



Oslo Centre for Research on Environmentally friendly Energy

Final Report 2011-2019



1. Foreword

This is the final report of CREE —The Oslo Centre for Research on Environmentally friendly Energy. CREE was established by the Norwegian Research Council in 2011 as one of three social science research centres on environmentally friendly energy (FME-S). The Frisch Centre has served as the host institution of CREE, with the Research department at Statistics Norway; Department of Economics, University of Oslo; and Tilburg Sustainability Centre as the main research partners. During the operational period of CREE, which ended in December 2019, the centre had four subcontractors and nine user partners.

The main goal of CREE was to generate knowledge that can contribute to a cost-effective and sustainable exploitation of Norwegian and international energy resources on the way towards the low-emissions society, that also ensures an effective and fair climate and energy policy, both nationally and internationally. The ambition of CREE was to become a leading international research centre; to create a dynamic environment for rigorous and policy-oriented studies through interaction with user partners; and to contribute to recruitment and training at the master, doctoral and post-doctoral levels in energy and environmental economics. We believe we have succeeded.

This report contains information on the outputs from the centre: scientific papers; dissemination of knowledge to professionals, user partners and society at large; cooperation between the research partners; user-oriented activities; educational activities; and assessment of the extent to which CREE has managed to meet its own visions and to contribute to the overarching goal of the Norwegian Research Council to form a solid knowledge basis for how to attain environmental and energy policy targets.

2. Summary

Vision of centre and key research topics

Main vision: To 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.

Key research topics:

- Radical emissions reductions in ETS sectors: Examine driving forces of emission activities in ETS sectors, and choice of regulatory instruments in ETS sectors, including carbon capture and storage (CCS).
- Environmentally friendly transport: Identify, analyze and recommend sustainable emission reduction strategies for the transport sector.
- Green innovations and utilization of smart technologies: How can policies motivate and incentivize research, development and diffusion of environmentally friendly technologies.
- Towards the low-emissions society. Study pathways for nations, regions and the world towards the low-emission society.

Research output

Publications: CREE has published 203 papers in peer reviewed international journals, see Appendix 3b. Several of the papers have been published in top field journals covering environmentally friendly energy. A few CREE papers have been published in top 5 general economics journals. In addition, CREE has published 82 papers in popular science journals, the centre has 96 other scientific publications, and 148 CREE working papers, see Appendix 3c-3e.

Awards:

During the CREE project period 2011-2019, the Erik Kempe award has been given as many as three times to CREE researchers. The prize is awarded every other year to the best paper in the field of environmental and resource economics, with at least one author affiliated to a European research institution.

The 2013 Erik Kempe Award was given to CREE researcher Bård Harstad for his study “Buy Coal! A Case for Supply-Side Environmental Policy”, published in Journal of Political Economy.

The 2017 Erik Kempe Award was given to the two CREE researchers Mads Greaker and Kristoffer Midttømme for their article “Optimal Environmental Policy with Network Effects: Will Pigouvian Taxation Lead to Excess Inertia?” published in Journal of Public Economics.

The 2019 Erik Kempe Award was given to the two CREE researchers Bård Harstad and Torben K. Mideksa for their article Conservation Contracts and Political Regimes, published in Review of Economic Studies.

In 2012, CREE researcher Michael Hoel received the price for the best paper published in the Scandinavian Journal of Economics (The Supply Side of CO₂ with Country Heterogeneity).

In January 2017, the Sören Wibe prize was awarded jointly to CREE researchers Michael Hoel, Bjart Holtsmark, and Katinka Holtsmark for their paper Faustmann and the Climate, published in Journal of Forest Economics. The Sören Wibe Prize is awarded biannually to an article that presents considerable development in empirical knowledge or methodology in the field of forest economics and is published in the Journal of Forest Economics.

The research group was awarded the grade “very good” by the RCN commissioned evaluation of social sciences in 2018 (SAMEVAL). In addition, the group’s work for the green tax commission was highlighted as one of four good practice cases for societal impact in economics.

Snapshot of research output:

- Policy design with network goods. The Nomination Committee of the 2017 Erik Kempe Award gave the following motivation for the award: “Mads Greaker and Kristoffer Midttømme receive the Erik Kempe Award for a novel and insightful contribution to the literature on environmental tax policy, which focuses on economies with network goods. They characterize the optimal tax on an externality-generating good in this environment. They also show, by means of numerical simulations that are calibrated to the adoption of electric vehicles in Norway, that network effects may temporarily motivate much higher taxes than suggested by standard Pigouvian formulas, and that suboptimal tax policies neglecting these network effects may hinder the diffusion of clean substitutes for the dirty technology.”
- International cooperation to lower GHG emissions. Free-riding is at the core on environmental problems: If a climate coalition reduces its emissions, world prices change and non-participating countries typically emit more, for example, by extracting the dirtiest type of fossil fuels. If, however, countries can trade the rights to exploit fossil-fuel deposits, the best policy of a coalition is simply to buy foreign deposits and conserve them, see Harstad (2012a), which was published in the prestigious Journal of Political Economy and was awarded the 2013 Erik Kempe Award.
- Alternative measure to cut GHG emissions. Nine CREE researchers argue in a paper published in Science that the Paris Agreement can be strengthened if complemented by a treaty among fossil fuel producers on limiting global fossil fuel supply, see Asheim et al. (2019). A supply-side climate treaty could enhance the impact of the Paris Agreement in the presence of free riders, since reduced supply will contribute to rising

fossil fuel prices for all market participants. It could also stimulate investment in low-carbon technology research and development (R&D), basically through the same price increase mechanisms. Finally, with a supply-side agreement carbon policies could look more acceptable to fossil fuel producers, also as a result of the fossil fuel price impacts.

- The future price of EU carbon allowances. Aune and Golombek (2020) offers a comprehensive assessment of the approved EU 2030 climate and energy package from 2018. The authors find that the targets for renewables and improved energy efficiency have been set so high that the implied GHG emissions reduction is 50 percent, which is higher than the agreed-upon 40 percent target by the key EU institutions – the Commission, the European Parliament, and the European Council. The paper finds that by achieving the renewable and energy efficiency targets, both the ETS and non-ETS emissions targets are met. This suggests that the future ETS price will be low.
- Zero GHG emissions and storage. Gaure and Golombek (2019) show, using optimization combined with simulations of spatial, hourly, re-analysis data for the period 2006-15, that the EU can design an electricity generation sector where around 98 percent of total production is generated by wind power and solar. This requires, however, that the storage (e.g., battery) energy capacity corresponds to 4 percent of average annual consumption of electricity. If the EU allows for overcapacity in total supply of wind and solar, the storage energy capacity can be reduced. For example, if total production of wind power and solar over the period 2006-15 is at least one third larger than total load, there is no need for a backup technology, and the required storage energy capacity is much lower than 4 percent of average annual consumption of electricity.

Training of researchers

The CREE research partner, Department of Economics at the University of Oslo, organizes regular PhD and Master courses, including classes related to environmentally friendly energy; this topic is covered in courses in energy economics, electricity economics, resource economics, environmental economics and climate change economics.

CREE organized one PhD class on integrated assessment models jointly with MILEN (in 2013), the University of Oslo's (former) interfaculty research network on environmental change and sustainable energy. CREE researchers have also given PhD or Master lectures related to environmentally friendly energy, both in Norway and abroad.

CREE has offered Master Thesis scholarships to Master students writing their Master thesis within environmentally friendly energy.

International cooperation

The international cooperation in CREE consists of four elements:

- An international research partner, Tilburg Sustainability Centre, with competence to complement CREE researchers

- International research affiliates. Each of these complemented the competence of the Norwegian CREE researchers
- All international research affiliates have always been invited to the annual CREE workshops, along with other international researchers in the field of environmentally friendly energy
- Participation in an EU funded project.

Value added to be a FME centre

The value added of being a FME centre is related to scale advantages, scope advantages, and unique funding possibilities:

- The CREE center has contributed to substantial research in the fields of energy, climate change and environmental economics, and has also triggered interdisciplinary research. While these activities can be accomplished in ordinary projects, the high number of international publications as well as the high quality of publications (most of the CREE working papers are published in top field journals or highly ranked general journals) have been possible mainly because of the long duration of the funding of CREE (Scale advantages). With CREE, researchers got the possibility to build up expertise, use their competence over several years and also to combine expertise from different fields, thereby providing a good foundation for alternative theoretical approaches, theory-based empirical work and also interdisciplinary research (Scope advantages).
- CREE has triggered substantial collaborations between the three Norwegian research partners and has also led to more contact and cooperation with the international research partner than what is possible through ordinary projects funded by the Norwegian Research Council (Scale advantages). Therefore, a substantial share of CREE publications is joint work between at least two CREE partners. Furthermore, CREE made it possible for the Norwegian research partners to build, maintain and extend domestic and international networks, which may have long-lasting effects.
- CREE has provided funding to a comprehensive extension and updating of the numerical energy market model LIBEMOD, and also made it possible to establish a new family of numerical models, suited for analysing energy and environmental policies both for the Norwegian economy and for the global economy – the SNOW models. These are now the main models for climate analyses and long-term forecasting used by the Norwegian Ministry of Finance and other ministries. It is not possible to obtain funding through ordinary projects from the Norwegian Research Council for comprehensive model development (Unique funding possibilities through CREE).
- Because of the long project period of CREE, there has been substantially more interactions with user partners than what was typical for the CREE research partners prior to CREE (Scale advantages). The dynamic environment of researchers and user partners had powerful implications with respect to generated ideas for policy questions to explore; joint research applications; and dissemination of research output. In particular, through the innovative arrangement CREE Hot Line researchers affiliated to CREE provided information on recent advances in the field of environmentally friendly energy to user partners.

Contribution for the overarching goal of the FME-programme

The overarching goal of the FME programme is to develop a scientific basis for the handling of environmental and climate challenges. CREE has covered all Norwegian energy-related GHG emissions sources, and also examined how to promote renewables. CREE has explored, within a multidisciplinary framework, costs and benefits of initiatives aiming at improving energy efficiency. CREE has contributed to design of instruments and regulations to reach energy, climate and environmental policy targets, as well as identifying obstacles on the way towards the low-emission society. The Centre has explored standard measures, like incentivised policy measures, as well as alternative measures, for example, supply-side climate policy measures.

While the main objective of CREE has been to improve the general knowledge base for policy design, CREE researchers have also contributed to reports from appointed commissions, and provided input to ministry publications, including The Green Tax Commission, Klimakur, various deliveries to Norwegian ministry publications, Norwegian expert groups and IPCC.

Norsk sammendrag

(Abstract in Norwegian)

Senterets visjon

CREE skal fremskaffe kunnskap som kan bidra til at bedrifter og myndigheter utnytter norske og internasjonale energiressurser kostnadseffektivt og bærekraftig, samt generere kunnskapsgrunnlag for en effektiv og rettferdig klima- og energipolitikk, nasjonalt og internasjonalt.

Forskningstemaer

- *Omfattende utslippsreduksjoner i ETS-sektorene.* Undersøke faktorer som leder til utslipp i ETS-sektorene, samt analysere reguleringer og virkemidler i ETS-sektoren, inkludert karbonfangst og –lagring, som kan redusere utslippene.
- *Miljøvennlig transport.* Identifisere, analysere og anbefale bærekraftige utslippsstrategier i transportsektoren.
- *Grønn innovasjon og bruk av smarte teknologier.* Hvordan kan virkemidler påvirke forskning, utvikling og spredning av miljøvennlig teknologi.
- *Mot lavutslippssamfunnet.* Studere nasjonale, regionale og globale baner mot lavutslippssamfunnet.

Forskningsproduksjon

CREE har 203 publiseringer i internasjonale tidsskrifter med referee-ordning, se appendiks 3b. Mange av arbeidene har blitt publisert i ledende spesialtidsskrifter innenfor miljøvennlig energi. Enkelte arbeider har blitt publisert i topp fem tidsskrifter med et bredt, tematisk nedslagsfelt. Videre har CREE publisert 82 arbeider i populærvitenskapelige tidsskrifter, 96 arbeider i andre tidsskrifter, samt utgitt 148 interne rapporter (CREE working papers), se appendiks 3c-3e.

Forskningspriser

I løpet av CREEs prosjektperiode (2011 til 2019) har CREE-forskere mottatt Erik Kempe prisen tre ganger; 2013, 2017 og 2019. Denne utmerkelsen deles ut annet hvert år til det beste arbeidet innenfor miljø- og ressursøkonomi med minst én forfatter knyttet til et forskningsinstitutt i Europa. Videre har en CREE-forsker mottatt prisen for det beste publiserte arbeidet i Scandinavian Journal of Economics, mens tre CREE-forskere delte Søren Wibe prisen i 2017; denne deles ut annet hvert år til et arbeid som er publisert i Journal of Forest Economics.

Eksempler på forskningsbidrag

- *Politikkdesign og nettverkseffekter.* I en del tilfeller er nytten av et gode avhengig av et nettverk. Dette er f.eks. tilfelle for elektriske biler; disse trenger ladestasjoner. CREE-forskere har utviklet teori for hvorfor og hvordan skatting av miljø- og klimaskadelige goder med nettverkseffekter (f.eks. bensinbiler) – eller subsidier til

deres grønne alternativer (f.eks. elbiler) – burde avvike fra verdien av den direkte miljøskadelige virkningen. Forskerne viser at dersom de politiske virkemidlene ikke tar høyde for nettverkseffektene i markedet, kan vi få en altfor treg overgang til grønne alternativer som det ville ha vært samfunnsøkonomisk optimalt å ta raskt i bruk, se Greaker og Midttømme (2016).

- *Internasjonalt klimasamarbeid.* En stor utfordring med å redusere de globale klimautslippene er at tiltak i noen land øker utslippene i land uten klimapolitikk. Virkningene kan skje gjennom bl.a. priseffekter i energimarkedene. Harstad (2012a) viser at en vei ut av dette uføret er at klimakoalisjoner kjøper ikke-utvunnet fossil energi, f.eks. kullgruver, og lar være å utvinne energien.
- *Tilbudssidepolitikk.* Ni CREE-forskere har i tidsskriftet Science argumentert for at Paris-avtalen kan styrkes gjennom en avtale mellom fossilproduserende land som reduserer produksjonen av fossilbasert energi, se Asheim et al. (2019). En slik avtale vil heve prisen på energi, og dermed redusere bruken av fossilbasert energi i land som ikke har innført en streng karbonpolitikk. De samme priseffektene vil gi et økonomisk insentiv til økt FoU innenfor klimavennlig energi.

Forskningsutdanning

CREE-partner Økonomisk institutt, UiO, tilbyr PhD- og masterkurser om miljøvennlig energi; dette temaet er dekket i kurs innenfor energiøkonomi, elektrisitetøkonomi, ressursøkonomi og miljøøkonomi. CREE organiserte et PhD kurs om modeller som knytter sammen klima og økonomiske mekanismer (integrated assessment models) i samarbeid med MILEN (i 2013). CREE-forskere har undervist PhD og masterkurser knyttet til miljøvennlig energi både i Norge og i utlandet. CREE har hatt 13 PhD studenter (7 kvinner) og en post.doc (mann). Endelig har CREE delt ut en rekke masterstipend til studenter som har skrevet masteroppgave innenfor miljøvennlig energi, se appendiks 2a.

Internasjonalt samarbeid

CREE har hatt en internasjonal forskningspartner (Tilburg Sustainability Centre) som har komplettert CREEs forskningskompetanse. En rekke internasjonale forskere har vært knyttet til senteret og CREEs årlige forsker-workshop har vært en viktig møteplass for hele forskergruppen. Endelig har CREE deltatt i ett EU-finansiert prosjekt.

Merverdi ved å være et FME-senter

- CREEs lange prosjektperiode har muliggjort å føre arbeidsnotater frem til internasjonal publisering (stordriftsfordel). Dette er den viktigste faktoren bak CREEs omfattende internasjonale publisering av høykvalitetsarbeider (En stor andel av CREEs arbeider er publisert i høyt rangerte tidsskrifter). CREE har muliggjort både spesialisert kompetanseoppbygging og samarbeid som har trukket på flere fagfelt. Dermed har det vært mulig å utvikle alternative teoretiske tilnærminger, teoribaserte empiriske arbeider og flerfaglig forskning (breddefordel).

- CREE har ledet til betydelig mer samarbeid mellom forskningspartnerne enn det som er mulig å få til gjennom ordinære prosjekter (stordriftsfordel). En stor andel av CREEs publiserte arbeider har derfor forfattere fra minst to forskningspartnerne.
- CREE har muliggjort utvikling og oppdatering av den numeriske energimarkedsmodellen (LIBEMOD) og finansiert utvikling av numeriske modeller for analyse av energi- og miljøpolitikk for både Norge og verden—SNOW modellene. Disse er nå hovedverktøyet når Finansdepartementet utarbeider langsiktige klimaanalyser. All erfaring tilsier at det ikke er mulig med omfattende modellutvikling innenfor ordinære forskningsråd-prosjekter.
- Den lange senterperioden har stimulert til flere brukerorienterte aktiviteter enn det forskningspartnerne har gjennomført i ordinære forskningsråd-prosjekter. Samarbeidet med brukerne har hatt betydning for hvilke forskningsspørsmål senteret har arbeidet med, omfanget av søknader med brukerinvolvering, samt senterets forskningsformidlingsaktiviteter.

Bidrag til det overordnede målet for FME-programmet

Det overordnede målet for etableringen av FME-sentrene er å utvikle et vitenskapelig basis for å håndtere miljø- og klimautfordringene. CREE har bidratt til dette ved å adressere hvordan norske energirelaterte klimagassutslipp kan reduseres, samt designe virkemidler for å utvikle klimavennlig teknologi. CREE-forskerne har styrket den generelle kunnskapsbasen, samt deltatt i offentlige kommisjoner og utredninger, spesielt grønn skattekommisjon, Klimakur og IPCC-arbeidet.



3. Vision/goals

The CREE Strategic Plan states the following vision for the centre:

i) To become a leading international research centre within energy, environmental and resource economics.

Own assessment: CREE researchers have published extensively in field journals covering environmentally friendly energy. CREE researchers have also published in top economics journals as well as in interdisciplinary journals. The number of publications, as well as the diversity of accepted peer-reviewed papers, suggest that CREE has been at the frontier of the field. This was confirmed by the midterm evaluation committee, who stated that CREE was a leading group in Europe, probably even world wide.

ii) To 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.

Own assessment: As stated above, CREE researchers have published extensively in leading field journals as well in general economics journals. Furthermore, CREE researchers have participated broadly in the public debate on climate and energy issues. Therefore, we believe that our scientific output and outreach activities had, and will continue to have, an influence on Norwegian energy and climate policy. Also, our participation in the public debate may have contributed to a better understanding of energy and climate issues in the general public. We believe that the novel insight achieved by our research will help industry and policy makers in making better decisions that can help us in the transformation towards a carbon-free society.

iii) 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.

Own assessment: The CREE research partner, Department of Economics at the University of Oslo, organizes regular PhD and Master courses, including classes related to environmentally friendly energy. In addition, CREE researchers have organized, or contributed to, other PhD or Master classes either at the University of Oslo or abroad, see Section 9 below.

As part of the activities of the centre, we have had 13 PhD students (7 of these are women). 8 of the 13 Phd students have received their titles (4 of these are women). We expect that 4 of the remaining 5 students will defend their theses in 2020, whereas one Phd student dropped out after one year of study (He returned to consultancy). CREE had one post. doc (male).

Also, each year we have awarded about three master scholarships to students writing their master thesis within environmentally friendly energy. Each of these students (half of them are women) have been offered a designated CREE supervisor as well as office space at a CREE institution. A modified version of one master thesis got published in the Norwegian journal *Samfunnsøkonomen*, whereas a modified version of another master thesis got published in the international field journal *Resource and Energy Economics*. Both publications are joint work between the master student and the supervisor. In addition, 14 students (12 women) wrote their master thesis within environmentally friendly energy with a CREE supervisor (but did not receive a scholarship).

To sum up, we believe CREE has contributed to recruitment and training.

