K. (2014): Reciprocal Climate Negotiators: Balancing Anger Against Even More Anger. CREE Workshop, Lysebu 22-23.09.
- Nyborg, K. (2014): Reciprocal Climate Negotiators: Balancing Anger Against Even More Anger. Departmental seminar, Department of Economics, Lund University.
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- Nyborg, K. (2014): What does Cost-Benefit Analysis Really Measure? Workshop on progress and challenges in applied BCA of government policies, Toulouse, 15-16.12.
- Rosendahl, K.E. (2014): Carbon leakage: Pay or not pay the polluter? 36th Meeting of the Norwegian Association of Economists (Forskermøtet), BI (Oslo): Januar 2014:
- Rosendahl, K.E. (2014): Petroleum Policy as Climate Policy. BEEER-konferansen, Bergen: Mai 2014:
- van den Bijgaart, Inge M. (2014): The Unilateral Implementation of a Sustainable Growth Path with Directed Technical Change., World Congress of Environmental and Resource Economics, Istanbul, June 28
- Voigt, C. (2014): Building consensus in the UN Climate negotiations. Staff seminar, University of Auckland, New Zealand, October 6, 2014
- Voigt, C. (2014): Environmentally Sustainable Development and Peace: The Role of International Law. International Law and Peace; University of Wisconsin, Madison, USA, 2014-04-06.
- Voigt, C. (2014): REDDpluss - Building Consensus in the UN climate negotiations. Faglunjsj; 2014-03-06, UiO



Voigt, C. (2014): Up in the Air - Aviation in the EU Emissions Trading Scheme and the Question of Sovereignty. Faglunnsj; 2014-05-21, UiO

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Winther, T. (2014): Hvorfor er kunnskap om mennesker viktig for bærekraftig utvikling? University of Oslo, 10-12 September.

## **CREE in the news**

[http://www.cree.uio.no/CREE\\_in\\_the\\_news.html](http://www.cree.uio.no/CREE_in_the_news.html)

-Dyrt klimatiltak? CREE forskerne Taran Fæhn (SSB), Cathrine Hagem (SSB) Lars Lindholt (SSB), Knut Einar Rosendahl (NMBU) anslår kostnader og CO<sub>2</sub> innsparinger ved å ikke bygge ut Johan Castberg feltet. *Aftenposten 03 Des. 2014.*

-Klimautslipp øker raskt. CREE forskeren Knut Einar Rosendahl (Professor NMBU) imøtegår myten om klimavennlig norsk produksjon. Se også artikkel i Samfunnøkonomen nr 8 om temaet. *Dagens Næringsliv 18. Nov. 2014.*

-Strømsparing opp i varme. CREE forskeren Bente Halvorsen (SSB) er med å uttrykke seg om folks adferd ved ENØK-tiltak. *Bergens Tidende 5. Nov. 2014.*

-Debatt om langsiktige elbilkostnader. Startet av CREE forskerne Mads Greaker (SSB) og Snorre Kverndokk (Frischsenteret). *Aftenposten Sep/Okt 2014.*

-UTSLIPP PÅ SOKKELEN Disse 5 feltene slipper ut minst på sokkelen. CREE forsker Knut Einar Rosendahl, professor NMBU, omtal og intervju i Teknisk Ukeblad om CO<sub>2</sub>-utslipp på norsk sokkel. *Teknisk Ukeblad 26 aug 2014.*

-Tror ikke norsk oljekutt gir utslippskutt. I en artikkel om forskjellige meninger av konsekvensen av et oljekutt gir Taran Fæhn, forsker SSB og CREE, uttrykk for uenighet med overskriften. *Aftenposten 25 aug 2014.*

-Hvem tror på sin egen propaganda, sa du? Bjart Holtsmark nevnt i en artikkel av Kurt Oddekalv. *NRK 22 juli 2014.*

-Ett år i klimakrigen. SSB-rapporten Norsk olje- og gassproduksjon nevnt i en artikkel av Pia Martine Gautier Bjerke. *Stavanger Aftenblad 21 juli 2014.*

-Et spel for galleriet. Bjart Holtsmark nevnt i en artikkel av Rune Skarstein. *Klassekampen 16 juli 2014.*

-En tid for store oljetanker. Intervju med Taran Fæhn, forsker SSB og CREE. *Nationen 27 juni 2014*

- LIBEMOD modellen utarbeidet av forskere ved Frischsenteret og Statistisk sentralbyrå blir referert til i Stavanger. *Aftenblad 16 mai 2014.*
- CREE forsker Knut Einar Rosendahl, professor NMBU, Intervju i Dagens Næringsliv, om elektrifisering av sokkelen og prisprognoser på CO2 og kraft. *Dagens Næringsliv 10 mai 2014*
- Utsirahøyden. Nok et klimapolitisk paradoks. Debatt om elektrifisering av sokkelen. Michael Hoel, professor Universitetet i Oslo og forsker CREE i debatt om temaet. Diverse innlegg
- Fire klimapolitiske paradokser. Bjarte Holtsmark, forsker, Statistisk sentralbyrå og CREE i debatt om temaet. Diverse innlegg
- Oppslag rundt FNs klimapanel. Snorre Kverndokk, seniorforsker Frischsenteret og CREE har vært med på å skrive tredje delrapport av FNs klimapanel (IPCC) Diverse oppslag
- Hva gjør politikerne nå? Jan Fuglestad, forskningsleder CICERO, Edgar Hertwich, professor, NTNU og Snorre Kverndokk, seniorforsker Frischsenteret og CREE skriver en kronikk om veien videre innen klimapolitikken. *Aftenposten 13 apr. 2014 og Klima 2-2014 CICERO*
- Kan vi få til rettferdig klimakutt? - Snorre Kverndokk og Eric Nævdal, seniorforskere ved Frischsenteret og CREE og Linda Nøstbakken, førsteamanuensis, Norges Handelshøyskole argumenterer for at de rike landene må ta utslippskuttene. *Aftenposten 02.04.2014*
- Utvinning för allmän vinning – en ESO-rapport om svenska mineralinkomster. Rapport skrevet av Jesper Roine (Stockholm School of Economics) og Daniel Spiro (Post doc ØI og CREE). Rapport og flere presseoppslag.
- Sammen med andre forskere var CREE forsker Karine Nyborg (Professor UiO) med i EKKO *Ekko, NRK P2, 04.02.14.*
- Fornuft og føleleser. Portrettintervju av CREE forsker Karine Nyborg (Professor UiO) i *Forskerforum nr 2 Februar 2014*
- He's dead, but he won't lay down. Debatt i Nationen om hogst av skog er bra for klimaet. Bjart Holtsmark, forsker SSB og CREE, kommer med motinnlegg til Gaute Nøkleholms kronikk i *Nationen 1 tert. 2014*
- Den industrielle revolusjon skjer. Bjart Holtsmark, forsker SSB og CREE, kommenterer Ole Mathismons artikkel. *Aftenposten jan. 2014*
- Diverse innslag om Elbiler. Både fra 2013 og 2014. Mye knyttet til Bjart Holtsmark. Diverse innslag om elbiler

## **Mot et grønnere Europa: Virkninger av EUs klimapolitikk for 2030**

Finn Roar Aune, Rolf Golombek, Hilde Hallre Le Tissier, Stefan Jaehnert, Steve Völler, Ove Wolfgang

[http://www.cree.uio.no/publications/2015\\_1/Aune\\_Golombek\\_m\\_flere\\_EUs\\_klimapolitikk\\_CR\\_EE\\_WP01\\_2015.pdf](http://www.cree.uio.no/publications/2015_1/Aune_Golombek_m_flere_EUs_klimapolitikk_CR_EE_WP01_2015.pdf)

Denne artikkelen benytter den numeriske likevektsmodellen LIBEMOD til å analysere effekter av EUs klimamål for 2030: Hvordan påvirker denne politikken investeringer i energisektoren, produksjon av energi, handel med energi og konsum av energi? Vil denne politikken gi en fornybarandel på minst 27 prosent, eller må EU innføre særskilte tiltak for å nå fornybarmålet på 27 prosent?

Resultatene fra LIBEMOD tilsier at det trengs en relativ moderat CO<sub>2</sub>-avgift i ETS sektoren (35 euro per tonn CO<sub>2</sub>) for å sikre at denne sektorens utslippsmål for 2030 realiseres. Modellkjøringen antyder også at uten nasjonale støtteordninger for fornybar energi vil EUs klimamål for 2030 medføre en fornybarandel i sluttkonsumet av energi rett under det vedtatte 27-prosent målet. Behovet for en særskilt fornybarpolitikk (for å nå EUs fornybarmålsetting) er derfor begrenset. Endelig antyr modellkjøringene at fornybarandelen i kraftkonsumet kan bli rundt 60 prosent.