4. Basic facts about the Centre

Organisation

Main organisation of centre

Research Partners:

Ragnar Frisch Centre for Economic Research (<http://www.frisch.uio.no/english/>)

Department of Economics, University of Oslo (<http://www.sv.uio.no/econ/english/>)

Research Department, Statistics Norway (<https://www.ssb.no/en/>)

Tilburg Sustainability Centre

(<https://www.tilburguniversity.edu/research/institutes-and-research-groups/tsc>)

User Partner:

Energy Norway (<https://www.energinorge.no/om-oss/in-english/>)

Gassnova SF (<http://www.gassnova.no/en>)

Norwegian Environment Agency (<https://tema.miljodirektoratet.no/en/>)

Norwegian Ministry of Climate and Environment

(<https://www.regjeringen.no/en/dep/kld/id668/#>)

Norwegian Ministry of Petroleum and Energy (<https://www.regjeringen.no/en/dep/oed/id750/>)

Norwegian Water Resources and Energy Directorate (<https://www.nve.no/english/>)

Statkraft Energi AS (<https://www.statkraft.com/>)

Statnett SF (<https://www.statnett.no/en>)

Equinor (2011-2015) (<https://www.equinor.com/en.html>)

Subcontractors:

IFE - Institute for Energy Technology (<https://ife.no/en/>)

Natural Resources Law at the Faculty of Law, University of Oslo

(<https://www.jus.uio.no/english/research/areas/natural-resources/>)

SUM - Centre for Development and the Environment, University of Oslo

(<https://www.sum.uio.no/english/>)

SINTEF (2011-2014) (<https://www.sintef.no/en/>)

Board

Board leaders:

Lars Bergmann
July 2015- Dec. 2019



(Bilde www.hhs.se.)

Einar Hope
July 2011-June 2015



(Bilde www.nhh.no)

Board members in 2019

Ståle Aakenes (*Gassnova*)

Brita Bye (*Statistics Norway*)

Rolf Korneliussen (*Statnett*)

Karine Nyborg (*Department of Economics
University of Oslo*)

Ellen Skaansar (*Norwegian Water
Resources and Energy Directorate*)

Kjell Steinar Berger (*Statkraft*)

Sverre A. C. Kittelsen (*Frisch Centre*)

Knut Kroepelien (*Energy Norway*)

Erik Nygaard (*Norwegian Environment
Agency*)

Researchers

Project leaders

Rolf Golombek
Senior
Research Fellow
The Frisch Centre
Apr. 2013-Mar. 2014
and
Oct. 2016-Mar. 2020



(Bilde www.frisch.uio.no)

Snorre Kverndokk
Senior
Research Fellow
The Frisch Centre
July 2011-Mar. 2013
and
Apr. 2014-Sep. 2016



(Bilde www.frisch.uio.no)

Key senior researchers

Brita Bye
Director of research
department (acting)
Statistics Norway



(Bilde www.ssb.no)

Taran Fæhn
Head of Research
Statistics Norway



(Bilde www.ssb.no)

Mads Greaker
Professor
OsloMet



(Bilde www.oslomet.no)

Cathrine Hagem
Senior Researcher
Statistics Norway



(Bilde www.ssb.no)

Bente Halvorsen
Senior Researcher
Statistics Norway



Michael Hoel
Professor emeritus
Department of
Economics



(Bilde www.uio.no)

Ole Røgeberg
Senior Research Fellow
The Frisch Centre



(Bilde www.frisch.uio.no)

Nils-Henrik M.
von der Fehr
Professor
Department of
Economics



(Bilde www.uio.no)

Other researchers:
See Appendix 2b

Cooperation within the centre

In CREE, research activities are organized in Flagships. In order to strengthen the cooperation between the research partners, all main research partners participate in all flagships. Hence, most projects have participation from at least two research partners, thereby transforming the organizational structure from institute oriented to centre focused.

To build up a common CREE identity, we have organized regular CREE lunch meetings where internal CREE matters are presented, for example, upcoming CREE activities, upcoming information and deadlines for research proposals (to stimulate joint applications), news from ongoing CREE projects and CREE research output in the news. In addition, we have organized numerous CREE seminars with presentation from both CREE researchers and external researchers. We have also organized an annual CREE two-day research workshop. Here most of the CREE researchers are present, along with international researchers.

To stimulate cooperation between CREE researchers and CREE user partners, we organize two annual events. First, joint with CICEP we offer a policy-oriented seminar with presentations and comments from both researchers and user partners, along with roundtable debates. Second, we offer a dialogue seminar. The structure of this seminar has changed considerably over time. Initially, we let users choose topics for the dialogue seminar from a menu offered by CREE. Then we invited users to give comments on the talks of the CREE researchers. Later, based on one to two meetings with each user partner, we obtained a list of topics that user partners found very interesting for the dialogue seminar. We have of course followed this list, and obtained great feedbacks from the users. Finally, we have organized a few user-oriented seminars jointly with research partners at the faculty of law, University of Oslo.

During the last three years of CREE, we have offered an activity called CREE Hot Line where user partners can meet with CREE researchers to discuss methodological challenges in their own work, obtain references to the literature, get an introduction to a specific field within environmentally friendly energy, discuss policy implications with CREE researchers, etc. Based on these meetings, there could be a potential for a common project or a common research proposal.

Further, we have kept our user partners updated on CREE projects and papers through the regular CREE News Letter, thereby generating an interest in our research activities. Finally, when organizing research proposals, we have always been in contact with user partners, aiming at finding topics of mutual interest where CREE user partners can participate in the research activities.

5. Financing through the life of the centre

CREE funding 2011-2019

Total CREE centre funding incl. own funding.¹ (195.7 mill.)

	Cash ²	In-kind (Own funding) ³	Total
Host (Frisch Centre)		51 429	51 429
Research partners		67 890	67 890
UiO		7 850	
SSB		58 040	
Tilburg		2 000	
Companies	3 800		3 800
Statkraft	800		
Statnett	2 000		
Statoil	1 000		
Public partners	4 230		4 230
Miljødirektoratet	200		
UiO	4 030		
User partners		4 311	4 311
Gassnova		1 600	
Statkraft		630	
Statnett		630	
Statoil		315	
Miljødirektoratet		450	
NVE		450	
Energi Norge		138	
KLD		98	
RCN	64 000		64 000
Sum	72 030	123 630	195 660

RCN research projects and competence projects affiliated to the center.	83 115
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See Appendix 1 for more details.

¹ 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.

² Cash: As a part of contribution from host and research partners.

³ In-kind (Own funding): Project affiliated to the centre but not included in the CREE accounts.

6. Results – Key figures

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Scientific Journal articles	9	20	22	32	18	25	23	25	18	11	203
Popular Science journal articles	5	11	13	7	7	17	1	5	16		82
Other scientific Publications	0	11	16	12	32	11	2	5	7		96
CREE's Working Paper series	6	19	27	20	24	15	11	13	11	2	148
Dissemination measures	29	88	95	77	90	83	68	63	87		680
PhD-degrees completed				1	2	4					7
Post docs					1	1		1			3
Master degrees		3	4	12	3	4	4	3	3		36

See Appendix 3 for details.



7. Research

7.1 Original research plan and development of research plan

Energy and climate policy is primarily focused on how to develop and utilize new technology and more environmentally friendly energy sources. This does not occur by itself, but is dependent on institutional and economic frameworks. The aim of CREE was to contribute to the collection and establishment of knowledge on how framework conditions affect both the energy market and technological development, including innovation and the diffusion of technology for renewable energy, energy efficiency and carbon capture and storage. The goal

of the centre was therefore to develop better framework conditions and policy instruments designed to reach the goals established in national and international energy and climate policy.

From the kickoff of the centre, the research activities were structured around five working packages:

Work Package 1: The International Politics of Climate and Energy

Improving the current climate regime - Building on the UNFCCC and the Kyoto Treaty, can new institutions and mechanisms be added in order to increase incentives for abatement, joining and complying?

- Alternative treaty forms - What issues are raised by alternative treaty forms such as sector- based treaties or R&D collaborations?
- Dealing with non-signatories - How can abating countries best prevent carbon leakage from eroding abatement achievements?
- Equity issues - How can economic mechanisms, such as tradable emission permit markets, be used to deal with equity issues?
- Implications for energy markets policies - How are energy markets and policies affected under various global climate policy scenarios?

Work Package 2: Innovation and Diffusion Policy

- The relevance of the experience curve - Will environmentally friendly technologies become cheaper, or will the historical fall in costs stagnate at a non-competitive level?
- The optimal policy mix - R&D in environmentally friendly technologies can be spurred by a variety of instruments such as high permit prices, subsidies to private R&D, innovation prizes, etc.; how should governments design and combine the instruments optimally?
- Increasing returns to scale - How should governments deal with learning externalities and network externalities that may constitute a barrier for the diffusion of an environmentally friendly new product?
- CCS and R&D - CCS may be a key technology for achieving the atmospheric stabilization of GHG concentration – what does the optimal R&D policy for a small, open economy with a limited home market for CCS look like?
- Behavioral economics - Is it possible to identify types of cognitive costs that prevent environmentally friendly technologies from succeeding in the market?

Work Package 3: Regulation and Market

- What is a reasonable level of energy security and how do we ensure that it is achieved?
- What are the requirements of a network infrastructure when large amounts of wind and other intermittent energy sources are introduced into the system?
- How do we best ensure integration of national energy markets, both with respect to the physical infrastructure and to the system's operation and regulatory oversight?
- How should measures to promote green energy be harmonized with the overall regulation of energy markets?

- When should we use market-based measures and when should we use other regulatory measures to increase the sustainability of our energy use?

Work Package 4: Evaluation of Environmental and Energy Policy Measures

- Rebound and adverse effects - How much of the initial energy efficiency gains are eaten up by increased consumption? Can the regulation of one good have unwanted effects on the consumption of close substitutes? How does the use of multiple policy tools affect behavior?
- Soft policy measures - How can we measure the effect of soft policies on preferences and behavior? How do these soft policies affect habits and attitudes, and do they affect the demand response to harder policy tools such as taxes and regulations?
- Environmentally friendly transportation - Have CO₂ taxes on car fuel induced the purchase of more energy efficient cars? Does the increased use of biofuel and electric cars reduce emissions from road traffic?



Work Package 5: The Next Generation of Numerical Models

- National and international integrated models - Unilateral and international policies interact and demand development of economy-energy-environment models to improve the analyses of how different policies affect efficiency and emissions.
- Technological innovation and diffusion processes - We will model and empirically pin down the dynamic characteristics of the innovation and diffusion processes in a general economic model framework.
- Identification and quantification of policy effects - Identification of behavioral, technological and market characteristics will improve the empirical basis of our integrated models and policy analyses.
- Electricity market models - We will improve the modeling of the electricity market by integrating detailed technology-based bottom-up electricity market models with top-down energy market and macroeconomic models.
- Model Forum and Scenarios - We will establish a model forum for the development of energy and environmental economic models, and present energy and climate policies scenarios for the Norwegian economy.

This research plan was followed strictly until CREE received the midterm evaluation, which gave a lot of academic credits to CREE (assessed as a leading research group in Europe, maybe even globally), but also raised considerable concerns related to i) additionality of research, ii) extent of multidisciplinary, iii) extent of user partner involvement, and iv) international cooperation. In 2016, CREE worked out strategies that addressed each of the concerns:

Strategies for additionality of research

- Improve the meeting places for CREE researchers, sub-contractors and users such that we get a dialog that benefits research.
- Cooperation on research proposals. New proposals should ideally include two or more research partners, one subcontractor (or researchers from another field), and involvement of user partners.
- Revise the research plan for 2016-19 to take into account recent research results, technological innovations and political developments.
- Revise the work packages of CREE to be in accordance with the new research plan.
- Synthesise the research at CREE once a year in connection with the annual reports.

Strategies for more multidisciplinary

- Include researchers from other fields in research proposals
- Strengthen cooperation with our subcontractors
- Write joint research papers with researchers from other fields
- Continue to invite researchers from other fields to our seminars, workshops and conferences.

Strategies for better user partner involvement

- Develop the meeting places between user- and research partners in CREE to arenas for two-way communication.
- Increase user partner funding and participation in research projects.
- Increase the access to our research.
- Involve user partners in research by, e.g., encouraging subjects for Master theses and PhDs based on the arrangements in the RCN for industry and Government.
- Encourage user partners to spend some time at research partners and vice versa.

Strategies for international cooperation

- Strengthen our participation in EU-projects by taking initiatives to research proposals.
- The research collaboration between the Norwegian research partners in CREE and the international partner, Tilburg Sustainability Center, should be strengthened.
- Develop quantitative measurements for the international cooperation in the work plans and annual reports.
- Strengthen the cooperation with China.
- Take initiatives for research agreements at the centre level with international centres.

Strategies for better organization

- Expand the board by to include all user partners.
- Establish an International Scientific Advisory Board.
- Undergo a further revision of the organization of the centre in connection with the revision of the work packages and research groups.

These strategies led to a number of changes, in particular, reorganization of the centre research activities as four flagships (see 7.2); major changes in the key roles of the centre (for example, a new centre director); more user partners; more CREE board members; tailor-made user activities, and a radical upgrading of the web site of the centre to make information on activities and access to various types of papers and reports easily available.

7.2 Research achievements

Flagship I: Radical emissions reductions in ETS sectors

Overview

This flagship analyzed emissions reductions in the emissions trading (ETS) sectors. In addition to the EU member states, Norway together with Iceland and Lichtenstein, have joined the EU ETS. The ETS covers about 45% of the greenhouse gas emissions in the EU, and includes CO₂ emissions from sectors such as power and heath generation, energy-intensive industries and civil aviation between the ETS countries. In Norway, a slightly larger share, about 50% of emissions, is covered by the ETS.

We concentrated our research on the power market, but we also studied other sectors. The aim was to understand the driving forces behind the regulations and the choice of regulatory instruments in these sectors. Further, we analyzed how they affect the Norwegian energy system



*Nils Henrik m.
von der Fehr*

and energy production, including investments in technologies and transmissions. We also studied how regulations can be designed to ensure socially warranted investment decisions. Finally, we took a further look at environmental costs of investments in the energy system.

This flagship was headed by Nils-Henrik von der Fehr (Department of Economics, UiO) and Snorre Kverndokk (Frisch Centre).



*Snorre
Kverndokk*

Research questions and main results

The Flagship concentrated on five major themes called masts, where the first three themes study the electric power market.

1.1 Intermittency, Flexibility and Security of Supply

To mitigate greenhouse gas emissions, a transition from fossil fuels to renewable energy are necessary and also ongoing, in electric power production. Some electricity production from renewable energy such as hydropower, can easily be regulated to meet demand. However, most of the renewable production are based on solar and wind, and faces the problem of intermittency, i.e., the available energy used in the production varies over the day or week, as the sun is not always shining and the wind is not always blowing. Thus, to be able to meet the demand for electric power, some flexibility is needed. How this can be achieved may therefore be valuable for policy makers and for the society. Below we summarize the conclusions.

The flexibility of the market so that imbalance can be reduced is dependent on features of wholesale market exchanges – such as gate closure, market time unit and bid format. Changes in these features can increase the ability of markets to provide flexibility and reduce imbalances; however, such changes may increase transaction costs and hence the attractiveness of power exchanges, see von der Fehr (2018). Electricity pricing may also have an effect, and smaller geographical price areas may also increase flexibility through better transmission capacities.

One challenge for the European power market is a phase out of nuclear power. 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, especially wind power and bio power, see Golombek et al. (2016a). With even more strict goals on renewable energy and energy efficiency in the EU (as agreed in June 2018), the share of the supply from renewable electricity and bio energy will be even higher in 2030, see Aune and Golombek (2018). This shows the relatively large flexibility of the European power market to adapt to new energy sources in the medium and long run.

Different policy instruments can incentivize integration of more renewable energy into the power system. However, different instruments affect costs differently. One example is uniform subsidies that may lead to inefficient locations of wind farms and grids, as the producer then has limited incentives to take fully into account the investments costs of the subsequent need for increased grid capacity, leading to an inefficient choice of location, see Bjørnebye (2018).



1.2 Transmission and Integration

As mentioned above, intermittent power generation will vary by time and place, and will frequently be produced in areas that currently have limited transmission capacity. This will require more transmission capacity. The impact of weather stochasticity may be reduced by increasing the capacity of interconnectors (such as the one between the Nordic countries and the rest of Europe). Also, more efficient use of existing transmission capacity is warranted.

Integration of new renewable energy is important to reach renewable energy goals. One example of research in this line is our work on the integration of wind power in the Nord Pool Area and beyond. The main research question is how Scandinavian hydro capacity can cope with a large-scale expansion of wind power both in and around the North Sea, taking into account the possibility of pumped storage and the cost of building international grid

interconnections that provide backup and regulate capacity to the countries in the Nord Pool area and beyond. We demonstrate that the exact regulating benefit of hydro depends finely on assumptions about availability of infrastructure, including pumped storage, see Førsund (2015).

One research question is if transmission system operators (TSOs) and regulators are able and willing to facilitate development of transmission networks, in particular where cooperation across jurisdictions is required. The current European model of transmission investment is largely decentralized and relies on the involvement of the nation's directly involved (say, those located on either side of an interconnector). Thus there is a lack of coordination, as this does not always allow for taking proper account of the considerable externalities of transmission investment and hence leads to inefficient (i.e. sub-optimal) investment. A subsidy to sustain the interconnector building is not sufficient to restore the best solution. To reach optimal investment without merging the two TSOs into an international operator that would internalize all the effects from its investment, we need a compensation to be paid to each TSO for the positive externality its internal investment creates abroad, see von der Fehr and Crampes (2018).



1.3 Distributed Electricity and Storage

New technology – including renewable generation, batteries and information and communication technology – is rapidly changing the role, not only of distribution networks, but also of distribution system operators (DSOs).

One research question we have been working on is if there are there barriers to the rolling out of new technologies. One barrier to diffusion of new technologies is commitment, i.e., that governments cannot commit to future climate policies. Policies to overcome this barrier are for instance emissions pricing with a state guarantee scheme whereby the regulatory risk is borne by the government and emission pricing combined with subsidies for upfront climate technology investments, see Fæhn and Isaksen (2016). Another barrier to diffusion of new technology is reluctance by households towards renewable resources such as solar energy, see Khan (2018).

1.4 Regulatory Instruments and Impacts

Reductions of emissions in the ETS sectors can be achieved with different instruments, including emissions quotas and taxes, quality standards, subsidies to green energy sources and an outright ban on the use of certain resources. Information of the impacts of different

regulatory instrument is important for the efficiency and costs of achieving energy and climate goals.

What is the experience with the various instruments? Using a rich Norwegian panel data set, we have studied the effects of various environmental regulations on environmental performance of firms measured as changes in emission intensities. There is 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 Bye and Klemetsen (2018).

Another example of the different impacts of policy instruments is our study on how renewable energy policy instruments affect competition on electricity markets, see von der Fehr and Ropenus (2016). We demonstrate that markets for green certificates allow generators with market power to squeeze the margins of their competitors, as a generator that is vertically integrated into network activities might do. Further, we find that whether or not a dominant firm is vertically integrated into network activities, it can disadvantage competitors in the renewables segment by distorting certificates prices, thereby inducing cost inefficiency in the generation of renewable energy. We compare green certificates to a system of feed-in tariffs, where a similar margin squeeze is not possible, concluding that these policy instruments have very different implications for competition and overall efficiency.

We have written several studies on the effects of carbon taxation. One example are studies on carbon taxes used on traded goods to reduce emissions when not all countries have restrictive climate goals. One such study concludes that such tariffs do reduce foreign emissions, but can increase rather than decrease the global cost of emission reduction. The main effect of carbon tariffs is to shift the economic burden of developed - world climate policies to the developing world, see Böhringer et al. (2016).

1.5 Carbon capture and storage

Carbon capture and storage (CCS) may be necessary to contain global warming below 1.5 or 2 degrees Celsius, as is the current political ambition. Adoption of CCS technology in the power sector, however, has by been far behind predictions. Research results on the barriers to implementation may therefore have a large impact on policy design and, in the end, on whether we are able to reach the climate goals specified in the Paris agreement.