Artikkelen bruker også modellene LIBEMOD og Samkjøringsmodellen - en partiell modell for kraftmarkeder - til å undersøke konsekvensene for kraftmarkedet av EUs klimapolitikk for 2030.

For Samkjøringsmodellen skilles det mellom to tilfeller: bruk av de samme kapasitetene for kraftverk (i 2030) som i LIBEMOD (tilfelle 1) og kapasiteter som bestemmes i Samkjøringsmodellen ut fra lønnsomhet beregnet i denne modellen. Vi finner at i tilfelle 1 blir årsproduksjon, handel og medianpriser ganske like i de to modellene. I Samkjøringsmodellen blir det imidlertid en del tilfeller av ekstrempriser (pga. rasjonering) og nullpriser (pga. overskuddstilbud fra fornybar kraft). Dette skyldes finere tidsoppløsning og dermed større variabilitet for vind- og solkraft.

Når kapasiteten som brukes i Samkjøringsmodellen bestemmes ut fra lønnsomhet i denne modellen (tilfelle 2), blir gjennomsnittsprisen i de to modellene nesten like. I Samkjøringsmodellen blir det ikke flere investeringer i vind- og solkraft enn det som allerede er vedtatt utbygd frem til 2020. På den annen side blir det mer vedlikehold og investeringer i termiske kraftverk; disse teknologiene kan brukes under ugunstige værforhold. Fornybarandelen opprettholdes pga. økt biokraftproduksjon.

## Beslutningsmakt i husholdningen målt med et økonomisk eksperiment

Ragnhild Haugli Braaten og Peter Martinsson

[http://www.cree.uio.no/publications/2015\\_2/Braaten\\_Martinsson\\_Houshold\\_Decision\\_power\\_CREE\\_WP02\\_2015.pdf](http://www.cree.uio.no/publications/2015_2/Braaten_Martinsson_Houshold_Decision_power_CREE_WP02_2015.pdf)

I denne artikkelen ser vi på hvordan ektepar i jordbrukslandsbyer i Peru tar beslutninger som har med risiko og usikkerhet å gjøre og hvem av ektefellene som har størst beslutningsmakt. 287 ektepar fra 15 landsbyer i det Peruanske høylandet har deltatt i undersøkelsene. I dette området er mannen tradisjonelt sett på som familiens overhode og hovedsakelige beslutningstager. Kvinner deltar lite i organisasjonslivet og i styringsorganer i landsbyene, og det er ofte mannen som snakker på vegne av familien. Det blir ofte argumentert med at når kvinner får økt beslutningsmakt så bruker familien mer ressurser på utdannelse, mat og klær til barna. Økt innflytelse for kvinner over viktige beslutninger er i tillegg et mål i seg selv, og derfor jobber politiske organisasjoner for å øke kvinners status og beslutningsmakt. Det finnes likevel lite empiriske basert kunnskap om hvordan beslutninger faktisk blir tatt innad i husholdningene og hvilke typer beslutninger hvor menn og kvinner har ulik innflytelse. I denne studien måler vi beslutningsmakt i husholdningen gjennom et økonomisk eksperiment. Vi ser på valg under risiko og usikkerhet, som er spesielt relevant for disse bøndene hvis avlinger er svært risikoutsatt. I dårlige år kan hele avlinger bli ødelagt grunnet uforutsigbare vær fenomener som tørke eller flom. Slike fenomener er et økende problem grunnet klimaendringer. Risikoreducerende tiltak vil få stadig økt betydning og det er derfor viktig å ha kunnskap om hvordan disse husholdningene tar slike valg i et stadig mer usikkert klima.

Hvert ektepar har deltatt i eksperimentet og svart på en større spørreundersøkelse. Det økonomiske eksperimentet har bestått av to ulike spill: et risikospill (hvor deltagerne velger mellom lotterier med kjente sannsynligheter) og et usikkerhetsspill (hvor deltagerne velger mellom lotterier med ukjente sannsynligheter). Gjennom å spille disse to spillene får vi et mål på deltagerens villighet til å ta risikable valg (risikovilje) og usikre valg (usikkerhetsvilje). Hver ektefelle deltar først i disse to spillene enkeltvis, for deretter å gjøre de samme beslutningene sammen. Når vi kjenner den enkeltes individuelle preferanser, kan vi bruke den felles beslutningen til å måle hvem som har størst innflytelse over fellesbeslutningen. Den ektefellen hvis individuelle valg ligger nærmest fellesbeslutningen antar vi at bestemmer mest i det aktuelle spillet. Eksperimentet gir oss altså to mål på beslutningsmakt for hvert ektepar: beslutningsmakt i et risikovalg og beslutningsmakt i et usikkerhetsvalg.

Resultatene fra eksperimentet viser at beslutningsmakt er relativt jevnt fordelt mellom menn og kvinner. Av de parene som har tatt ulike individuelle valg (det er kun disse vi kan si noe om beslutningsmakt for) er det 45% hvor kvinner bestemmer og 55% hvor mannen bestemmer, både i risikospillet og i usikkerhetsspillet. Dette utgjør ingen statistisk signifikant kjønnsforskjell i beslutningsmakt. I stedet ser vi at den som er minst villig til å ta risiko (mest risikoavers) oftest er den som får størst innflytelse i risikospillet. Den mest risikoaverse har størst innflytelse hos 70% av parene som vi kan si noe om beslutningsmakt for. Vi får det samme resultatet i usikkerhetsspillet, hvor den som er minst villig til å ta usikre valg (mest usikkerhetsavers) får størst innflytelse i 65% av parene med ulike individuelle valg.

Studien konkluderer med at beslutningsmakt i de to valgene vi har sett på har mer med individuelle preferanser enn med kjønn å gjøre. Den som er mest forsiktig i sine meninger har størst sannsynlighet for å få gjennomslag i beslutningsprosessen. Gjennom data fra spørreundersøkelser viser vi også at beslutningsmakt i husholdningen er svært differensiert mellom ulike oppgaver, og at det ikke nødvendigvis er slik at den som bestemmer i et valg også bestemmer i andre valg.

## - Working Paper 03/2015

### Tillitsspill, risikoaversjon og treplanting i Malawi

Ragnhild Haugli Bråten , Erling Berge , Henrik Wiig , Daimon Kambewa og Stanley Khaila

[http://www.cree.uio.no/publications/2015\\_3/Braaten\\_m\\_fler\\_Planting\\_in\\_Malawi\\_CREE\\_WP03\\_2015.pdf](http://www.cree.uio.no/publications/2015_3/Braaten_m_fler_Planting_in_Malawi_CREE_WP03_2015.pdf)

I denne studien analyserer vi treplanting blant 109 bønder fra 18 landsbyer i Malawi. Treplanting på jordbruksland er viktig som et risiko-reduserende tiltak i disse områdene, som svært utsatt for jorderosjon. Kraftige regnskyl, oversvømmelser og sterk vind kan ødelegge avlinger og vaske vekk jord. Trær som plantes på jordene, spesielt langs jordegrensene, reduserer risikoen under slike kraftige værphenomen. Trær vil imidlertid også konkurrere med mer profitable avlinger om næring og plass, og treplanting til derfor også medføre en kostnad. Det er derfor de mer risikoaverse bøndene som bør være mest villige til å plante trær.

Vi undersøker hvorvidt det er en sammenheng mellom risikoaversjon og treplanting ved å bruke et mål på risikoaversjon fra et økonomisk eksperiment, kalt et tillitsspill. I et tillitsspill deles deltagerne opp i par, uten å kjenne identiteten til sin medspiller. Den ene spilleren får deretter utdelt 80 kwacha (den Malawiske myntenheten) og kan velge å gi noe av denne summen videre til sin medspiller. Det som blir gitt til medspilleren blir tredoblet. Medspilleren får deretter velge hvor mye av denne summen han eller hun vil gi tilbake til den første spilleren. Andelen den første spilleren velger å gi videre til sin anonyme medspiller brukes ofte som mål på generell tillit til andre mennesker. Den første spilleren må ha tillit til at den andre spilleren skal gi noe av fortjenesten tilbake. Men bidraget kan også sees på som en usikker investering, som kan gi stor eller ingen avkastning, og dermed er den første spillerens bidrag også et mål på vilje til å ta risiko. Ved å kontrollere for sosiale komponentene av dette målet får vi et renere mål på risikoaversjon.

Resultatene fra den empiriske analysen viser at de mer risikoaverse bøndene har signifikant høyere sannsynlighet for å ha plantet trær. En økning på 20 kwacha i spillinvesteringer henger sammen med en 29% reduksjon av sannsynligheten for å ha plantet trær. Risikoaversjon ser altså ut til å være en viktig faktor for treplanting blant disse bøndene. Vi finner også at bønder som eier jorden selv har dobbel så høy sannsynlighet for å ha plantet trær. Dette støtter opp under eksisterende teorier om sammenhengen mellom selveie og investeringer.