An interesting research question is therefore, why has the technology not been implemented in a large scale as many model scenarios show is necessary to reach the Paris goals in a cost-effective way? We have written a survey article where we go through the arguments in the literature for the low implementation of CCS, see Golombek et al. (2019). In particular, we point to market imperfections in the three markets capture, transport and storage as a main reason, as well as the use of a large number of policy instruments to reach the climate targets in the EU. While a price on CO₂ is necessary for CCS to be implemented, the EU has targets for renewable energy and energy efficiency in addition to the emissions targets. This reduces the CO₂ price substantially in the EU-ETS, see Aune and Golombek (2018). One of our studies show that a substantial CO₂ tax is necessary for CCS to play an important role in the European

energy market. According to our model simulations, subsidies are necessary unless there is a very high carbon tax. Our simulations show that with a tax of \$90 per ton CO₂ in 2030, CCS will be installed without subsidies, see Golombek et al. (2011). This is far above the present carbon price in the European permit trade system.

Can CCS be economically profitable without government support? Based on our studies, this is likely not the case in the near future. A study on the design of support shows that subsidies to CCS are more efficient if they are provided to development of the CCS technology in Europe than to the use of the technology, see Golombek et al. (2016b). Support to development gives Europe a strategic benefit, while support to use will benefit all developers. In addition, support to CCS in coal production should be larger than for gas production due to the higher CO₂ content in coal than gas, and due to terms of trade effects. Support to CCS can, however, only be justified if there are market imperfections or barriers so that the investors or owners of power plants do not find CCS profitable even if it is socially optimal. We find that such support may be justified as there may be network effects in the energy market, and this may be a barrier to the implementation of CCS, see Velten (2017).

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To sum up, the research in this Flagship finds that the energy market faces several challenges due to the transition to renewable energy. More flexibility is needed to reduce possible imbalance in the market. This again requires increased investments in transmission capacity. Another challenge is that many decisions are decentralized. Policy instruments therefore, have to take this into account to avoid inefficiency. A final important challenge is how to achieve negative emissions to meet the long-term climate targets. Even though CCS is regarded as a necessary technology in the long run, it is barely implemented due to lack of appropriate carbon pricing as well as support. This also points to the design of policy instruments as introducing many regulations at the same time as in the EU, reduces the carbon price and creates incentives for other energy investments than in CCS.

Flagship II: Environmentally friendly transport

Overview

Norway has committed to a 40% reduction of greenhouse gas emissions from the non-ETS sectors by 2030. Transport makes up a major share of Norwegian emissions in the non-ETS. Although there will be flexibility available for the non-ETS sector across the EU members, the Norwegian Parliament has announced that they aim for radical domestic emission cuts in transport.



Cathrine Hagem

The sustainability of transport can be improved by the following measures: i) reducing the total amount of traveling, ii) modal shift, e.g. from road to rail, and iii) by introducing new technologies (e.g., electric vehicles and increased fuel efficiency). For policy it is important to obtain the right balance between the measures. It is not only the direct cost of the measures that must be taken into account, but also potential market imperfections and external effects.

The Flagship was headed by Cathrine Hagem, Statistics Norway.

Research questions and main results

The Flagship concentrates on three major themes.

II.1 Electrification of the private road transport and the electricity market

Norway is a pioneer when it comes to electrification of the car fleet. In 2018, 30 % of new cars were zero-emission cars, of which almost all were battery electric cars. Electrification of the car fleet will increase the interdependence between the transport system and the electricity market. This will require new policy measures and improved coordination and collaboration between different policy makers and institutions. The pricing of electric cars charging may have a lot to say for the success and costs of the transition to an electrified car fleet.

EV-friendly transport policies increase the demand for power, thus challenging the distribution grid's capacity, while electricity policies immediately impact on the costs of driving EVs. If enough EV-owning agents charge during power peak hours, costly grid expansions may be needed. In a study we examine how the distribution grid company in Norway can respond in order to mitigate these costs with different pricing schemes and how this in turn affects the transport equilibrium, see Wangsness et al. (2019). It is found that applying peak tariffs for the grid will help support a better balance between investment costs and EV-owners' disutility of charging during off-peak hours.

The organization of the charging market may be crucial for the market diffusion of electric cars. In a CREE study we show that a charging network with incompatible high-speed charging systems will unambiguously imply slower phase-in than a network in which all cars are compatible with all charging stations, see Greaker (2019).

Electric vehicles are dependent on electricity supply from the grid, and they will increase total electricity demand. On the other hand, bidirectional chargers (Vehicle-to-grid, V2G) imply that

EVs may also store and supply electricity to the grid. This can smooth out daily variability in demand and supply of electricity from other sources. The larger battery, the larger possibility to store and supply electricity from the EV. Moreover, the EV can also help balancing the grid by supplying quick power when there is a local imbalance. In CREE we have address the following research question: what is the impact of V2G on the electricity market, see Hagem et al. (2019)? To answer this question, we integrate a model of EV users' choice of battery capacity with a simple model of the electricity market. We show how consumers' optimal battery capacity choices affect the equilibrium electricity prices during peak and off-peak hours, and optimal investments in power plants. One finding is that viable V2G solutions increase welfare as the need for investment in backup power capacity decreases.



ELECTRIC VS GASOLINE

II.2 Policy instruments for promoting sustainable private and commercial transport

Over the past years, many countries have been greening the car fleet through revisions of purchase taxes, road taxes, or by special privileges for low emission car owners.

In CREE we have exploit the variation in the stringency of vehicle fiscal policies across EU countries and time to address the following research question: to what extent have national fiscal policies contributed to the decarbonization of newly sold passenger cars, see Gerlagh et al. (2018)? The study is based on a data set of vehicle-specific taxes across 15 countries over the years 2001–2010. The study finds empirical evidence that fiscal vehicle policies significantly affect emission intensities of new bought cars. There is evidence that especially the CO₂-sensitivity of registration taxes and the level of the fuel taxes are important determinants of the emission intensity of new cars. The diesel–petrol substitution induced by changes in relative taxes for diesel versus petrol cars is an important factor for the average fleet's fuel efficiency. The study also finds higher CO₂-intensities with increasing income and a clear convergence pattern between EU countries.

In CREE we have also studied the implication of the Norwegian reform for vehicle registration tax in 2007. The results show that average CO₂ intensity of new vehicles was reduced in the year of the implementation of the reform by about 7.5 g of CO₂/km. This reduction is the result of a 12 percentage points drop in the share of highly polluting cars and of an increase of about 20 percentage points in the market share of diesel cars, see Ciccone (2014).

A tax on fuel is implemented in many countries to reduce both greenhouse gas emissions and other negative externalities from road traffic. The road user charge on fuel can partly be avoided by purchasing fuel-efficient vehicles. This may lead to too much investment in fuel-efficient cars and may call for heavier tax on fuel-efficient vehicles, see Bjertnæs (2019).

The large share of electric vehicles of new cars in Norway is induced by a set of policies that include tax exemptions as well as various driving privileges, like the use of bus and collective lanes in cities, exemption from parking fees in city centers, and often battery charging at zero cost. In some of CREEs research it is argued that this policy leads to very high cost for small emission reduction, and that it may lead to more driving causing other externalities, see Holtmark and Skonhoft (2014).

Although electrification is a viable solution for passenger cars and light-duty vehicles, it is less so for heavy duty vehicles under present technologies. Different policies for inducing less emission intensive commercial transport has been proposed, including both subsidy-schemes and tax-schemes. In CREE we have analyzed the optimal environmental policy for the commercial transport sector in Norway, see Segiet (2018). The result indicates that when the government can commit to the level of tax in the future, or when there is no strategic action when the government cannot commit, the subsidy for the commercial transport sector in Norway is not a cost-effective climate policy and a tax on CO₂ emissions is more desirable. However, when we assumed that the government was not able to commit to a certain level of the tax in the future and firms acted strategically, the optimal policy involved a subsidy on capital.

Fuel efficiency improvements in the transports sector leads to less emissions per of unit output (transport services) and can play an important role on the path to a decarbonized economy. A popular policy instrument to reduce oil consumption has been fuel efficiency standards for new vehicles, and there have been significant improvements in energy efficiency globally over the last decades. However, fuel efficiency measures may be less effective than expected due to the so-called rebound effect; fuel efficiency improvements lower the cost of energy services, thereby encouraging more use of those services. In CREE we have developed a model to investigate the effects in the oil market of fuel efficiency improvements in the transport sector, see Aune et al. (2017). One conclusion from that study is that the rebound effect has a noticeable effect on the transport sector, with the magnitude depending on the oil demand elasticity. In the benchmark simulations, almost half of the energy savings may be lost to a direct rebound effect and an additional 10% to oil price adjustments. If market power is present in the oil market, the directions of change in consumption and price might contrast with those in a competitive market, see Kverndokk and Rosendahl (2013).

Another research question we have address in CREE is whether the promotion to purchase and use electric cars change the driving pattern of the owners of fossil cars, see Kverndokk et al. (2019). Evidence from a survey indicates that Norwegian policies to promote emission free cars have moderately reduced fossil car driving.

II.3 Biofuels in road transport

Biofuel and other forms of bioenergy has been considered as an important alternative to fossil energy. For 2020 there is a biofuel blending mandate of 20 per cent in the in the transport sector in Norway.

Bioenergy is usually considered as carbon neutral. However, food-crop-based biofuels has been criticized for the upward pressure such production has put on food prices. It can also cause greenhouse gas emissions related to growing and processing, and emissions due to land use changes when converting grazing land or forest land to land for producing crops for bioenergy. An alternative to converting grazing land or forest land into land for growing suitable crops for bioenergy production is to use the harvest from standing forests to produce bioenergy. So-called second-generation liquid biofuels can be produced from processing cellulosic biomass. However, one can argue that wood harvesting is not a carbon neutral policy. A higher level of harvest leads to a lower stock of carbon in the forest. So even though the second-generation biofuels replace petrol in the transport sector, and thereby reduce emissions, the carbon stock has decreased, and hence carbon has been released. For the Norwegian type of forest, it takes a very long time before the carbon stock in the forest is restored, see Holtmark (2012).

There is a tradeoff between forest as a source for producing bioenergy and as a carbon sink. An unregulated market will not yield the social optimal balance, and thus market intervention through optimal subsidies (on carbon sequestration) and taxes (on fossil fuel emissions) are called for, see Hoel and Sletten (2016).

The results for the analysis of the impact of a biofuel mandate are highly dependent on whether the analysis is static or dynamic. It is well known that a biofuel mandate is equivalent to a revenue neutral combination of a carbon tax and a subsidy on biofuel production. In a static setting, a blending biofuel mandate will lead to less emissions for fossil fuels and increased use of biofuels. However, considering that oil is a non-renewable resource, a blending mandate may not have any effect on accumulated oil consumption. It will however, shift the consumption pattern over time. Extraction of oil is postponed because of the blending biofuel mandate. This has beneficial climate effects, see Greaker et al. (2014).

Flagship III: Green innovations and utilization of smart technologies

Overview

Achieving ambitious environmental and climate goals requires broad adoption of environmentally friendly and energy efficient technologies in homes and businesses. The aim of this Flagship was to increase our understanding of how policies can motivate research, development and diffusion of both low-emission technologies and technologies aiming at lowering energy consumption. What impact will economic factors, habits and norms have on development and utilization of new technologies? How do firms and consumers use and respond to new technologies? To what extent does adoption of the new technologies reduce energy demand?



Bente Halvorsen

The Flagship was led by senior researcher Dr. Bente Halvorsen from Statistics Norway.

Research questions and main results

The research on this Flagship has focused on two major themes: Innovation and diffusion of green technologies, and how green technologies affect energy use. Research and Development (R&D) in a firm creates new knowledge, which also benefits other firms, and thus entails a positive externality in society. A main reason to support private R&D is that the innovator will in general not be able to appropriate the full social benefit of the innovation. In economics, this is usually referred to as the appropriability problem, and it provides a rationalization for the government to support private R&D. This research examines how policies should be designed to overcome the appropriability problem. An important aspect of the research is to see the design of Research, Development and Diffusion (R&D&D) instruments in relation to other environmental policies. A key research topic is therefore the optimal design of the R&D&D policy instruments.

Development of new and more environmentally friendly technologies is a premise for achieving a green transition, but no guarantee. To ensure the desired development, the technology needs to be widely spread and used in the desired way. As most economic decisions are left to consumers and producers, the diffusion and use of an environmentally friendly technology depends on how it meets the wishes and needs of the public, given their preferences, costs considerations, income/profits and what alternative technologies are available. An important research topic is thus how these new technologies are spread and used in society, and how this affects the use of different energy sources.

III.1 Innovation and diffusion of green technologies

Like other types of R&D, environmentally-friendly R&D is also characterized by market failures and obstacles. In many regions, renewable energy targets are a primary decarbonization policy. Another instrument that might trigger more use of renewable energy is simply a subsidy on use of renewable energy and/or on production of renewable energy capital. Fischer et. al (2018) demonstrate that under imperfect competition upstream, subsidies may improve welfare both globally and nationally. From a national point of view, Fischer et. al finds that upstream

subsidies (support to producers) are preferred over downstream subsidies (support to users) of renewable energy.

We have also conducted a study on how patents work together with R&D subsidies and climate policy (Gerlagh et. al, 2014). If the emission price is set according to the marginal damage of the emissions, the optimal clean energy R&D subsidies are initially high, but then fall over time.

Whereas research subsidies are standard policy instruments, innovation prizes have not been much discussed in the literature. With an innovation prize, the actor receives an amount of money from the regulator/government if he/she succeeds in developing a new technology that meets some pre-specified technical conditions. The innovator invests in R&D to develop a new technology, being aware that an innovation prize will be received if he is successful.

Golombek et al. (2020) show that the regulator can design an innovation prize that solves the appropriability problem. The paper compares a market good innovation—to develop a more efficient technology to produce a standard market good—with an environmental innovation—to develop a more efficient abatement technology—that has the same potential to increase the social surplus. In the first-best outcome, which can be achieved by offering an R&D subsidy and a diffusion subsidy, the R&D subsidy should be greatest for an environmental innovation, whereas the diffusion subsidy should be greatest for a market good innovation. The ranking of the two types of subsidies reflects that the appropriability problem is greater for an environmental innovation than for a market good innovation.

Design of instruments to promote more Carbon Capture and Storage (CCS) is another key research topic. This technology has been seen by the IEA and the EU as having 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 costs. These may, however, be lower through 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). Golombek et. al (2016) have shown that for the EU it is optimal to offer an upstream subsidy to the EU producers, but no downstream subsidy. By offering an upstream subsidy to the EU producers, production is shifted from the non-EU producers to the EU producers, thereby shifting profits to the EU producers and at the same time gaining consumers because total production increases.

Econometric analysis on the efficiency of Norwegian policy instruments to promote R&D in firms are also conducted on this Flagship. Klemetsen et. al (2018) study empirically how environmental regulations may trigger more environmentally friendly R&D, measured by number of patents. The results indicate that indirect regulations will only have potential persistent effects if environmental taxes are increasing over time. Thus, technology standards and non-tradable emission permits may be a useful complement to market-based instruments in spurring innovation in environmentally friendly technologies (see also section 3.1).

Klemetsen (2015) examines the impact of R&D tax credits and direct R&D subsidies on Norwegian firms' patenting. For environmental patenting, the study found no significant effects of tax credits, whereas the effects of direct subsidies are large and significant.

Some argue that environmental R&D should take precedence over market goods R&D in subsidy programs. Unless there is reason to believe there is a systematic difference in the magnitude of these market failures between the two cases, these market failures should not lead to any systematic difference in the incentives for environmental R&D and for market goods R&D. Greaker and Hoel (2011) discuss a potential difference between the market goods case and the environmental technology case, namely the way in which demand for the new innovation is determined. They show that the assumption that incentives for environmental R&D are lower than incentives for market goods R&D is not generally true. This holds independent of the type of environmental policy instrument being used. Greaker et. al (2017) illustrate another situation where the governments should prioritize clean R&D. Dealing with major environmental problems requires a R&D shift towards clean technology. In the case where most researchers are working with developing clean technology, both productivity spillovers and the risks of future replacement increase. Consequently, the gap between the private and social values of an innovation is greatest for clean technologies as compared to other technology developments.

To sum up, the research finds that both innovation prizes, technology standards and non-tradable emission permits may be important policy instruments to trigger more environmentally-friendly R&D as an alternative to, or in combination with, more traditional subsidies and taxes. The research also finds a clear preference to up-stream (producer) subsidies as compared to down-stream (user) subsidies to enhance the environmentally friendly R&D activities in the economy.

III.2 Green technologies and energy use

The installation and utilization of environmentally friendly technology in households and firms is necessary for accomplishing the green transition. Thus, the other main field of research in this Flagship is how new technology is used in households and firms, and how this affects energy consumption. One of the major topics of this research has been rebound and adverse effects of energy efficiency measures on energy consumption. These effects occur because increased efficiency decreases the cost of using energy to produce goods and services. In our research, the rebound effects have been exemplified by the effect on household energy consumption of having invested in a heat pump. We have conducted both economic and anthropological analyses on this topic (Halvorsen et. al 2016; Winther and Wilhite 2015; Halvorsen and Larsen 2013; Bøeng et. al 2013). We find large rebound effects of heat pump ownership, and on average, electricity consumption is unchanged after installing a pump. This is partly due to reduced use of alternative fuels like firewood and fuel oils, but also a result of an increase in the heated area and higher average indoor temperature in the residence.

These findings seem to be robust with respect to analytical approach, as we find the same effects both in economic and anthropological analyses. Similar results are found in a study analyzing

factors effecting residential indoor temperature, where we find that the indoor temperature varies with the heating equipment (Halvorsen and Dalen 2013). Households with a common central heating system is the group with the highest indoor temperature, followed by households with a heat pump. On the other end of the spectrum, households that use a lot of firewood for heating have the lowest average temperature in the living room on cold winter mornings.

Another important topic of this research has been behavioral responses to soft policy tools (i.e. to increase awareness) to reduce energy consumption. Using anthropological methods, Westskog et. al (2015) have analyzed how households relate to electricity meters showing energy consumption by various activities. They find that households are concerned with the information provided, and especially seems to appreciate information about costs.

Winther and Bell (2018) use qualitative data from Norway and the United Kingdom to analyze how the new technology of in-home display monitors may affect social practices and relations. A key question is whether the display triggers a new practice of monitoring electricity consumption. Among both groups, many participants gave detailed accounts of how they monitored the displays. The regular consulting of displays suggest that monitoring electricity became a new routine for many of the participating households. This conclusion was strengthened by the observation that the Norwegian flat-owners continued to use less electricity than their neighbors up to one year following the installation of the new meter display.

A new technology may only affect energy consumption if it fulfills the wishes and needs of its user. The ability of the technology to reduce energy use thus depends on the publics preferences. We find that households concerned about costs tend to invest in heat pumps more than others, whereas environmental concerns are paramount in explaining purchase of wood pellets stoves (Lillemo et. al 2013). We also find that the main reason very few households chose to purchase a pellets stove, despite the investment subsidy, is that alternative heating equipment are viewed as better or more desirable (Lillemo et. al 2011). A study comparing the distribution of electricity on different end-uses for the years 1990, 2001 and 2006 find that electricity for basic use, such as washing, cooling of food and heating of water, does not vary much over the period (Dalen and Larsen 2015). Total energy consumption for heating purposes is also quite stable over the period. However, electricity for heating may vary considerably across years, depending on relative energy prices and temperature.

With respect to how policies affect technology choices in firms, Storrøsten (2012) finds that tradable emissions permit and an emissions tax affect the technology choice differently under uncertainty. A tax encourages the most flexible abatement technology if and only if stochastic costs and the equilibrium permit price have sufficiently strong positive covariance, compared with the variance in consumer demand for the good produced. Moreover, the regulator may not, in general, be able to design tradable emissions permits and an emissions tax such that the two regimes are equivalent when technology choice, uncertainty and the product market are considered. Finally, the firms' technology choices are socially optimal under tradable emissions permits, but not under an emission tax.

To sum up, the research conducted illustrates that policy measures may help facilitate a green transition with respect to energy use, but that the policy measures must be carefully designed to reduce behavioral barriers and avoid undesired side effects, such as rebound effects. Our research indicates that subsidizing the purchase of a particular equipment is no guarantee for its diffusion if the potential buyers perceive alternative technologies as superior or more desirable. This was the case for pellet stoves, where the Norwegian public preferred to buy heat pumps instead despite a subsidy on pellet stove purchases. Given that a household or a firm has chosen to install more energy efficient equipment, we find (in some cases) very strong rebound effects, as the new technology may change how they choose to use energy after the equipment is installed. Some of these changes may be desired (e.g. increased energy efficiency) whereas others are more discussable (e.g. increased share of electricity for heating). We also find that increased information about personal electricity use in the form of more advanced meter displays affects how the households use electricity in their homes, resulting in reduced consumption.

Flagship IV: Towards the low-emission society

Overview

While Flagship I, II and III focus on specific sectors and technologies, this flagship aimed at taking a comprehensive view by focussing on larger entities; nations, regions and the world. Changes in behaviour and investments towards a more environmentally friendly and less carbon-intensive energy use are largely affected by policies. Approaches in Flagship IV embrace theoretical and numerical models of technological, behavioural and political responses to challenges in the energy-environment-climate nexus. It is also pivotal to learn from experience by using empirical methods and experiments of behavioural responses. There is a need to understand the political, legal, economic, behavioural and technological motivations and obstacles for alternative pathways.



Taran Fæhn

The flagship Towards the low-emission society embraces three sub-themes—or masts:

- 1: Greening the economy
- 2: National and international climate policies and treaties
- 3: Barriers and opportunities to transformation.

This flagship was headed by Senior Researcher Taran Fæhn at Statistics Norway.

Research questions and main results

IV.1 Greening the economy

This mast addressed economic structures nationally and globally and their transitions from fossil-fuel based industries and petroleum dependency to green energy and clean activities. Technological change is naturally a big part of this.

Reducing demand for fossil fuels

Analyses of demand changes in the fossil fuels markets have to a large extent been based on models. For instance, the LIBEMOD model of the European energy markets has been simulated to look at the impacts of the EU climate target in 2030 on imports of natural gas from Russia, showing that as EU demand for natural gas is moderately affected, the imports from Russia will only increase slightly, see Aune et al. (2015a). In another study of the gas markets, we have looked at the impacts on arctic gas production of phasing out coal and promoting renewables in the European power sector in 2050 in line with the 2 °C scenario, see Lindholt and Glomsrød (2018). We have used the model FRISBEE that has a detailed modelling of the supply side of the gas market. That study finds that the arctic gas production decreases significantly by 2050, and a small decrease is also found for Russian extraction.

PETRO2 is also an oil market model where the demand side and the intertemporal dynamics of the oil market can be captured. The model is used for studying two different demand-side climate actions, see Aune et al. (2017). First, a global phasing-out of subsidies to transport fuels have been examined. Second, scenarios with increased transport fuel efficiency is explored. Both studies revealed rebound effects and carbon leakage to other sectors and countries.

Yet another type of model that takes an economy-wide perspective (so-called Computable General Equilibrium – CGE – model) is used in Böhringer et al. (2014, 2018) to consider carbon leakage when taking into account the strategic behaviour of OPEC in the oil market. They show that OPEC's response to EU's climate policy can be large, and hence including these responses can be important for the results. It is shown that if OPEC believes the EU is pursuing a quantity target, it will counteract a European carbon price reduction by reducing production. By doing this, the producers shift the rents from taxation from the EU to themselves. The authors show that the response might be sufficiently strong for the carbon leakage to be negative.

Reducing supply of fossil fuels

CREE research has contributed significantly to the knowledge frontier when it comes to supply side climate policies. Recently, nine CREE researchers published a Science article posing arguments for redirecting climate policies toward fossil fuel producers directly by capping the flows of extraction and restricting the stocks of resources available for exploration, Asheim et al. (2019). Four arguments are given: To enhance the effectiveness of the Paris Agreement, to insure against the failure of the Agreement, to stimulate green R&D and to get fossil fuel producing countries and companies on board as capping supply will increase fossil fuel prices. A treaty among producers need not be costly and could help reduce the costs of the required transition to a low-carbon economy. Numerical contributions support the idea. Unilateral climate policies will in general minimise costs if directed partly to the demand-side and partly to the supply-side. In the Norwegian case, we find that the optimal is to do about 2/3 of the measures as supply-side cuts in the production of oil, see Fæhn et al. (2017).

Two contributions from CREE have extended the analysis to consider demand-side/supply-side combinations when accounting for intertemporal changes of extraction. It is a well-known mechanism that expectations of future demand-side policy tend to increase present extractions

(the so-called green paradox). Hagem and Storrøsten (2018) consider carbon leakage in a dynamic framework and show that the green paradox argument strengthens the case for supply-side policy. The reason is that commitment to future reductions in extraction by one country/coalition provides incentives for producers in other countries to delay extraction to increase overall profits. For similar reasons, Hoel (2013a) argue that supply-side policies are less likely to create the green paradox that can result from demand-side policies. Specifically, there will be no green paradox if supply-side climate policies are aimed at high-cost carbon reserves. If instead low-cost reserves are removed, the possibility that both early and total emissions increase cannot be ruled out. Harstad (2012a) further develops the arguments made by Hoel and shows that supply-side carbon leakage can be avoided completely if marginal fossil energy resources can be bought internationally and conserved.

IV.2 National and international climate policies and treaties

In this flagship, national climate policies are limited to sector-overarching climate policy goals and instruments. Emissions outside of the EU-ETS has been the main focus. The ETS is thoroughly addressed in Flagship I. International policies in focus have primarily been at the EU level or at the global level. The research in this field has mainly focussed on what will be the costs and distributional impacts of meeting greenhouse gas emission targets, what are good choices of instruments and how will they affect behaviour.

Norwegian climate policies

In the Norwegian setting, national climate policy goals have until now been formulated in ways that allow for buying quotas or otherwise obtain credits by implementing emission cuts abroad. An important discussion has therefore been what are the pros and cons and a sensible balancing of measures at home versus abroad.

Norway's national emission reduction target for 2030 is established by law and restates the country's Nationally Determined Contribution (NDC) in the Paris Agreement: a 40 percent reduction compared to the 1990 level. Norway has been part of the EU-ETS since 2008. Recently, the non-ETS target has been linked to that of the EU, and Norway's share of the European efforts imply a 40% cut from the 2005 emission level. EU bans the purchase of allowances from outside the EU, which Norway has previously relied heavily on for meeting the targets in the Kyoto Agreements. The mechanisms most exploited until now are the Clean Development Mechanisms (CDM): Several early CREE contributions have assessed them to be ineffective and unfair, see Rosendahl and Strand (2011), Hagem and Holtmark (2011) and Strand and Rosendahl (2012).

On the other hand, the common implementation with the EU now decided gives Norway access to several European flexibility mechanisms, vis-à-vis the ETS, vis-à-vis the Land Use, Land-Use Change and Forestry (LULUCF) sector, across time, and last but not least, across borders within the non-ETS sector. The latter is most subject to discussion now. There is still large uncertainty as to what specific mechanisms will be available. To date, the EU has not established any institutions to organise and monitor this trading. Moreover, no one knows what the prices will be for such emission allowances. In a study of a completely flexible trading of

non-ETS allowances across borders, simulated prices well exceed the permit prices in the ETS – amounting to around 200€/t CO₂ in 2030, see Aune et al. (2015b) and Aune and Fæhn (2016). However, when accounting for the other flexibilities and comparing with more updated reference paths from the EU, the prices appear to become lower, see Bye et al. (2019).

The prices of European allowances, both within and outside of the EU-ETS, will not least be sensitive to what other policies will be implemented. In a recent study, a comprehensive assessment of the EU climate and energy package is offered, with its three main targets: lower greenhouse gas emissions, higher renewable share in final energy consumption, and improved energy efficiency. The study finds that the renewable and energy-efficiency targets have been set so high that the derived emissions reduction (50 percent) exceeds the EU climate target (40 percent). Hence, there is no need for an EU climate policy. Put differently, the allowance prices both within and outside the EU-ETS will render zero. The abatement cost of the full package will however become high, see Aune and Golombek (2019). This analysis is a good example of how interplays among various instruments and goals counteract or overlap each other and render the overall policies unnecessarily expensive. This subject has also been addressed in earlier CREE research, particularly emphasising Norwegian evidence and the Norwegian debate about multiple goals and instruments, see Bøeng and Rosnes (2013), Hoel (2013b), Bruvoll and Dalen (2015) and Bye et al. (2019).

Irrespective of assumptions and inclusions in the computations of EU allowance prices, fulfilling the non-ETS target by domestic emission cuts, only, are found to be dramatically more costly than buying allowances within Europe, see Fæhn and Isaksen (2016) and Aune and Fæhn (2016). These findings are relevant for the political decisions on Norway's ambitions within own borders. Essential arguments for concentrating efforts at home are that transition takes time and that innovation, learning and R&D is needed domestically in order to be prepared for increasing global and national targets in the decades to come. Similar arguments can be used for domestic regulations of emissions covered by the EU-ETS on top of the allowance price, even if the immediate mitigation impacts of such interference will be more or less fully counteracted by increased emissions elsewhere in the market. Recently, CREE projects have started that address the trade-off between emission cuts in the shorter and longer run.

Unilateral climate policies and carbon leakage

Low-emission strategies of single countries or coalitions like the EU bear the risk of adverse impacts on competitiveness, trade and carbon leakage. CREE has been very active in the field of carbon leakage and what are effective and feasible countermeasures. Carbon leakage can occur both via the final goods markets and via the energy markets. For the latter, see the discussion of fossil fuel policies from the demand and supply side above.

Leakage via final goods markets is associated with domestic firms losing competitiveness vis-à-vis less regulated, higher-emitting firms abroad. CREE's contributions are mainly based on large-scale global models, see Carbone and Rivers (2017). Theory suggests that border carbon adjustments (BCA), i.e., import tariffs and export subsidies on the carbon embodied in trade,

can be used as an instrument to improve the economic efficiency of unilateral emissions pricing policies.

A more common action is to rebate domestic firms for the tax payments in proportion to their output. This is known as output-based rebating (OBR) and is fairly equivalent to the free allocation of quotas practised in the EU-ETS. Computations usually find OBR to be less effective but more feasible legally and politically from a free trade perspective than BCA, see Böhringer et al. (2012). However, recently, the European Commission has become more concrete about implementing BCAs. Both types of instruments have been studied in CREE by large-scale models. One study investigates how optimal OBR policies depend on the actions of large trading partners, see Böhringer et al. (2017a). Two analyses suggest combining OBR with a consumption tax. They show that this combination is equivalent with the more efficient BCA option, and that under uncertainty, these policies constitute a hedging option against carbon leakage, see Böhringer et al. (2017b) and Böhringer et al. (2019). Other studies compare various BCA designs and show that the choice typically will have to involve a trade-off between efficiency and administrative costs, see Böhringer et al. (2012). The most efficient would be to incentivise abatement responses among exporters in trading partner countries; however, such designs are complicated and relatively costly to administer as each shipment would need to be individually treated, see Böhringer et al. (2017c).

International climate negotiations

The international negotiations on climate change mitigation is riddled with severe prisoner's dilemma problems, i.e. curbing climate change would benefit all countries, but individual countries' incentives to cut emissions are weak. The costs of mitigation are borne individually, while the gains are shared by everyone. Such a situation will lead to emission reductions that fall short of the globally optimal level of emission reduction. CREE has contributed significantly to the research literature on designs of agreements and organisation of the negotiations in order to obtain robust and ambitious results. These contributions mainly apply game-theoretical models. In an article, the literature covering the period before the Paris Agreement is reviewed, see de Zeeuw (2015). The basic picture is not optimistic: If there are large gains of cooperation, the stable coalition is small. There is a general view that top-down general agreements on emission reductions such as the Kyoto Protocol have not and will not obtain sufficient participation and mitigation.

Several articles from CREE have broadened the negotiation game to include development and transfer of low-carbon technologies, see Hoel and de Zeeuw (2014), Harstad (2012b; 2016) and Harstad et al. (2019). If countries can share the R&D costs for the technological development, this additional positive externality will strengthen the incentives to cooperate. If the new technology spills over to other countries, an extra benefit occurs as these other countries will emit less. There is a complex relationship between abatement commitments and technological decisions. For instance, investments in green technologies by one country today will reduce the incentives of others to invest tomorrow. Technological investments will also foster pressure in the negotiations for stronger commitments. Technological positive spillovers can make it more difficult to design self-enforcing agreements. The length of the agreement is an important aspect.

Longer agreement periods will incentivise investments, however, will be less robust to changes in surroundings along time. With weak patenting systems or other discouragements for investing in innovation, long agreement periods are pivotal.

The success of international climate agreements depends on credible enforcement institutions, i.e. possibilities to legally prosecute and penalise if the agreement is violated. Both economic and legal perspectives are taken by CREE researchers on drivers determining the enforcement institutions and solutions to how systems can be designed, see Hovi et al. (2012), Ulfstein and Voigt (2014), Voigt (2014a) and Battaglini and Harstad (2019).

The Paris Agreement in 2015 represented a significant change in design and process from the previous Kyoto Agreements. A main change was that pledges were given from each country independently of their summed impact. The main benefit was that almost every country participated and determined their NDC. However, the total impact in terms of mitigation is most probably far from what is needed to meet the overall, long-term temperature goal of staying well below 2 degrees of global warming. A couple of recent contributions from CREE analyse the features of the Paris Agreement and, also, give comparisons between the Kyoto and Paris designs to explain their differences, see Voigt (2014b), Strand (2017) and Harstad (2018).

IV.3 Barriers and opportunities to transformation

Behavioural economics

As reflected above, game-theoretical models tend to provide little optimism into the analysis of how countries can manage to coordinate for a shared gain. Negotiators and governmental representatives are humans, and recent literature on negotiations have nuanced the predictions from game-theoretical models by integrating novel findings from behavioural economics. For instance, Nyborg (2018a) has introduced so-called reciprocal preferences, i.e. the desire of humans to repay mean intentions by mean actions and kind intentions by kind actions, in a setting of international climate negotiations. A result is that a grand or majority coalition may be stable. Agreements like the Paris Agreement, in which countries pledge to abate voluntarily with no external enforcement, could conceivably be successful.

Our results shed light on several conditions that favour collaboration. For instance, when individuals can choose to join groups pre-committed to charity, such groups seem better able to sustain cooperation. The groups attract a greater number of more generous individuals, triggering generous responses by conditional co-operators, Hauge et al. (2019). More generally, social norms are found to complement more formal institutions in enforcing collectively desirable outcomes, see Nyborg et al. (2016) and Nyborg (2018b). People can be more willing to choose a behaviour the more widespread it is, and tipping points exist, where vicious cycles can turn into virtuous ones. Social sanctioning can create such tipping points, as can the occurrence of so-called conditional cooperation — an often observed willingness to cooperate more when others cooperate more. It is a precondition that the behaviour of others is observable. The role of policy could be to increase the visibility of behaviour that signal and form more climate-friendly norms.

The empirical analysis of behavioural economics is largely based on lab experiments of individuals, and CREE research has provided significant contributions, see Braaten (2014a; 2014b), Czajkowski et al. (2015), Hauge (2014; 2015; 2016), and Hauge et al. (2015). However, a possible concern with insights from lab experiments is whether this insight based on individual making decisions can be generalised to decisions made by firms and countries in global issues such as climate negotiations. CREE has contributed to a strand of literature within behavioural economics studying whether decisions made on behalf of others differ compared to decision made on own behalf. This is relevant for international climate policy negotiations, where negotiators represent their governments, see Hauge and Røgeberg (2015). Interestingly, we find a difference between men and women: women make less self-interested choices as representatives compared to as individuals, while no such difference was found for men.

Moral aspects of climate action

Related to social norms are moral norms and moral obligations. One question that is often raised in case of climate actions of individuals, countries, and regions, is whether there is a moral obligation for action even if the contribution might be small and of little practical significance. Fairness and equity can be reasons for expecting that capable individuals, for example rich countries like Norway, make disproportionately large contributions to global emission cuts. Several works from CREE address the potential trade-off between equity and efficiency and have suggestions to how undesired distributional impacts, both across generations and countries, can be compensated, see Kverndokk et al. (2014), Isaac and Piacquadio (2015), Kverndokk (2018) and Hoel et al. (2019). We have also studied what types of instruments and policy designs that can be perceived as fair, see Kverndokk (2012), Greaker et al. (2013), and Piacquadio (2017).



8. International cooperation

The main value added to CREE from international cooperation is access to a wider network with competence that complements the expertise of the CREE researchers.

The international cooperation in CREE consists of five factors. First, we had an international research partner, Tilburg Sustainability Centre (TSC). This centre has high competence in the interrelationships between technological change, economic growth and sustainability, as well as in theoretical analyses of environmental economic instruments. This expertise complements CREE researchers, some of whom have theory expertise in other areas, while others have expertise in more applied methods. As an example of the successful collaboration coming out of this complementarity, the CREE expertise on numerical modelling was combined with the TSC expertise on theory studies of emission trading. This led to a joint study of the new regulatory rules in the EU-ETS.

Second, the centre had international research affiliates. Each of these complemented the competence of the Norwegian CREE researchers:

- Professor Fridrik Baldursson, Reykjavik University (Stochasticity and the electricity market)
- Professor Claude Crampes, University of Toulouse (Competition in energy markets)
- Dr. ing. Markus Blesl, University of Stuttgart (Storage technologies)
- Professor Claudie Boiteau, Director of the Master programme Law and Market Regulation, Université Paris-Dauphine (Electricity markets and law).
- Professor Stef Proost at Leuven University (Transport economics)
- Professor Böhringer, University of Oldenburg (Computable general equilibrium models).

The duration of CREE made it possible to undertake research projects running over several years that were finalized with international publications.

Third, all international research affiliates have always been invited to the annual CREE workshops, along with other international researchers in the field of environmentally friendly energy, to present suitable papers.

Fourth, CREE has participated in the EU funded project ENTRACTE under the 7th Framework Programme (Project No. 308481). CREE researchers did research on energy efficiency policies, renewable energy supply, and efficiency of policy instruments.

Finally, there has been some exchange of researchers. Dr. Mads Greaker spent time in Tilburg, working on a joint research paper. Furthermore, PhD student Frikk Nesje intended to visit Tilburg University for one year. Nesje's plan was to spend time with Professor Reyer Gerlagh and other theorists to further his game theoretic studies of intergenerational decision making. Although there was interest from Tilburg and also available funding, the funding requirement was that Frikk Nesje would need to register as a dual PhD student at Tilburg University. The University of Oslo did not agree to this proposal, due to the imposed administrative burden of negotiating such an agreement.



Illustrasjonsfoto: Colourbox.no

9. Training of researchers

The CREE research partner, Department of Economics at the University of Oslo, organizes regular PhD and Master courses, including classes related to environmentally friendly energy; this topic is covered in courses in energy economics, electricity economics, resource economics, environmental economics and climate change economics.

CREE organized one PhD class on integrated assessment models jointly with MILEN (in 2013), the University of Oslo's (former) interfaculty research network on environmental change and sustainable energy. Several CREE researchers lectured. CREE researchers have also given PhD or Master lectures related to environmentally friendly energy, both in Norway (organized, for example, by the FME research school NorRen, and also by UiO Energy), and internationally (organized by the EAERE-FEEM summer school in Venice).

CREE has offered Master Thesis scholarships to master students writing their Master thesis within environmentally friendly energy. As a rule of thumb, each year three students have received scholarship. These have been integrated into CREE projects, working jointly with

CREE researchers, and they have been provided office space in a CREE institution. In total, 22 students have submitted their master thesis after receiving this scholarship, see Appendix 2a for names and title of theses.