## **Tilbakevirkningseffekter i husholdningenes energiforbruk: Perspektiver fra en tverrfaglig studie**

Bente Halvorsen, Bodil Larsen, Harold Wilhite og Tanja Winther

[http://www.cree.uio.no/publications/2015\\_4/Larsen\\_Winther\\_Wilhite\\_Halvorsen\\_Household\\_energ\\_y\\_rebound\\_CREE\\_WP04\\_2015.pdf](http://www.cree.uio.no/publications/2015_4/Larsen_Winther_Wilhite_Halvorsen_Household_energ_y_rebound_CREE_WP04_2015.pdf)

I denne artikkelen studerer økonomer og antropologer bruk av varmepumpe i norske husholdninger. Som følge av en betydelig høyere virkningsgrad enn tradisjonell elektrisk oppvarming skulle varmepumpeteknologien teoretisk sett redusert elektrisitetsforbruket, men, som vi viser i artikkelen; når varmepumper blir tatt i bruk skjer det ingen endring i elektrisitetsforbruket selv om totalt energiforbruk går noe ned.

Målsettingen med artikkelen er å forklare disse resultatene ved hjelp av to koordinerte studier; en kvalitativ antropologisk studie basert på dybdeintervjuer, og en kvantitativ mikroøkonometrisk studie basert på informasjon fra Statistisk sentralbyrås forbruksundersøkelse for 2009 og informasjon om strømforbruk fra husholdningenes nettselskap. Resultatene fra disse to studiene utfyller hverandre. Den økonomiske studien kvantifiserer effektene av varmepumpeeierskap på forbruk av ulike energibærere, mens den kvalitative studien er med på å belyse hva som skjer av atferdsendringer i husholdninger som har skaffet seg varmepumpe.

Vi finner at noen husholdninger bruker mindre elektrisitet, mens andre bruker mer elektrisitet etter investeringen i varmepumpe. I den kvantitative studien finner vi at i gjennomsnitt bruker husholdninger med varmepumpe om lag like mye elektrisitet som husholdninger uten varmepumpe. Samtidig bruker de mindre ved og fyringsoljer i oppvarmingen, og de holder en høyere gjennomsnittlig innetemperatur, spesielt på kalde vintermorgener. Den kvalitative studien bekrefter disse funnene i tillegg til å identifisere ytterligere årsaker til de store tilbakevirkningseffektene i elektrisitetsforbruket. Den finner, som i den økonometriske studien, at husholdningene bruker mindre ved og fyringsoljer etter at de skaffet seg varmepumpe, og de holder en jevnere innetemperatur over døgnet. En hovedgrunn til det siste er at de ikke senker temperaturen om natten i samme utstrekning som før de skaffet seg varmepumpe. De varmer også opp et større areal enn før, ved at de åpner opp dører og varmer opp deler av huset som tidligere har stått kaldt.

Vi konkluderer med at norske husholdninger har tatt ut energisparepotensialet som ligger i en varmepumpe til økt komfort, både med hensyn til økt innetemperatur, mindre energisparing og redusert forbruk av mer arbeidskrevende energibærere som ved og fyringsoljer.

## Utfasing av atomkraft

Finn Roar Aune, Rolf Golombek og Hilde Hallre Le Tissier

[http://www.cree.uio.no/publications/2015\\_5/Aune\\_Golombek\\_Tissier\\_Phasing\\_out\\_CREE\\_WP05\\_2015.pdf](http://www.cree.uio.no/publications/2015_5/Aune_Golombek_Tissier_Phasing_out_CREE_WP05_2015.pdf)

I 2011 ble et kraftverk på nordkysten av Japan (Fukushima) rammet av jordskjelv. Den påfølgende tsunamien var større enn kraftverket var dimensjonert for å tåle. Anleggets kjølesystem ble derfor satt ut av spill, og reaktorkjernen ble overopphetet og delvis nedsmeltet. Alle japanske atomkraftverk ble raskt stengt. I Europa var reaksjonene på atomkraftulykken varierende. Tyskland besluttet å stenge sine syv eldste atomkraftanlegg, samt fase ut øvrige atomkraftverk innen 2022. Belgia besluttet å fase ut tre atomkraftverk i 2015, samt fase ut øvrige anlegg innen 2025. I Frankrike, der atomkraft har en markedsandel på rundt 75 prosent, har det kommet signaler om at atomkraftens markedsandel skal reduseres til 50 prosent innen 2025. Andre land, spesielt i Øst-Europa, har ikke skrinlagt sine utbyggingsplaner, men mangler finansiering.