Finally, one CREE researcher has three times taught in a multidisciplinary energy course offered by UiO Energy, and also written a memo on energy markets for master students taking the class.

CREE has recruited well qualified PhD students and a post doc. through joint (international) announcements with Department of Economics at the University of Oslo and Statistics. Below, two CREE PhD students, and one CREE post doc, share their experience from being part of the CREE centre.

Alice Ciccone (Italy), former CREE PhD student:

When I started on my PhD in 2011, CREE was the most suitable and interesting environmental economics research centre. CREE managed to unite many different Norwegian and international researchers to create a lively research community focusing on a variety of relevant economic problems and using a large range of methodologies. This was the main reason for why I thrived as a CREE member during my PhD period. I had the opportunity to extend my research network, and to participate in conferences and summer schools where I discovered new approaches to problems that really helped me writing the thesis and also shaped my interests as a researcher. Moreover, I really enjoyed the internal activities such as the annual CREE workshop. This is because junior researchers like me had the opportunity to present work in progress and get important feedback from more senior and experienced researchers in the field. These inputs helped me a lot in writing my dissertation. I am now working as a senior researcher at the Norwegian Centre for Transport Research (TØI).

Marit Klemetsen (Norway), former CREE PhD student:

My PhD thesis was on the effects of government environmental regulations and R&D funding on Norwegian firms' environmental behavior. The CREE affiliation was particularly important to me as my supervisors were not working on environmental or climate topics (they worked on topics as industrial organization and innovation and had insight in applied micro econometrics). CREE significantly broadened the opportunity for me to learn about the topic from senior researchers. I wanted to investigate the development of firms' polluting emissions and also innovation, as innovation is decisive to achieve sufficient emission reductions. As CREE covered both areas, I had many opportunities to learn and get feedback on my work. Through CREE, I was part of a strong academic environment.

I found it very stimulating to be a PhD student at CREE. It gave me the opportunity to work with and present my work regularly to some of the leading scholars in the field. As the dissertation was on Norwegian firms' environmental behavior, both with regards to emissions and innovation, my work fit into several of the CREE WPs. I benefited a lot from working with other CREE researchers, like Brita Bye and Knut Einar Rosendahl. Through Rosendahl, I got the possibility to co-supervise two master students on the econometric part of their theses. I

learned a lot from attending and presenting at workshops and conferences, and to relevant actors such as the Norwegian Environmental Agency and several ministries.

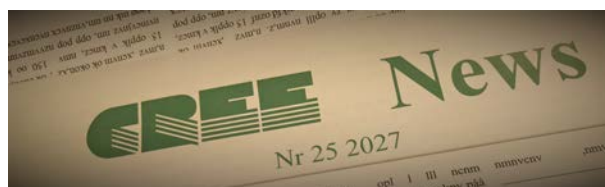
During the first few years after the PhD, I used my empirical data knowledge as a government analyst, working for agencies such as the Tax Authority and a multi-agency analytics and intelligence center. This provided me with a broader knowledge on political and bureaucratic decision-making, which is crucial to make the research relevant.

Today, I have a permanent position as a senior researcher at CICERO center for international climate research, and I work on several projects, e.g. related to climate attitudes and behavior, climate adaptation in Norwegian municipalities, and climate finance. I use the knowledge attained during my PhD on a daily basis.

Daniel Spiro (Sweden), former CREE post.doc:

I spent four years funded by CREE and enjoyed this fantastic research environment. I must say that these years were formative for my research career. CREE and the Oslo area is probably the leading research centre in Europe when it comes to environmental economics and is one of the best in the world. Being part of it was indispensable as I got feedback and ideas for my own work. I also got the opportunity to listen to the presentations of other researchers, and to expand my network. The members of the network were always generous with their time and interested in listening. One very valuable aspect was the atmosphere of a joint goal of pushing the research frontier rather than competing against your peers. This paved the way for great research, and also for a very pleasant work environment. Currently, I am an assistant professor at Uppsala University in Sweden.

Employment of PhD-candidates (number)							
By centre company	By other companies	By public organisations	By university	By research institute	Outside Norway	Other	Total
1			2	3	1		7



10. Communication / Popular dissemination of knowledge

In CREE, communication to the academic audience is mainly organized through three channels: publication of working papers available at the CREE web site; presentation at international research conferences and seminars; and publication of academic papers in peer review journals, see point 6 in this report.

The channels used for dissemination of knowledge outside the research communities have been:

- The CREE web site <https://www.cree.uio.no/>. Substantial resources were used to develop and upgrade this site. It provides information on the structure of CREE: all CREE projects with project description, project members, funding and associated papers of various types; a complete listing of papers of various types; outreach activities like CREE events and presentations for users and academic peers.
- When posting a new CREE working paper at the CREE web site, a non-technical summary in Norwegian is provided.
- CREE News Letter is mailed to CREE user partners at least three times a year. It provides information on upcoming CREE events, a short description of recent CREE working papers, and typically in-depth information about one or two CREE publications.
- In 2014, a Royal Commission was formed to develop and describe a green tax reform to help the Government reach local, national and international environmental targets (NOU 2015:15 Sett pris på miljøet—Rapport fra grønn skattekommisjon). As many as three members of Commission were key CREE researchers, while three other CREE researchers contributed to a sub-report summarizing the research on policies for promoting the development and uptake of green technologies. This work was highlighted as one of four good practice cases for societal impact in economics by the RCN commissioned evaluation of social sciences in 2018 (SAMEVAL).
- The contribution from the CREE researchers drew on the group's general competence in a number of subfields within economics (like public economics, environmental economics, climate economics, R&D) as well as their own research.
- CREE researchers have contributed to a number of other reports from various commissions, see point 13 below.
- CREE researchers have been encouraged (through an internal incentive mechanism) to be visible with policy-oriented results from their CREE projects in newspapers, TV and radio: CREE in the media (<https://www.cree.uio.no/outreach/news/in-the-news/>). As a rough rule of thumb, CREE was in the media every second week.

11. Effects of centre for the host institution and research partners

Effects of serving as the host institution for CREE

Strategy:

CREE has been an essential part of the research strategy of the Frisch Centre, a non-profit research foundation established by the Economics Department at the University of Oslo. The aims of the Frisch Centre is defined in its statutes to be a centre for research in economics, serve basic research, strengthen applied research and to contribute to the education of new researchers at the University of Oslo (UiO). The strategic aims are constrained by the need for financing: the majority of the Frisch Centre's funding comes from competitive grants from the Research Council of Norway (RCN).

CREE has enabled the Frisch Centre to work with a longer time perspective and a wider scientific field than the shorter RCN project grants. CREE has enabled the Frisch Centre to maintain and expand the group of highly competent researchers within the field of environmental and energy economics, one of the three main pillars of research at the Frisch Centre along with labour economics and public economics. The scientific goal of the group is to do high-quality, theoretical and empirical research on topics of relevance to energy, natural resources, and climate policy, and to have methods and results communicated to and assessed by the broader scientific community through publication in high-quality, peer-reviewed scientific journals. CREE has allowed the continued development of the European energy market model LIBEMOD that is operated jointly with Statistics Norway, work which is not easily financed within other projects with a narrower focus. The long-term funding through CREE has provided a basis for developing research ideas that have resulted in excellent publications in the international scientific literature.

Network:

The Frisch Centre collaborates in several formal research networks in Norway. The CREE Centre formalizes collaboration with research groups in Statistics Norway, the Department of Economics (UiO) and the Tilburg Sustainability Center, and also formalizes collaboration on environmental/energy research with individual researchers from other disciplines (e.g., law) and countries (e.g., USA). These networks are now well established and have resulted in a number of joint research projects with separate funding within the thematic framework of CREE. The Frisch Centre aims at continuing this cooperation in future research projects and using internal funding to sustain the CREE network with common seminars, web-pages and dissemination activities.

CREE has also strengthened the informal networks with academics in the field across the world, by allowing participation in international conferences, the invitation of guests and the paid or unpaid collaboration with individual researchers from other institutions.

Collaboration with non-academic partners has been a core consideration in CREE. CREE has a number of user partners, involved in and served by the research activities. Frisch Centre

researchers have been involved in extensive communication with users, regularly holding presentations for relevant government groups and units. This activity also requires an interest and demand from the user groups, and this demand has varied over time, but CREE has provided a platform for dialog and channeling questions and research interest to and from users both in the public and private sector. The user contacts have resulted in cooperation on new research proposals with industry and government involvement.

Quality in education:

CREE has provided scholarships for master students and has thus encouraged master students to write their theses on themes in environmental and energy economics under the supervision of Frisch Centre and other CREE researchers. The Frisch Centre is not an educational establishment, but our staff has contributed to the quality of education in the field by holding formal courses at the University of Oslo and other institutions, both at doctoral and lower levels.

Recruitment of students and researchers:

The Frisch Centre is by intention a small institution, but CREE has consolidated our standing and reputation as a major research group within the field of environmental and energy economics. Thus CREE has contributed to the brand building of the Frisch Centre. When last hiring researchers we had a very strong list of applicants including several highly successful economists within the field, and succeeded in employing a very promising and competent young researcher with a recent PhD within empirical environmental economics.

Effects of being a CREE research partner

Research.

The CREE center has contributed to substantial research in the fields of energy, climate change and environmental economics. The centre has also triggered interdisciplinary research, mainly as cooperation between i) economists and social anthropologists, and ii) economists and technology experts, but also with contributions from political science, law and psychology to complement the economic perspective. CREE funding has been important to ensure that working papers have been developed into international publications; this may require a substantial amount of work after the working paper was finalized.

Within centre cooperation and network.

CREE has triggered substantial collaborations between the three Norwegian research partners, and also led to more contact and cooperation with the international research partner. This is reflected in our reference list as numerous publications with authors from more than one research partner. CREE has also made it possible for the Norwegian research partners to build, maintain and extend domestic and international networks, for example, by having international experts affiliated to the centre. This has led to substantial cooperation and materialized in several international publications.

Numerical model development.

In the first period of the CREE center, the work package “The Next Generation of Numerical Models” provided funding to a comprehensive extension and updating of the numerical energy market model LIBEMOD. Furthermore, it made it possible for CREE to establish a new family of numerical models, suited for analyzing energy and environmental policies both for the Norwegian economy and for the global economy – the SNOW models. This modelling project included a collaboration between several institutions that expanded the CREE network, thereby making it possible for Statistics Norway to take part in a Stanford Energy Model Forum study. The SNOW model for Norway is now the main model for climate analyses and long-term forecasting used by the Norwegian Ministry of Finance and other ministries.

Cooperation with other FME-S centers.

The CREE center has also opened the opportunity for a community among the three FME-S centers – CENSES, CICEP and CREE. There has been collaboration with respect to research applications, user seminars, and modelling.

Education and recruitment.

CREE has offered Master scholarships which have led to a number of Master Theses being written as part of the activity of the centre, with CREE researchers as supervisors. Some of these students have continued as PhD students. Also, there has been CREE funding of PhD students and one post doc.

User partners.

During the CREE period, there has been substantially more interactions with user partners than what was typical prior to CREE. This has had powerful implications with respect to dissemination of research output; new ideas for research questions to explore; and joint research applications.

Research applications.

CREE has triggered a number of research applications with participation from the research partners, subcontractors and user partners. In general, the success rate has been good. Hence, CREE has obtained additional funding for research activities (WINDLAND, ELECTTRANS, SMARTH PATH, PLATON) related to the core topics in the centre. Some CREE researchers also participated in an EU Horizon 2020 application that obtained funding.

To sum up, through generous funding from the RCN, CREE has been given the opportunity for long-term, high-quality, user and policy oriented research. Our effort has clearly enhanced cooperation between the research partners, which has materialized in numerous publications in peer-review international journals, in particular, several publications in top field journals, top general economics journal and also publications in multidisciplinary journals.



12. Effects of centre for the company partners, public partners and society at large

The CREE user partners have values like scientific-based decisions, promote sustainability, and facilitate green transition. These values are in line with the basic idea of CREE; to design and assess policy measures that facilitate and ease the transition to a low-emissions society. Also, the main objectives of the user partners are aligned with the research activities of CREE; improved knowledge on how to cut GHG emissions and obstacles to achieve emissions cuts, how to achieve more electrification, the role of consumer flexibility, and green R&D and growth.

a) Review of what is considered the most important effects

The CREE user partners are in general involved in a number of R&D activities, but typically these are outsourced to a number of R&D firms, for example, CREE. Hence, CREE has had a minor influence on the general R&D and innovation strategy of the user partners, but user partners have facilitated easy internal access to output from CREE R&D activities.

The feedback from the user partners suggest that CREE has been important because of:

- Improved general understanding of basic issues related to environmentally friendly energy. In particular, improved understanding of challenges facing user partners aiming at reaching specific policy targets.
- Significantly more dialogue with researchers and thereby stimulated interest in reading research papers as well as learning about recent developments in the field.
- Significantly more dialogue with other user partners in the field of environmentally friendly energy
- Enhanced opportunity to detailed professional discussions with CREE researchers on topics related to ongoing projects at the user partners.

b) Success stories

I CREE Hot Line

CREE offers CREE Hot Line to its user partners. These are informal meetings where the user can discuss methodological and policy issues with CREE researchers. In a Hot Line with the Norwegian Environment Agency in 2017, CREE researchers presented output from model runs of the European energy market model LIBEMOD for the development of non-ETS emissions in the EU. The meeting was followed up by multi-stage dialogue between the CREE researchers and the Norwegian Environment Agency, which resulted in more model runs and a CREE memo with updated and extended results on non-ETS emissions in the EU. The Norwegian Environment Agency used the results as inputs in their own report on flexible climate policy mechanisms in the EU, which was commissioned by the Ministry of Climate and Environment.

II CREE Dialogue Seminar

Once a year, CREE organizes a half-day seminar for its user partners on topics of mutual interest. In 2017, the topic was the social discount rate, which had been requested by several CREE user partners. Both CREE researchers and user partners gave presentations. Later, an article on the social discount rate was written by two CREE researchers. The paper was published in the journal *Samfunnsøkonomen*, and received significant interest among the CREE user partners.

III Model development

CREE has collaborated with the Ministry of Finance to develop an equilibrium model for the Norwegian economy (SNOW-No) that can be used for calculations in the next White Paper on Long-term Perspectives for the Norwegian Economy (Perspektivmeldingen). In accordance with the wishes of the Ministry of Finance, the model extensions include updating the dataset, expansion of the number of sectors, more detailed breakdown of taxes, as well as the inclusion of all greenhouse gases in the Kyoto Protocol. The model has been adapted so that the model user can control some parameters that are particularly relevant/interesting for the Ministry of Finance. Further adaptations make it possible for the Ministry of Finance to simulate various configurations of climate policy (e.g., a cap on emissions, carbon taxes and allowances). In addition, the model has become more user-friendly. Several courses and workshops on how to use the model have been arranged for the Ministry of Finance.

IV Model development — energy and climate policy

CREE has developed and updated a model for the study of energy and climate policy. The model combines the macro perspective of numerical equilibrium approaches with the technology knowledge of energy models. In this project CREE has collaborated with The Norwegian Environment Agency on data processing and with IFE (Institute for Energy Technology) on modelling.

c) Feedback from some active company or public partners

NVE (The Norwegian Water Resources and Energy Directorate)

NVE has used CREE as a platform for debate and exchange of economic methodologies, as well as a discussion partner for challenges facing an energy agency in a green transition period. NVE has participated in projects as well as in research proposals, although the latter ones did not obtain funding. For NVE, participation in CREE has been important as it enhances the agency's cooperation with social science research groups, and also provides access to user partner events to discuss research results that are applicable in the ongoing work at NVE.

NVE monitors relevant research. Once NVE finds results that have powerful implications for its daily operations, their own models and approaches are adjusted to take recent developments into account. One example is the CREE analysis of the rebound effect of heat pumps, which joint with internal analyses at NVE triggered an assessment of the TIMES Norway model with respect to the possibilities to incorporate behavioural effects that come in addition to existing techno-economic factors.

NVE has been active in participating in all types of CREE user partner events, in particular, in the dialogue seminars. We have benefited a lot from the professional discussions at these seminars. Also, NVE has had the pleasure to take advantage of the CREE Hot Line a few times. NVE appreciates the effort of CREE to offer tailor made presentations and synthesis memos on energy markets and household behavior.

For NVE, the greatest challenge with the CREE cooperation is all the administrative efforts necessary to follow up research projects funded by the Norwegian Research Council. NVE is involved in numerous projects that differ along several dimensions, and even the administrative terminology of the projects may differ. Frequently, the role of NVE is not clear; should we assist researchers or govern the project? Finally, NVE employees find that the time available for following up research projects may be a buffer; managing daily operations always has the highest priority. Therefore, each NVE employee should not be involved in too many projects.

MDIR (Norwegian Environmental Agency)

The objective of the Norwegian Environment Agency is to obtain a clean and diverse environment. Our primary tasks are to reduce greenhouse gas emissions, manage Norwegian nature, and prevent pollution.

We are a government agency under the Ministry of Climate and Environment. We implement and give advice on the development of climate and environmental policy. We are professionally independent with respect to decision making, advising, communication of knowledge and information dissemination.

One of our main values is to be knowledge based. Our decisions and advices to the Ministry are based on facts and knowledge. Thus, having access to high quality, state-of-the art knowledge and research is crucial.

We have participated as a user partner in CREE, and have been a board member in most of the project period.

For us, the main benefit of CREE has been the way the centre has constituted an arena for dialogue with highly qualified researchers within environmental economics, as well as with other user partners. Through our participation in the centre, we have gained access to relevant research, and have had research presented for us at the agency. More importantly, the user seminars have been a good arena for discussing methodological questions, such as the seminar on the discount rate. The CREE Hot Line, which we have used in three different cases, has also been useful, giving us the opportunity to discuss top-of-the-list topics with the CREE researchers.

GASSNOVA

Influence on R&D and Innovation strategy

Through participation in CREE, Gassnova has gained more insight into results from economic research, in particular, CREE research output. The understanding of the need for economic research on CCS has increased over time as it has become clearer that market barriers and other market failures have implied lower dissemination of technology than what is socially warranted. Insight from economic research into issues concerning the climate and energy use has enabled Gassnova to target its own activities on international market trends, which is important for the development of CCS. Indirectly, this has also contributed to Gassnova being able to give more robust advice to the Ministry of Petroleum and Energy on CCS issues and to make more robust assessments to applications submitted to CLIMIT.

Strengthened knowledge base

As a CREE user partner, Gassnova has gained a better knowledge on:

- Utilization of results from economic analyzes on public investment projects, including improved foundation for the choice of the discount rate
- CO₂ pricing in different markets, and improved understanding of spillover-effects between markets
- How policies affect CO₂ pricing and the uncertainty associated with future CO₂ prices
- How various policy instruments, for example, supply-side policy, may influence CCS decisions
- Specific considerations on ambitious climate political measures, including the interrelationship between CCS and carbon leakage
- Insight into how climate negotiations are taking place, and thus a greater opportunity to interpret possible outcomes and effects related to adoption of CCS.

Improved access to competent personnel and research institutions

Through participation in CREE, Gassnova has gained easy access to research and academic resources that would otherwise have been less accessible.



13. Effects of centre for the overarching goal of the FME-programme

As stated above, the main vision of CREE was to 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. Hence, the purpose of our research activities has been to improve the knowledge base on how to reach energy, climate and environmental policy targets.

CREE has covered all Norwegian energy-related GHG emissions sources, and CREE has also examined how to promote renewables as well as explored, within a multidisciplinary framework, costs and benefits of initiatives aiming at improving energy efficiency. These tasks are reflected in the titles of our four flagships:

- i) ***Radical emissions reductions in ETS sectors.*** This flagship examines driving forces of emission activities in ETS sectors, and choice of regulatory instruments in ETS sectors, including carbon capture and storage (CCS).
- ii) ***Environmentally friendly transport.*** Identification, analyses and recommendation of sustainable emission reduction strategies for the transport sector.
- iii) ***Green innovations and utilization of smart technologies.*** How policies can motivate and incentivize research, development and diffusion of environmentally friendly technologies.
- iv) ***Towards the low-emissions society.*** Pathways for nations, regions and the world towards the low-emission society.

CREE has contributed to design of instruments and regulations to reach energy, climate and environmental policy targets, as well as identifying obstacles on the way towards the low-emission society. The Centre has explored standard measures, like incentivised policy measures, as well as alternative measures, for example, supply-side climate policy measures.

While the main objective has been to improve the general knowledge base for policy design, CREE researchers have also contributed to reports from appointed commissions, and provided input to ministry publications. The most important contributions are listed below:

- ***Green Tax Commission.*** Six CREE researchers contributed to the Royal Commission aiming at designing a green tax reform to help the Government reach local, national and international environmental targets (NOU 2015:15 Sett pris på miljøet—Rapport fra

grønn skattekommisjon), see point 10 in this report. The contribution from the CREE researchers drew on the group's general competence in a number of subfields within economics, as well as their CREE research.

The Commission recommended specific and broad-ranging changes to the tax structure and regulatory system, and their report was widely discussed in Norway, forming an important basis and common ground for later political discussions in the Parliament. A keyword search in print newspapers finds some 260 references to the Commission in 2015 and a further 295 in 2016, documenting how the Commission's report became widely discussed and accepted as an important reference in the ongoing debate about environmental policy and a green transition. In the recommendations of the Parliament's Financial Committee for 2017, the Green Tax Commission is referenced some 15 times. The core principles of the Commission received broad support, and representatives from different political parties emphasized their acceptance of the Commission's report (though frequently differing in which of the recommendations they emphasized).

- ***Supply side climate policy.*** CREE researchers raised the debate on whether a petroleum extraction country like Norway should use a combination of demand and supply side measures in its climate policy, that is, whether cuts in oil and natural gas extraction should be part of Norway's measures to reduce GHG emissions. This triggered a heated debate, which is still ongoing. Several CREE papers were written on supply side measures, two examples are i) Fæhn, T., C. Hagem, L. Lindholt, S. Mæland, and K.-E. Rosendahl (2017): Climate policies in a fossil fuel producing country, Demand versus supply side policies, *Energy Journal*, 38 (1), 77-102, and ii) Asheim, G. B., T. Fæhn, K. Nyborg, M. Greaker, C. Hagem, B. Harstad, M. O. Hoel, D. Lund, K. E. Rosendahl (2019): The case for a supply-side climate treaty, *Science* 365(6451), 325-327. The latter paper inspired a party at Stortinget to suggest that Norway takes the initiative to establish an international agreement to lower oil and natural gas extraction (Representantforslag 26S I 2019, December 12, 2019).
- ***Klimakur.*** Right before the establishment of CREE, researchers at Statistics Norway, who later became CREE researchers, contributed to the report *Klimakur 2020*. The same group has since 2019 been working on their contribution to *Klimakur 2030* (their part of the report will be delivered before June 2020). It will build on numerical models that have been developed and updated during the CREE period.
- ***Various deliveries to Norwegian ministry publications.*** CREE researchers have contributed to
 - Stortingsmelding 25 (2015-2016) Kraft til endring – Energipolitikken mot 2030. Model runs of the computable general equilibrium model MSG.
 - Stortingsmelding 41 (2016-2017) Klimastrategi for 2030 – norsk omstilling i europeisk samarbeid. Model runs based on an energy market model (LIBEMOD) and a computable general equilibrium model (SNOW).

- Perspektivdelingen 2020. This is work in progress that will build on models runs of two computable general equilibrium models (MSG and SNOW).
- **Norwegian expert groups.** One CREE researcher was member of the “Ekspertgruppen for Oslo kommunes klimabudsjett (2019)”. One CREE researcher is currently member of “Teknisk beregningsutvalg for klima”, whereas another CREE researcher is member of “Teknisk beregningsutvalg for utslipp fra jordbruket”.
- **IPCC.** One CREE researcher has twice served in the IPCC secretariat. For the 5th assessment report, he was Review Editor for working group III (Mitigation). For the 6th assessment report (work started in spring 2019), he is Lead Author with the objective to write the Introduction to the report from working group III.

14. Analysis of the role of the centre

i) “Environmentally friendly energy” is a comprehensive field in several academic disciplines. In economics, the core discipline in CREE, it builds on both micro and macro economics, and it is related to a substantial part of energy economics, environmental economics, resource economics and climate economics. The economics of environmentally friendly energy is an applied field with applied theory contributions as well as empirical contributions. Most papers in the field are either policy oriented or provide a foundation for future policy-oriented contributions.

At the start of the period of CREE, a substantial part of the economics of environmentally friendly energy was related to policy questions that were under academic and public debate around 2011. For example, how to design instruments to minimize the carbon leakage, how to spur environmentally friendly R&D, the role of climate-friendly electricity, and development and use of large-scale numerical models to simulate the impact of alternative environmentally friendly policies, both at the sectoral level, in particular, the electricity market, and for the entire economy of a country or a region of countries.

ii) After 2011, the EU has announced ambitious energy and climate targets and most countries in the world have ratified the Paris agreement. These events have had impact on the research agenda of CREE as well as on the general field. There is now much attention on predictions of future GHG emissions from various countries, whereas carbon leakage is not an important topic any longer. Furthermore, with the EU target of lowering carbon emissions in the electricity generation sector by 95 percent by 2050, there is more focus on intermittent power sources and storage technologies, as well as consumer flexibility and the value of lost load. These trends are also reflected in the CREE project portfolio.

iii) Most of the CREE user partners take a general interest in the economics of environmentally friendly energy. Through CREE user activities, our users have been given an opportunity to follow the general development in the field as well as been invited to discuss

output from state-of-the-art CREE projects. Our user partners do not have a substantial internal R&D department, and hence to be updated on the development in the field they appreciate user activities like the ones CREE have organized.

iv) It is beyond the scope of this report to assess the role of CREE in the recent development of the field environmentally friendly energy, but the high number of published peer-reviewed articles from CREE, as well as the international awards to CREE researchers, suggest that CREE has contributed to the field.

Case: Flagship III

To take one example of how a specific field has evolved and the associated CREE research activities, we focus on flagship III. Here, the main focus has been on micro economic behavioral analysis of the diffusion of environmentally friendly and smart technologies in households and firms. The analysis in this flagship have focused on getting a more in-depth understanding of energy behavior, how it is affected by external changes such as energy efficiency measures or smart technologies, and how this in turn affect energy consumption. An extensive collaboration between economists and social anthropologists have been conducted to get a deeper understanding of household preferences and energy practices.

At the start of the center period, very little empirical work had been done on these topics in the economic literature at the micro level. There was a substantial literature, also on Norwegian data, on the technical savings potential of various energy savings measures. However, very few studies discussed how households and firms would use these new devices in conjunction with their existing equipment, and how this would change their behavior and thus their energy consumption. Both types of studies are necessary to design an efficient policy based on empirical knowledge, as studies of the technical savings potential, although very important, only give a part of the story, namely the technical aspects of the equipment. As economists, we expected the behavioral changes (rebound effects) to increase with the technical energy savings potential. Thus, we expected to find that the most efficient energy saving devices would generate the largest rebound effects. This was exactly what we found in our research.

At the end of the CREE period, much of the existing literature in this field is still focused on the technical energy savings potential. There are some analyses done focusing on behavior and rebound effects, both in micro (as in flagship III) and secondary rebound effects through the markets. However, there is still a potential for new empirical behavioral studies, in particular with respect to the dissemination of new technologies with a potentially big impact on society, such as electric vehicles.

15. Future prospects

Two of the CREE research partners –the Frisch Centre (the CREE host institution) and the research department at Statistics Norway – are interested in a continuation of the CREE network. The main activities may be the following:

- Joint research proposals with participation from CREE user partners as well as other CREE research partners/subcontractors
- Regular CREE research seminars
- An annual CREE research work shop, organized jointly with ongoing research projects at the Frisch Centre and Statistics Norway
- Continuation of the CREE working paper series
- Continuation of the CREE web site (but content has to reflect that CREE mainly offers network activities).

The main challenge of the plan is funding. As of March 2020, the strategy is that the research work shop is funded by ongoing research projects within the field of environmentally friendly energy, whereas other activities are funded by the Frisch Centre and Statistics Norway. In addition, in Mai we will apply for network funding from the Norwegian Research Council as the core of the CREE researchers is almost identical to the Energy and Environmental Economics group of the Frisch Centre that obtained grade 4 under the SAMVAL evaluation.

16. Conclusions

CREE had powerful impact along a number of dimensions:

- It has stimulated joint research activities between the research partners. Prior to CREE, there was some cooperation between the groups, but this increased significantly once CREE was established. The funding of the centre paved the way for joint long-run projects and associated papers. In particular, it made it possible for substantial development of numerical models, an activity that was given first priority of the expert panel that assessed the application from CREE.
- The stated purpose of the social science research centers for environmentally friendly energy, and also the midterm evaluation of CREE, triggered more interdisciplinary research and also more projects exploring other topics than what has been typical by academic economists.
- The centre building activities (seminars, research workshops, summer and Christmas parties, CREE lunches) also had impact on research cooperation. However, the participation on the more social-oriented activities tended to decrease over time.
- The annual requirement of submitting work plans had a disciplinary effect on those in charge of work packages and flagships, thereby pushing research groups to finish their

papers in time. Also, for the management group of CREE, it increased the transparency of the centre, thereby enhancing cost control.

- The stated purpose of the social science research centers for environmentally friendly energy, and also the midterm evaluation of CREE, triggered more user-oriented activities and also more participation of users on research proposals. Our experience is, however, that it is hard to get user partners involved in projects, even if the projects are aligned with the R&D activities of the user partners, see Section 12c) on NVE as an example. Typically, time spent on CREE activities is squeezed if key activities of the employer require more time. This might be solved if the employer allows for commitment of personal involved in CREE activities.



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Appendix 1 Funding and cost

Statement of accounts for the complete period of centre financing. 1000 NOK

Funding

Activity/ Item	Host institution (Frisch)		ECON UoO		Tilburg Gassnova		Statkraft		Statnett		Statoil		
	Cash	Own funding	Cash	Own funding	Own funding	Own funding	Cash	Own funding	Cash	Own funding	Cash	Own funding	
Flagship (WP) 1	19 251	15 346	7 777	1 212	4 396	500	800	241	315	602	158	301	0
Flagship (WP) 2	5 498	8 229	3 308	346	707	500	0	69	0	172	0	86	0
Flagship (WP) 3	9 459	3 363	5 804	596	1 492	500	0	118	0	296	158	148	0
Flagship (WP) 4	20 237	24 490	41 150	1 274	1 256	500	0	253	0	632	0	316	158
Management	9 555	0	0	602	0	0	800	119	315	299	315	149	158
Sum	64 000	51 429	58 040	4030	7850	2000	1600	800	630	2000	630	1000	315

(Continue Funding table)

Activity/ Item	Miljødirektoratet		NVE	Energi Norge	KLD	Total %	Total
	Cash	Own funding	Own funding	Own funding	Own funding		
Flagship (WP) 1	60	56	113	17	0	26 %	51 145
Flagship (WP) 2	17	56	0	17	0	10 %	19 004
Flagship (WP) 3	30	56	113	17	0	11 %	22 148
Flagship (WP) 4	63	56	0	17	49	46 %	90 453
Management	30	225	225	69	49	7 %	12 910
Sum	200	450	450	138	98		195 660

Appendix 1 Cost

Cost

Activity/Item	Host institution (Frisch)	SSB	ECON UoO	Tilburg	Gassnova	Statkraft	Statnett	Statoil	Miljødirektoratet	NVE	Energi Norge
Flagship (WP) 1	22 656	9 742	9 682	1 000	800	315	158	0	56	113	17
Flagship (WP) 2	12 513	4 144	1 274	1 000	0	0	0	0	56	0	17
Flagship (WP) 3	6 327	7 270	2 704	1 000	0	0	158	0	56	113	17
Flagship (WP) 4	29 957	51 544	6 217	1 000	0	0	0	158	56	0	17
Management	10 754	0	0	0	800	315	315	158	225	225	69
Sum	82 208	72 700	19 877	4 000	1 600	630	630	315	450	450	138

(Continue Cost table)

Activity/Item	KLD	Affiliated experts	IFE	JUS UoO	MILEN UoO	SINTEF	SUM UoO	Vista	Total %	Total
Flagship (WP) 1	0	1 359	2 600	1 387	0	1 258	0	0	26 %	51 143
Flagship (WP) 2	0	0	0	0	0	0	0	0	10 %	19 005
Flagship (WP) 3	0	0	0	0	0	0	3 605	900	11 %	22 150
Flagship (WP) 4	49	1 359	0	0	96	0	0	0	46 %	90 454
Management	49	0	0	0	0	0	0	0	7 %	12 909
Sum	98	2 718	2 600	1 387	96	1 258	3 605	900		195 660

Appendix 2a List of Postdocs, Candidates for PhD and MSc degrees during the full period of the centre

Name	Sex	Nationality	Funding	Scientific area	Period	Thesis title	Main thesis Advisor
Post Doc students with financial support from the Centre budget and other sources							
Spiro, Daniel	M	Swedish	CREE	Energy and environmental economics	2012 - 2016		
Okullo, Samuel Jovan	M	Dutch	CREE	Energy economics, resource economics, climate economics, and firm behavior	2013 - 2015		
Post Doc with financial support from other sources							
Holtmark, Katinka	F	Norwegian	Department of Economics, University of Oslo	Microeconomics, political economy, environmental economics	2016 - 2018		
PhD students working on projects in the centre with financial support from CREE and other sources							
Ciccione, Alice	F	Italian	CREE	Economic of the climate change with econometric applications and climate technologies diffusion	2011 - 2015	Decision making in environmental-related dilemmas: From natural to laboratory experiments	Brekke, Kjell arne and Strøm, Steinar
Dalen, Hanne Marit	F	Norwegian	Research Department, Statistics Norway	The use of multiple instruments in energy and environmental policy.	2010 -		
Klemetsen, Marit	F	Norwegian	CREE	Innovation in energy- and environmental technology industries: Identifying knowledge externalities and effects of policies	2011 - 2015	Impacts of policies on emissions and environmental innovation in Norway	Ulltveit-Moe, Karen Helene and Raknerud, Arvid
Michielsen, Thomas	M	Dutch	Tilburg Sustainability Center	Innovation in energy marked	2010 - 2014		
Wahlquist, Henning	M	Norwegian	CREE	Energy markets and uncertainty. (Ended after one year)	2014 - 2015		
PhD students working on projects in the centre with financial support from other sources							
Coelli, Federica	F	Italian	Department of Economics, University of Oslo	International trade, Innovation, Environmental economics, Climate change	2016 -		
Hjort, Ingrid	F	Norwegian	Department of Economics, University of Oslo	Environmental Economics, Political Economy, Resources, Climate Change	2015 -		
Holtmark, Bjart	M	Norwegian	Research Department, Statistics Norway	Climate policy and economics	-2016	Seven essays on policies and international cooperation to abate emissions of greenhouse gases	Dr. Philos
Holtmark, Katinka K.	F	Norwegian	Department of Economics, University of Oslo	Development Economics, Natural Resource Economics, Microeconomics	2012 - 2016	Four essays on the dynamics of global public goods provision	Mehlum, Halvor and Ulltveit-Moe, Karen Helene
Mideksa, Torben	M	Swedish	Department of Economics, University of Oslo	Primary Concentration: Contract Theory Secondary Concentrations: Environmental Economics and Political Economics	2012 - 2016	Leading for the Common Good	Harstad, Bård and Mehlum, Halvor
Midtømme, Kristoffer	M	Norwegian	Department of Economics, University of Oslo	Technology diffusion	2011 - 2014	Essays on strategic considerations in environmental economics	Greaker, Mads and Harstad, Bård
Nesje, Frikk	M	Norwegian	Department of Economics, University of Oslo	Welfare economics, environmental economics, development economics	2014 -		
van den Bijgaart, Inge M.	F	Dutch	Planbureau voor Leefomgeving (Netherlands Environmental)	Effect of Fiscal Regulations of CO2 Emissions of New Cars	2013 - 2016		

The CREE centre had several different fellowships. Alice Ciccione was 75 % financed by the CREE project 209698. The same was Daniel Spiro. The rest was mostly In-kind financed. Most of them was in Norway, but there were also three in Netherlands at Tilburg. Henning Wahlquist decided to end his fellowship after one year.

Appendix 2a: List of Postdocs, Candidates for PhD and MSc degrees

Master thesis CREE

Name	Sex	Institution granting degree	Scientific area	Year	Title of thesis - CREE WP	Adviser
Abrahamsen, Kamila Lund	F		Environmentally friendly Energy	2014	Elektrisitetspriser: En empirisk og teoretisk analyse av tilbud og etterspørsel	Spiro, Daniel
Andersson, Runa Haave	F		Environmentally friendly Energy	2013	"STABILITY OF INTERNATIONAL CLIMATE TREATIES THE IMPORTANCE OF HETEROGENEITY"	Nyborg, Karine og Holtsmark, Bjart
Andenes, Liv Jorunn	F		Environmentally friendly Energy	2014	Bicycle Commuting in Oslo - Practices, Constraints and new Directions for Policy	Wilhite, Harold Langford
Beisland, Christina Stene	F	CREE	Green innovations and utilization of smart technologies	2013	From Targets and Timetables to Technology Investments - CREE WP 12/2013	Greaker, Mads
Birkelund, Henriette	F	CREE	Green innovations and utilization of smart technologies	2013	Oppvarming og innnetemperaturer i norske barnefamilier - En analyse av husholdningenes valg av innnetemperatur - CREE WP 13/2013	Halvorsen, Bente
Boroumand, Yasaman	F		Environmentally friendly Energy	2014	Price Elasticity of Non-OPEC Supply	Rosendahl, Knut Einar
Elkadi, Nour-Eddine	M	CREE	Environmentally friendly transport	2017	Husholdningenes transport og miljøpolitikk - Modellering og virkemidler - CREE WP 08/2017	Bye, Brita
Gavenas, Ekaterina	F		Environmentally friendly Energy	2014	On the way to a Cleaner Future: A Study of CO2 Emissions on Norwegian Continental Shelf	Rosendahl, Knut Einar
Hjort, Ingrid C.	F	CREE	Green innovations and utilization of smart technologies	2015	Innovation Prizes for Environmental R&D in Presence of Lobbyism - CREE WP 14/2015	Greaker, Mads
Jakobsen, Anja Lund	F		Environmentally friendly Energy	2014	Does the Polluter Pay in the EU ETS, or does the EU ETS Pay the Polluter?	Rosendahl, Knut Einar
Jelsness, Silje	F	CREE	Towards the low-emission society	2019	Vind eller forsvinn - I hvilken grad blir miljøhensyn vektlagt i avgjørelsen om konsesjon for vindkraft? - CREE WP 06/2019	Hagem, Cathrine og Grimsrud, Kristine
Jemsek, Misha	M		Green innovations and utilization of smart technologies	2014	Heat Pumps and Household Energy Consumption in Norway - CREE WP 03/2014	Winther, Tanja
Jiang, Shan	F	CREE	Towards the low-emission society	2016	Pareto improving Climate Policies for the Main CO2 Emitting Countries/Regions - CREE WP 06/2016	Kverndokk, Snorre
Khan, Ahmer Zaman	M	CREE	Green innovations and utilization of smart technologies	2018	Why Say No to Solar Energy? - An Exploration of Residential Reluctance towards Solar Energy - CREE WP 04/2018	Nyborg, Karine
Kontny, C. F.	M	CREE	Radical emissions reductions in ETS sectors	2017	The road to meeting Norway's non-ETS climate goal in 2030 - Is an electric vehicle subsidy the way to go? - CREE WP 05/2017	Rosendahl, Knut Einar
Kristoffersen M.	M	CREE	Environmentally friendly transport	2016	Compatibility Choice: In the Electric Vehicle- and Charging Market - CREE WP 15/2016	Greaker, Mads
Landmark, Marie Brun	F	CREE	Radical emissions reductions in ETS sectors	2016	Environmental effects of international electricity trade - CREE WP 07/2016	Harstad, Bård