I et prosjekt finansiert av CREE og EU kommisjonen (ENTRACTE) har vi studert virkninger i de europeiske energimarkedene hvis alle land i Europa følger strategien til Tyskland og Belgia om å fase ut all atomkraft. Vi sammenlikner de europeiske energimarkedene i 2030 i tilfellet der atomkraftkapasitetene er i samsvar med dagens planer for utbygging og utfasing av atomkraft med et hypotetisk tilfelle der all atomkraft i alle (30) europeiske land er utfaset. Vi har lagt til grunn at EUs nylig vedtatte energi- og klimapolitikk for 2030 blir implementert, dvs. utslippene av drivhusgasser skal i 2030 være 40 prosent lavere enn i 1990, og fornybarandelen i sluttkonsumet av energi er minst 27 prosent.

Vi har benyttet den numeriske energimarkedsmodellen LIBEMOD til å studere virkninger av en fullstendig utfasing av atomkraft. Denne modellen beskriver energimarkedene i 30 Europeiske land, samt interaksjonen mellom landene gjennom handel med energi. Modellen dekker alle energivarer (flere typer kull, naturgass, olje, flere typer bioenergi og elektrisitet), og bestemmer utvinning, investeringer, produksjon, handel og konsum av energi, samt et konsistent sett av markedsklarerende priser. Produksjon av elektrisitet kan utføres med en rekke teknologier; kullkraft, gasskraft, oljekraft, biokraft, vannkraft, vindkraft, solkraft og atomkraft (som blir faset ut). Tilgangen til ressurser og karakteristiske trekk ved elektrisitetsteknologier varierer mellom land.

Når atomkraft fases ut reduseres tilbudet av kraft, og prisen på kraft stiger. Dette gir insentiver til å investere i andre elektrisitetsteknologier. Dermed stiger elektrisitetsproduksjonen og prisen på elektrisitet faller. Et sentralt spørsmål blir derfor hvor mye kraftproduksjonen alt i alt vil falle, samt hvilke teknologier som fyller opp (deler av) produksjonsnedgangen når EU implementerer sin klima- og energipolitikk for 2030. Vi finner at en atomkraftutfasing gir kun en marginal reduksjon i samlet produksjon av elektrisitet. Bortfallet av atomkraft fylles opp av fornybar kraftproduksjon, spesielt biokraft og vindkraft.





## - Working Paper 06/2015

### Fondering och utgiftsbegränsningar i naturresursrika utvecklingsländer

John Hassler, Per Krusell, Abdulaziz Shifa, og Daniel Spiro

[http://www.cree.uio.no/publications/2015\\_6/Hassler\\_Krusell\\_Shifa\\_Spiro\\_Sovereign\\_wealth\\_CREE\\_WP06\\_2015.pdf](http://www.cree.uio.no/publications/2015_6/Hassler_Krusell_Shifa_Spiro_Sovereign_wealth_CREE_WP06_2015.pdf)

I denna artikel analyserar vi huruvida ett fattigt land som hittar en värdefull naturresurs bör skapa en nationell fond där vinsterna sätts in och koppla detta till en regel för hur många procent som får tas ut ur fonden per år (såsom i Norge). Fördelen med ett sådant system är att det minskar riskerna för politisk kortsiktighet. Nackdelen är dock att det begränsar möjligheten för ett fattigt land att satsa pengar på fattigdomsreduktion, nationell infrastruktur och kapitaluppbyggnad. Dessa två motstridiga aspekter skapar ett dilemma för politiker i fattiga länder. I tidigare forskning har båda dessa aspekter diskuterats separat men frågan är vilket av dem som överväger.

För att komma närmare ett svar analyserar vi kvantitativt förlusten för ett fattigt land av att försena användningen av olje-pengar. Analysen appliceras på Uganda som nyligen funnit stora mängder olja. Vi använder en makroekonomisk modell av Ugandas ekonomi som inkluderar aspekter så som kapitaluppbyggnad, teknisk utveckling, ekonomisk upphämtning gentemot andra länder och investeringsfriktioner till följd av korruption. I modellen kan man simulera hur ekonomin kommer utvecklas med och utan en oljefond. Vi finner att förlusten som en fond och utgiftsregel medför med all sannolikhet är väldigt små. Detta är delvis förvånansvärt men beror till stor del på att Ugandas befolkning förväntas växa i framtiden vilket gör att oljepengarna kan komma till god användning även senare. Baserat på dessa resultat drar vi slutsatsen att fondering av oljepengar är lämpligt i Uganda.