Appendix 2a: List of Postdocs, Candidates for PhD and MSc degrees
Master thesis continue

Name	Sex	Institution granting degree	Scientific area	Year	Title of thesis - CREE WP	Adviser
Lorentzen, Linnea	F	CREE	Green innovations and utilization of smart technologies	2018	Grønn teknologi eller klimakrise: En teoretisk studie med to stokastiske terskler - CREE WP 06/2018	Vislie, Jon
Matungwa, Bernard	M		Environmentally friendly Energy	2014	An Analysis of PV Solar Electrification on Rural Livelihood Transformation: A Case of Kisiju-Pwani in Mkuranga District, Tanzania	Wilhite, Harold Langford
Nesje, Frikk	M	CREE	Towards the low-emission society	2013	Distrust, but verify?: Theoretical insights into auditing carbon sequestration in tropical forests - CREE WP 18/2013	Ekstern
Nesvik, Linn Camilla	F		Environmentally friendly Energy	2012	Geografiske kostnads- og prisforskjeller i det norske kraftmarkedet : En tidsserieanalyse av de norske kraftprisene fra 2006 til 2011	von der Fehr, Nils-Henrik M.
Reinlie, Kristine Borgeraas	F		Environmentally friendly Energy	2014	Er elsertifikatene grønne? En analyse av samspillet mellom det svensk-norske elsertifikatmarkedet og det europeiske kvotemarkedet	Brekke, Kjell Arne
Røed, Tiril Salhus	F		Environmentally friendly Energy	2014	Klimagassutslipp og subsidiering av fornybar Energi: En numerisk analyse av klimagevinst ved innføring av grønne sertifikater	Hoel, Michael
Røgeberg, Ole	M	CREE	Environmentally friendly transport	2017	Competing Technologies in Transport - Battery, hydrogen, or both? - CREE WP 11/2017	Greaker, Mads
Salvesen, Ingerid	F		Environmentally friendly Energy	2014	Practicing the preaching?: A study of the Transition Movement in Norway and its effort to change energy-related practices	Wilhite, Harold Langford
Segiet, Katarzyna	F	CREE	Environmentally friendly transport	2018	Should the Norwegian commercial transport sector be subsidized? - CREE WP 13/2018	Greaker, Mads
Skulstad, Andreas	M	CREE	Towards the low-emission society	2019	Environmental goods for sale - An analysis of Geitfjellet wind power plant with an offset scheme for ecosystem services - CREE WP 10/2019	Hagem, Cathrine
Sletten, Thea Marcelia	F		Environmentally friendly transport	2012	A Framework for Studying the Environmental Impact of Biofuel Policies - CREE WP 07/2012	Hoel, Michael
Syrstad, Ragnhild Sjoner	F	CREE	Towards the low-emission society	2016	Climate and Energy Security Policies in the EU: Conflict or Cohesion? - CREE WP 01/2016	Golombek, Rolf and Müller, Andreas
Vágner, Dalibor	M	CREE	Radical emissions reductions in ETS sectors	2019	The effect on domestic price of electricity in Norway as a result of further integration to European electricity market - CREE WP 05/2019	Golombek, Rolf
Valseth, Asmund Sunde	M	CREE	Towards the low-emission society	2014	Competing Climate Policies - CREE WP 04/2014	Harstad, Bård
Velten, Cassandra	F	CREE	Radical emissions reductions in ETS sectors	2017	Network effects and excess inertia: Do Carbon Capture and Storage Technologies Suffer from Technology Lock-In? - CREE WP 07/2017	Greaker, Mads

Appendix 2a: List of Postdocs, Candidates for PhD and MSc degrees

Master thesis continue

Name	Sex	Institution granting degree	Scientific area	Year	Title of thesis - CREE WP	Adviser
Verlo, Kjell Rune	M	CREE	Radical emissions reductions in ETS sectors	2015	Is low carbon taxation optimal climate policy for a developing country? A numerical simulation of technology adoption - CREE WP 22/2015	von der Fehr, Nils-Henrik M.
Vik, Martin Andreas	M		Environmentally friendly Energy	2012	Node- eller soneprising i kraftmarkeder: Hvilket markedsdesign løser best markedsmakt ved flaskehals?	von der Fehr, Nils-Henrik M.
Weidle, Maiken Katrine	F	CREE	Towards the low-emission society	2014	Is low carbon taxation optimal climate policy for a developing country? A numerical simulation of technology adoption - CREE WP 05/2014	Greaker, Mads and Nyborg, Karine
Weyer, Ingrid Semb	F	CREE	Green innovations and utilization of smart technologies	2015	Directed technical change in clean and dirty technologies: Is it possible to redirect R&D in a multiregion world? - CREE WP 17/2015	Greaker, Mads

Appendix 2b Researchers and staff

Researchers and staff

Asheim, Geir Professor Department of Economics, University of Oslo	Aune, Finn Roar Senior Adviser Statistics Norway	Baldursson, Fridrik Professor Reykjavik University	Banet, Catherine Professor Reykjavik University	Bijgaart, Inge van den Post Doc University of Gothenburg
Brekke, Kjell Arne Professor Department of Economics, University of Oslo	Bye, Brita Head of Research at Statistics Norway Statistics Norway	Böhringer, Christoph Professor Universität Oldenburg	Carbone, Jared Professor Universität Oldenburg	Ciccione, Alice Senior Research Economist The Institute of Transport Economics (TØI)
Coelli, Federica PhD student Department of Economics, University of Oslo	Dalen, Hanne Marit PhD student Statistics Norway	de Zeeuw, Aart Professor Tilburg University	Eyckmans, Johan Professor Tilburg University	Framstad, Nils Christian Associate Professor Department of Economics, University of Oslo
Fæhn, Taran Senior Researcher Statistics Norway	Førsund, Finn Professor Emeritus Department of Economics, University of Oslo	Gaure, Simen Research Fellow Frisch Centre	Gerlagh, Reyer Research Fellow Frisch Centre	Gjestvang, Jørg Projectcoordinator for CREE Frisch Centre
Golombek, Rolf Director of CREE Frisch Centre	Greaker, Mads Associate Professor OsloMet	Grimsrud, Kristine M. Researcher Statistics Norway	Hagem, Cathrine Researcher Statistics Norway	Halvorsen, Bente Senior Researcher Statistics Norway

Appendix 2b Researchers and staff

Harstad, Bård Professor Department of Economics, University of Oslo	Hauge, Karen Research Fellow Frisch Centre	Heijmans, Roweno PhD Candidate Tilburg University	Hjort, Ingrid PhD Candidate Tilburg University	Hoel, Michael Professor Department of Economics, University of Oslo
Holtmark, Bjart Senior Researcher Statistics Norway	Holtmark, Katinka Kristine Post Doc. Department of Economics, University of Oslo	Imenes, Anders Gravir, PhD student Ringeriks-Kraft AS	Isaksen, Elisabeth Thuestad, PhD student Ringeriks-Kraft AS	Jaimes, Richard Bonilla PhD Candidate Tilburg University
Jensen, Svenn Assistant professor Norwegian University of Life Sciences	Kittelsen, Sverre Senior Research Fellow Frisch Centre	Klemetsen, Marit Former PhD student CICERO	Kverndokk, Snorre Former PhD student CICERO	Larsen, Bodil Merethe Senior Researcher Statistics Norway
Lindholt, Lars Researcher Statistics Norway	Liski, Matti Professor Aalto University	Lund, Diderik Professor Department of Economics, University of Oslo	Michielsen, Thomas Professor Department of Economics, University of Oslo	Mideksa, Torben Kenea Former PhD student Department of Economics, University of Oslo
Nesje, Frikk PhD student Department of Economics, University of Oslo	Nyborg, Karine Professor Department of Economics, University of Oslo	Nævdal, Eric Senior Research Fellow Frisch Centre	Piacquadio, Paolo Senior Research Fellow Frisch Centre	Rosendahl, Knut Einar Senior Researcher Statistics Norway

Appendix 2b Researchers and staff

Rosnes, Orvika Researcher Statistics Norway	Røgeberg, Ole Senior Research Fellow Frisch Centre	Smulders, Sjak Full Professor Tilburg University	Spiro, Daniel Full Professor Tilburg University	Storrøsten, Halvor Researcher Statistics Norway
Strand, Jon Professor Department of Economics, University of Oslo	Strøm, Steinar Professor Frisch Centre	Tahvonen, Olli Researcher University of Helsinki	Traeger, Christian Researcher University of Helsinki	Vislie, Jon Professor Department of Economics, University of Oslo
Von der Fehr, Nils Professor Department of Economics, University of Oslo	Yonezawa, Hidemichi Senior Researcher Statistics Norway			

Appendix 3 Publications

Appendix 3a - REFERENCES: Publications referred to in Section 7

Asheim, G. B., T. Fæhn, K. Nyborg, M. Greaker, C. Hagem, B. Harstad, M. O. Hoel, D. Lund and K. E. Rosendahl (2019): The case for a supply-side climate treaty. *Science*, Vol. 365, Issue 6451, 325-327.

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Aune, F. R., A.C. Bøeng, S. Kverndokk, L. Lindholt and K. R. Rosendahl (2017): Fuel efficiency improvements - Feedback mechanisms and distributional effects in the oil market, *Environmental and Resource Economics*, Vol. 68, No. 1, 15-45.

Aune, F. R., R. Golombek R. and H. Halre le Tissier (2015b): Phasing Out Nuclear Power in Europe, CREE WP 5/2015

Aune, F.R. and T. Fæhn (2016): Makroøkonomisk analyse for Norge av klimapolitikken i EU og Norge mot 203. Rapport 2016/25, Statistisk sentralbyrå.

Aune, F.R., K. Grimsrud, L. Lindholt, K.E. Rosendahl and H.B. Storøsten (2017): Oil consumption subsidy removal in OPEC and other Non-OECD countries. *Energy Economics*, Vol. 68, 395–409.

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Battaglini, M. and B. Harstad, (2020): The Political Economy of Weak Treaties, *Journal of Political Economy*. In press.

Bjertnæs, G. H. M. (2019): Efficient Combinations of Taxes on Fuel and Vehicles, *The Energy Journal*, Vol. 40, 387-408.

Bjørnebye, H., C. Hagem and A. Lind (2018): Optimal location of renewable power, *Energy*, Vol. 147, No. 15, 1203-1215.

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

Bruvoll, A. and H.M. Dalen (2015): Mange motiver i klimapolitikken. *Samfunnsøkonomen*, Nr 1, 37-45.

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Bye, B., T. Fæhn and O. Rosnes (2018): Residential energy efficiency policies: Costs, emissions and rebound effects. *Energy*, Vol. 143, 191-201.

Bye, B., T. Fæhn and O. Rosnes (2019): Marginal Abatement Costs under EU's Effort Sharing Regulation - A CGE analysis. CREE WP 03/2019.

Bøeng, A.C. and O. Rosnes (2013): Virkinger av Energieffektiviseringsdirektivet i Norge. *Økonomisk analyse*, 5/2013.

Bøeng, A.-C., B. Halvorsen and B.M. Larsen (2013): Fører effektiviseringstiltak til uønskede adferdsendringer? RØST No. 1.

Böhringer, C. K. E. Rosendahl and H. B. Storrøsten (2019): Smart hedging against carbon leakage. CREE WP 09/2019.

Böhringer, C., B. Bye, T. Fæhn and K.E. Rosendahl (2012): Alternative designs for tariffs on embodied carbon – a global cost-effectiveness analysis. *Energy Economics*, Vol. 34 (suppl. 2), 143-153.

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Böhringer, C., K.E. Rosendahl and H.B. Storrøsten (2017b): Robust policies to mitigate carbon leakage. *Journal of Public Economics*, Vol. 149, 35–46.

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Dalen H.M. and B.M. Larsen (2015): Residential End-use Electricity Demand: Development over Time. *The Energy Journal*, Vol. 36, No. 4, 165-182.

Fischer, C., M. Greaker and K.E. Rosendahl (2017): Robust technology policy against emission leakage: The case of upstream subsidies. *Journal of Environmental Economics and Management*, 84, 44-61.

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Hagem, C., M. Greaker and S. Proost (2019): Vehicle-to-Grid: Impacts on the electricity market and consumer cost of electric vehicles, CREE WP 01/2019.

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Hauge, K. E. (2016): Generosity and guilt: The role of beliefs and moral standards of others. *Journal of Economic Psychology*, Vol. 54, June, 35-43.

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Piacquadio, P. G. (2017): A Fairness Justification of Utilitarianism. *Econometrica*, Vol. 85, Issue 4, 1261-1276.

Rosendahl, K.E. and J. Strand (2011): Carbon Leakage from the Clean Development Mechanism. *The Energy Journal*, Vol. 32, No. 4, 27-50.

Segiet, K. (2018): Should the Norwegian commercial transport sector be subsidized? CREE Working paper 13/2018.

Strand, J. (2017): Unconditional and conditional NDCs under the Paris Agreement: Interpretations and their relations to policy instruments. CREE WP 09/2017.

Strand, J. and K.E. Rosendahl (2012): Global Emissions Effects of CDM Projects with Relative Baselines. *Resource and Energy Economics*, Vol. 34, Issue 4, 533-548.

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), pp. 183-198.

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Voigt, C. (2014b): Equity in the 2015 climate agreement: Lessons from differential treatment in multilateral environmental agreements. *Climate Law*, Vol. 4, Issue 1-2, 2014, 50-69. .

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von der Fehr, N-H. and C. Crampes (2018): Cooperation and regulation for building electric interconnectors, draft.

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Winther, T. and H. Wilhite (2015): An analysis of the household energy rebound effect from a practice perspective: spatial and temporal dimensions. *Energy Efficiency*, Vol. 8, Issue 3, 595-607.

Winther, T. and S. Bell (2018): Domesticating In Home Displays in selected British and Norwegian households. *Science & Technology Studies*, Vol. 31, Issue 2, 19 - 38.

Zeeuw, A. de (2015): International environmental agreements. *Annual Review of Resource Economics*, Vol. 7, 151-168.

Appendix 3b Scientific Journals

Scientific Journals

Author	Title	Publication	Year
Aaheim, A., T. Mideksa	Requirements to Metrics of Greenhouse Gas Emissions, Given a Cap on Temperature.	Ecological Economics. Vol. 131, 460- 467.	2016
Abrell, J.,S. Rausch, H. Yonezawa	Higher Price, Lower Costs? Minimum Prices in the EU Emissions Trading Scheme	The Scandinavian Journal of Economics 2019. Volum 121.(2) s.446-481	2019
Acocella N., G. Di Bartolomeo, A. H. Hallett, P. G. Piacquadio	Announcements as an equilibrium selection device	Oxford Economic Papers, Vol. 66, Issue 1, 325–347,	2013
Andersen J.J., M. Greaker	Emission Trading with Fiscal Externalities: The Case for a Common Carbon Tax for the Non-ETS Emissions in the EU	Environmental and Resource Economics, Vol. 71, Issue 3, 803-823, 2018.	2018
André, F. J., S. Smulders	Fueling growth when oil peaks: directed technological change and the limits to efficiency.	European Economic Review 69 (2014), 18-39.	2014
Asheim, G. B., F.. Nesje	Destructive intergenerational altruism.	Journal of the Association of Environmental and Resource Economics, Vol. 3, no. 4, 957-984.	2016
Asheim, G. B., T. Fæhn, K. Nyborg, M. Greaker, C. Hagem, B. Harstad, M. O. Hoel, D. Lund, K. E. Rosendahl	The case for a supply-side climate treaty	Science, Vol. 365, Issue 6451, 325-327	2019
Aune, F. R., A.C. Bøeng, S. Kverndokk, L. Lindholt, K. E. Rosendahl	Fuel efficiency improvements - Feedback mechanisms and distributional effects in the oil market	Environmental and Resource Economics, Vol. 68, Issue 1, 15–45, 2017.	2017
Aune, F.R. , K. Grimsrud, L. Lindholt, K.E. Rosendahl, H.B. Storrøsten	Oil consumption subsidy removal in OPEC and other Non-OECD countries	Energy Economics 68, 395–409	2017
Aune, F.R., H.M. Dalen, C. Hagem	Implementing the EU renewable target through green certificate markets.	Energy Economics, Vol. 34, Issue 4, 992-1000.	2012
Aune, F.R., R. Golombek, A. Moe, K.E. Rosendahl, H. Hallre Le Tissier	Liberalizing Russian gas markets – an economic analysis.	The Energy Journal Vol. 36 - Adelman Special Issue, 63-97	2015
Aune, F. R., R. Golombek, A. Moe, K. E. Rosendahl, H. H. Le Tissier	The Future of Russian Gas Exports	Economics of Energy & Environmental Policy, Vol. 6, Number 2	2017
Baldursson, F. M., E. Lazarczyk, M. Ovaere, S. Proost	Cross-Border Exchange and Sharing of Generation Reserve Capacity	The Energy Journal, Vol. 39(4), 57-84.	2018
Baldursson, F. M., N.-H. M. von der Fehr	Natural resources and sovereign expropriation	Journal of Environmental Economics and Management, Vol. 92, November 2018, 580-607	2018
Baldursson, F.M., N.H.M. von der Fehr.	Price Volatility and Risk Exposure: On the Interaction of Quota and Product Markets.	Environmental and Resource Economics Vol. 52, Issue 2, 213-233	2012

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Author	Title	Publication	Year
Balistreri, E. J., D. T. Kaffine, H. Yonezawa.	Optimal Environmental Border Adjustments Under the General Agreement on Tariffs and Trade	Environmental and Resource Economics 2019 ;Volum 74.(3) s.1-39.	2019
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, A. de Zeeuw	Climate engineering reconsidered.	Nature Climate Change 4, 527–529.	2014
Battaglini, M., B. Harstad	Participation and Duration of Environmental Agreements.	Journal of Political Economy, Vol. 124, No 1, 160-204.	2016
Battaglini, M., B. Harstad	The Political Economy of Weak Treaties	Journal of Political Economy.	2019
Bijgaart, I. van den , S. Smulders	Does a Recession call for Less Stringent Environmental Policy? A Partial-Equilibrium Second-Best Analysis.	Environmental and Resource Economics 70, 807-834.	2018
Bijgaart, I.M. van den, R. Gerlagh, M. Liski	A simple formula for the social cost of carbon	Journal of Environmental Economics and Management, Vol. 77, May 2016, 75-94	2016
Bijgaart, I.M.van den	The unilateral implementation of a sustainable growth path with directed technical change.	European Economic Review, Vol. 91, Jan 2017, 305-327	2016
Bjertnæs, G. H. M.	Efficient Combinations of Taxes on Fuel and Vehicles	The Energy Journal, Vol. 40, The New Era of Energy Transition Special Issue, 387-408.	2019
Bjertnæs, G.H., M. Tsygankova, T. Martinsen	Norwegian Climate Policy Reforms in the Presence of an International Quota Market.	Energy Economics, 39, 147-158.	2013
Bjørnebye, Henrik, C. Hagem, A. Lind	Optimal location of renewable power	Energy, Vol. 147, 1203-1215	2018
Braaten, R.H.	Land Rights and Community Cooperation: Public Goods Experiments from Peru.	World Development Vol. 61, September 2014, 127–141	2014
Braaten, R.H.	Testing deontological warm glow motivation for carbon abatements.	Resource and Energy Economics, Vol. 38, November 2014, 96-109, ISSN 0928-7655	2014
Braaten, R.H., K.A. Brekke, O. Røgeberg	Buying the right to do wrong – An experimental test of moral objections to trading emission permits.	Resource and Energy Economics, Vol. 42, November 2015, 110–124	2015
Brekke, K. A., J. Konow, K. Nyborg	Framing in a Threshold Public Goods Experiment with Heterogeneous Endowments	Journal of Economic Behavior and Organization 138, 99-110.	2017

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Author	Title	Publication	Year
Brekke, K. A., R. Golombek, M. Kaut, S.A.C. Kittelsen, S. W. Wallace	Stochastic energy market equilibrium modeling with multiple agents	Energy, Vol. 134, 984-990	2017
Bretschger, L., S. Smulders.	Challenges for Sustainable Resource Use: Uncertainty, Trade and Climate Policies.	Journal of Environmental Economics and Management 64 (2012), 279–287.	2012
Bretschger, L., S. Smulders.	Sustainability and climate change: From theory to pragmatic policy.	European Economic Review 69 (2014) 1-3 (editorial, with Lucas Bretschger).	2014
Bretschger, L., S. Smulders.	Sustainability and substitution of exhaustible natural resources. How structural change affects long-term R&D-investments.	Journal of economic dynamics and control 36, issue 4 (April 2012), pp. 536–549.	2012
Bye, B., M. E. Klemetsen	The Impacts of Alternative Policy Instruments on Environmental Performance: A Firm Level Study of Temporary and Persistent Effects	Environmental and Resource Economics, Vol. 69, Issue 2, 317–34	2018
Bye, B., M. E. Klemetsen	The impacts of alternative policy instruments on environmental performance: A firm level study of temporary and persistent effects	Environmental and Resource Economics, Vol. 69, Issue 2 317-341	2017
Bye, B., T. Fæhn, O. Rosnes	Residential energy efficiency policies: Costs, emissions and rebound effects	Energy, Vol. 143, 191-201	2018
Böhringer, C., B. Bye, T. Fæhn, K.E. Rosendahl	Alternative designs for tariffs on embodied carbon – a global cost-effectiveness analysis.	Energy Economics Vol. 34 (suppl. 2), 143-153,	2012
Böhringer, C., B. Bye, T. Fæhn, K.E. Rosendahl	Output-based rebating of carbon taxes in the neighbor’s backyard. Competitiveness, leakage and welfare	Canadian Journal of Economics 50, 426-455	2017
Böhringer, C., B. Bye, T. Fæhn, K.E. Rosendahl	Targeted carbon tariffs: Export response, leakage and welfare	Resource and Energy Economics 50, 51-73	2017
Böhringer, C., B. Dijkstra, K.E. Rosendahl	Sectoral and regional expansion of emissions trading.	Resource and Energy Economics. Vol. 37, August 2014, 201–225	2014
Böhringer, C., C. Fischer, K.E. Rosendahl	Cost-Effective Unilateral Climate Policy Design: Size Matters.	Journal of Environmental Economics and Management. Vol. 67, Issue 3, May 2014, 318–339	2014
Böhringer, C., J. C. Carbone, T. F. Rutherford	The Strategic Value of Carbon Tariffs.	American Economic Journal: Economic Policy, Vol 8 Issue 1, 28-51.	2016
Böhringer, C., J.C. Carbone, T. F. Rutherford	Embodied Carbon Tariffs.	Scandinavian Journal of Economics, Vol. 120, Issue 1, p 183-210	2016
Böhringer, C., J.C. Carbone, T. F. Rutherford	Unilateral Climate Policy Design: Efficiency and Equity Implications of Alternative Instruments to Reduce Carbon Leakage,.	Energy Economics. Vol. 34 (Supplement 2), 208-S217.	2012

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Author	Title	Publication	Year
Böhringer, C., K.E. Rosendahl	Greening Electricity More Than Necessary: On the Cost Implications of Overlapping Regulation in EU Climate Policy.	Journal of Applied Social Science Studies (Schmollers Jahrbuch) 131, Issue 3, 469-492.	2011
Böhringer, C., K.E. Rosendahl, H.B. Storrøsten	Robust policies to mitigate carbon leakage	Journal of Public Economics 149, 35–46	2017
Böhringer, C., K.E. Rosendahl, J. Schneider	Unilateral Climate Policy: Can OPEC Resolve the Leakage Problem? .	The Energy Journal 35 (4), 79-100.	2014
Böhringer, C., N. Rivers, H. Yonezawa	Vertical fiscal externalities and the environment	Journal of Environmental Economics and Management Volume 77, Pages 51-74	2016
Böhringer, C., Rosendahl, K.E., Schneider, J.	Unilateral Emission Pricing and OPEC's Behaviour	Strategic Behavior and the Environment, now publishers, vol. 7(3--4), 225-280, February.	2018
Carbone, J. C.	Linking Numerical and Analytical Models of Carbon Leakage.	American Economic Review, Papers and Proceedings, 103, 3, 326-331.	2013
Carbone, J. C., and N. Rivers	The Impacts of Unilateral Climate Policy on Competitiveness: Evidence From Computable General Equilibrium Models	Review of Environmental Economics and Policy 11, no. 1, 24-42.	2017
Carbone, J. C., K. Smith	Valuing Nature in General Equilibrium.	Journal of Environmental Economics and Management, Vol. 66, Issue 1, 72–89	2013
Carbone, J. C., N. Rivers, A. Yamazaki, H. Yonezawa.	Comparing applied general equilibrium and econometric estimates of the effect of an environmental policy shock	Journal of the Association of Environmental and Resource Economists.(forthcoming:conditionally accepted)	2020
Carbone, J. C., R. S. Gazzale	A Shared Sense of Responsibility: Money Versus Effort Contributions in the Voluntary Provision of Public Goods	Journal of Economic Behavior and Organization, 139, 74-87.	2017
Castagneto-Gissey, G., R.J. Green	Exchange Rates, Oil Prices & Electricity Spot Prices: Empirical Insights from EU markets.	Journal of Energy Markets, vol. 7, no. 2, 3-33	2014
Chakravorty, U., M. Liski	Economics of Market Power in the Extraction of Nonrenewable Resources .	Encyclopedia of Energy, Natural Resource, and Environmental Economics, Vol. 2, 22-30	2013
Ciccone, A.	Environmental effects of a vehicle tax reform: Empirical evidence from Norway	Transport Policy Vol. 69, 141-157	2018
Crépin, S. A., E. Nævdal	Inertia in risk; improving economic models of catastrophes	Scandinavian Journal of Economics, 1-27	2019
Czajkowski, M., N. Hanley, K. Nyborg	Social norms, Morals and Self-interest as Determinants of Pro-Environment Behaviours: The Case of Household Recycling.	Environmental and Resource Economics, Vol. 66, Issue 4, 647-670	2015
Dalen H.M., B.M. Larsen	Residential End-use Electricity Demand: Development over Time.	The Energy Journal Vol. 36, No. 4, 165-182	2015

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Author	Title	Publication	Year
Dengler S., R. Gerlagh, S. T. Trautmann, G. van de Kuilen	Climate policy commitment devices	Journal of Environmental Economics and Management, Vol. 92, November 2018, 331-343	2018
Drupp, M., M. Freeman, B. Groom, R. Nesje	Discounting Disentangled	American Economic Journal: Economic Policy	2018
Eggert, H., M. Greaker	Promoting Second Generation Biofuels: Does the First Generation Pave the Road?.	Energies 7, 1-16	2014
Eggert, H., M. Greaker	Trade Policies for Biofuels.	Journal of Environment & Development, Vol 21, Issue 2, 281-306.	2012
Eyckmans, J., S. Fankhauser, S. Kverndokk	Development Aid and Climate Finance.	Environmental and Resource Economics, Vol. 63, Issue 2, 429-450	2016
Fischer, C., M. Greaker, K.E. Rosendahl	Robust technology policy against emission leakage: The case of upstream subsidies	Journal of Environmental Economics and Management 84, 44-61	2017
Fischer, C., M. Greaker, K.E. Rosendahl	Strategic technology policy as a supplement to energy standards	Resource and Energy Economics, Vol. 51, 84-98	2018
Framstad, N.C.	When can the environmental profile and emissions reduction be optimised independently of the pollutant level?.	Journal of Environmental Economics and Policy, , Vol. 3, Issue 1, 2014 , 25-45	2014
Framstad, N.C., J. Strand	Energy intensive infrastructure investments with retrofits in continuous time: Effects of uncertainty on energy use and carbon emissions.	Resource and Energy Economics, Vol. 41, 1-18	2015
Fæhn, T.	A shaft of light into the black box of CGE analyses of tax reforms.	Economic Modelling, Vol. 49 September 2015, 320–330.	2015
Fæhn, T., A.G. Gómez-Plana, S. Kverndokk	How can carbon policies impact unemployment?.	OPINION, Carbon Management Vol 4, Issue, 27–29.	2013
Fæhn, T., C. Hagem, L. Lindholt, S. Mæland, K.E. Rosendahl	Climate policies in a fossil fuel producing country. Demand versus supply side policies	The Energy Journal Vol. 38 (1), 77-102	2017
Fæhn, T., E. T. Isaksen	Diffusion of climate technologies in the presence of commitment problems.	Energy Journal, Vol. 37, No 2, 155-180	2016
Gabriel, S.A., K.E. Rosendahl, R.G. Egging, H. Avetisyan, S. Siddiqui	Cartelization in Gas Markets: Studying the Potential for a "Gas OPEC".	Energy Economics Vol. 34, Issue 1, 137-152.	2012
Gavenas, E., K.E. Rosendahl, T. Skjerpen	CO2-emissions from Norwegian oil and gas extraction.	Energy, Vol. 90, Part 2, October 2015, 1956–1966	2015
Gerlagh R., Bijgaart, I.M. van den, Michielsen, T., Nijland, H	Fiscal policy and CO2 emissions of new passenger cars in the EU.	Environmental and Resource Economics, Vol. 65 Issues 263, 1-32	2016
Gerlagh, R. S. Kverndokk, K.E. Rosendahl	The optimal time path of clean energy R&D policy when patents have finite lifetime.	Journal of Environmental Economics and Management, 39, Vol. 67, Issue 1, January 2014, 2–19	2014

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Author	Title	Publication	Year
Gerlagh, R., Bijgaart, I.van den, H. Nijland, T. Michielsen	Fiscal policy and CO2 emissions of new passenger cars in the EU	Environmental and Resource Economics 69(1): 103-134	2018
Gerlagh, Reyer, Roweno J. R. K. Heijmans	Climate-conscious consumers and the buy, bank, burn program	Nature Climate Change 9, 2019, 431-433	2019
Godal, O., B. Holtsmark	Emissions trading: Merely an efficiency neutral redistribution away from climate change victims?.	Scandinavian Journal of Economics. Vol. 113, Issue 4, 784-797	2011
Golombek, R., K.A. Brekke, S.A.C. Kittelsen	Is electricity more important than natural gas? Partial liberalizations of the Western European energy markets.	Economic Modelling. Vol. 35, September, 99-111	2013
Golombek, R., M. Greaker M. Hoel.	Should environmental R&D be prioritized?	Resource and Energy Economics.Forthcoming	2020
Golombek, R., M. Greaker, S.A.C. Kittelsen, O. Røgeberg, F.R. Aune	Carbon Capture and Storage Technologies in the European Power Market.	Energy Journal , Vol. 32, No. 3, 209-238	2011
Golombek, R., M. Hoel	International Cooperation on Climate-Friendly Technologies.	Environmental and Resource Economics , Vol. 49, Issue 4, 473-490	2011
Golombek, R., S.A.C. Kittelsen, I. Haddeland	Climate change: impacts on electricity markets in Western Europe.	Climate Change, Vol. 113, Number 2, 357-370,	2012
Golombek, R., S.A.C. Kittelsen, K.E. Rosendahl	Price and welfare effects of emission quota allocation.	Energy Economics, Vol. 36, March , 568–580	2013
Greaker, M.	Strategic Environmental Policy.	Encyclopaedia of Energy, Natural Resource and Environmental Economics, Vol. 3, 313-320	2013
Greaker, M., C. Hagem	Strategic investment in climate friendly technologies: The impact of global emissions trading.	Environmental and Resource Economics 59, 65-85.	2014
Greaker, M., K. Midttømme	Network effects and environmental externalities: Do clean technologies suffer from excess inertia?	Journal of Public Economics, Vol. 143, 27-38	2016
Greaker, M., M. Hoel, K.E. Rosendahl	Does a renewable fuel standard for biofuels reduce climate costs? .	Journal of the Association of Environmental and Resource Economists 1, 337-363	2014
Greaker, M., P.E. Stoknes, K.H. Alfsen, T. Ericson	A Kantian approach to sustainable development indicators for climate change.	Ecological Economics 91, 10-18	2013
Greaker, M., R. Golombek, M. Hoel .	Global impact of national climate policy in the Nordic countries.	Nordic Economic Policy Review 2019, 157-202. Nordic Council of Ministers.	2019
Greaker, M., T. R. Heggedal, K. E. Rosendahl	Environmental Policy and the Direction of Technical Change	Scandinavian Journal of Economics	2017
Green R., I. Staffell	“Prosumage” and the British Electricity Market	Economics of Energy & Environmental Policy, Vol. 6 Nr 1	2017
Green, R.J., D. Pudjianto, I. Staffell, G. Strbac	Market Design for Long-Distance Trade in Renewable Electricity.	The Energy Journal, Vol. 37, Bollino-Madlener Special Issue, 5-22	2016

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Author	Title	Publication	Year
Green, R.J., I. Staffell, N. Vasilakos	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	2014
Grimsrud, K., H. Lindhjem, I. V. Sem, K. E. Rosendahl.	Public acceptance and willingness to pay cost-effective taxes on red meat and city traffic in Norway.	Journal of Environmental Economics and Policy 2019	2019
Grimsrud, K., K. E. Rosendahl, H. B. Storrøsten, M. Tsygankova	Short Run Effects of Bleaker Prospects for Oligopolistic Producers of a Non-renewable Resource.	The Energy Journal, Vol. 37, Nr 3 , 293-314	2016
Haberl, H., E.D. Schulze, C. Körner, B.E. Law, B. Holtsmark, S. Luyssaert	Response: complexities of sustainable forest use.	GCB Bioenergy Vol. 5, Issue 1, 1-2.	2013
Haensel, M., M. A. Drupp, D. Johansson, F. Nesje, C. Azar, B. Groom, T. Sterner	The Economics Nobel Prize and the UN Climate Targets: From Clash to Consistency	Revise-and-resubmit in Nature Climate Change	2020
Hagem, C.	Incentives for Strategic Behavior in the Permit Market.	Strategic Behavior and the Environment , Vol. 3, issue 3. 149-167	2013
Hagem, C., B. Holtsmark	Is the clean development mechanism compatible with an ambitious climate agreement?.	Environmental Economics, Vol. 2, Issue 3, 24-35.	2011
Hagem, C., Storrøsten, H. B.	Supply-versus Demand-side Policies in the Presence of Carbon Leakage and the Green Paradox	The Scandinavian Journal of Economics, 121(1), 379-406.	2018
Halvorsen, B.	Estimating consumption and changes in stock of storable goods applying micro expenditure data.	Environmental Economics Vol. 4, Issue 2, 42 - 53.	2013
Halvorsen, B., B. Larsen, H.L. Wilhite, T. Winther	Revisiting household energy rebound: Perspectives from a multidisciplinary study.	Indoor and Built Environment 25(7), 1114-1123.	2016
Halvorsen, B., B.M. Larsen	How serious is the aggregation problem? An empirical illustration.	Applied Economics, 45: 26, 3786-3794	2013
Hansen, A., K. Nielsen, H. Wilhite.	Staying Cool, Looking Good, Moving Around: Consumption, Sustainability and the 'Rise of the South'.	Forum for Development Studies Vol. 43 Issue 1, 5-25.	2016
Harstad, B, F. Lancia, A. Russo	Compliance Technology and Self-enforcing Agreements	Journal of the European Economic Association, Vol. 17, Issue 1, 1 February 2019, 1–29	2019
Harstad, B.	Buy Coal! A Case for Supply-Side Environmental Policy.	Journal of Political Economy Vol. 120, No 1, 77-115,	2012
Harstad, B.	Climate Contracts: A Game of Emissions, Investments, Negotiations, and Renegotiations.	Review of Economic Studies, Vol 79, Issue 4, 1527-1557	2012
Harstad, B.	Technology and Time Inconsistency	Journal of Political Economy (accepted)	2020

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Author	Title	Publication	Year
Harstad, B.	The Dynamics of Climate Agreements.	Journal of the European Economic Association, Vol. 14, Issue 3, 719-752	2016
Harstad, B.	The Market for Conservation and Other Hostages.	Journal of Economic Theory 166(Nov): 124-151.	2016
Harstad, B., T. Mideksa	Conservation Contracts and Political Regimes	Review of Economic Studies 84(4): 1708-34.	2017
Hassler, J. , P. Krusell, A. B. Shifa, D. Spiro	Should Developing Countries Constrain Resource-Income Spending? A Quantitative Analysis of Oil Income in Uganda.	The Energy Journal Vol. 38 (1), 103-132	2017
Hauge, K. E.	Generosity and guilt: The role of beliefs and moral standards of others.	Journal of Economic Psychology, Vol. 54, June 2016, 35-43	2016
Hauge, K. E.	Moral opinions are conditional on the behavior of others.	Review of Social Economy, Vol. 73 (2), 154-175.	2015
Hauge, K. E., K. A. Brekke, K. Nyborg, J. T. Lind	Sustaining cooperation through self-sorting: The good, the bad, and the conditional	Proceedings of the National Academy of Sciences, Vol 116(12), 5299-5304	2019
Hauge, K. E., K.A. Brekke, L.O. Johansson, O. Johansson-Stenman, H. Svedsäter	Keeping others in our mind or in our heart? Distribution games under cognitive load.	Experimental Economics, Vol. 19, Issue 3, 562-576	2015
Hauge, K. E., O. Røgeberg	Representing others in a Public Good Game.	Games, 6, 381-393.	2015
Hauge, K.E., K.A. Brekke, K. Nyborg, J.T. Lind	Sustaining cooperation through self-sorting: The good, the bad, and the conditional	Proceedings of the National Academy of Sciences	2018
Hoel, M, SAC Kittelsen, S Kverndokk	Correcting the climate externality: Pareto improvements across generations and regions	Environmental and Resource Economics	2019
Hoel, M.	The Green Paradox and Greenhouse Gas Reducing Investments.	International Review of Environmental and Resource Economics Vol. 5, No 4, 353-379	2011
Hoel, M., B. Holtmark	Haavelmo on the Climate Issue.	Nordic Journal of Political Economy 37 (5), 1-22.	2012
Hoel, M., B. Holtmark, K. Holtmark	Faustmann and the climate.	Journal of Forest Economics, ,Vol. 20, Issue 2, 192-210	2014
Hoel, M., S. Jensen	Cutting costs of catching carbon-Intertemporal effects under imperfect climate policy.	Resource & Energy Economics , Vol. 34(4), 680-695	2012
Hoel, M., T. M. Sletten	Climate and forests: The tradeoff between forests as a source for producing bioenergy and as a carbon sink.	Resource and Energy Economics, Vol. 43, 112-129	2016
Holtmark B., M. L. Weitzman	On the Effects of Linking Cap-and-Trade Systems for CO2 Emissions	Environmental and Resource Economics, 1–16	2020
Holtmark, B.	A comparison of the global warming impact of wood fuels and fossil fuels taking albedo effects into account.	GCB Bioenergy, Vol. 7, Issue 5, p 984-997	2014
Holtmark, B.	Boreal forest management and its effect on atmospheric CO2.	Ecological Modelling Vol. 248, 10 January, 130–134.	2013

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Author	Title	Publication	Year
Holtmark, B.	Harvesting in boreal forests and the biofuel carbon debt.	Climatic Change, Vol. 112, Issue 2 . 415-428	2012
Holtmark, B.	Quantifying the global warming potential of CO2 emissions from wood fuels.	GCB Bioenergy, Vol. 7, Issue 2, 195–206.	2015
Holtmark, B.	The outcome is in the assumptions: analyzing the effects on atmospheric CO2 levels of increased use of bioenergy from forest biomass.	GCB Bioenergy , Vol. 5, Issue 4, July 2013, 467-473	2012
Holtmark, B., A. Skonhoft	The Norwegian support and subsidy policy of electric cars. Should it be adopted by other countries?	Environmental Science & Policy Vol. 42, 160-168 .	2014
Holtmark, B., D.E. Sommervoll	International emissions trading: Good or bad?.	Economics Letters Vol. 117, Issue 1, October, 362–364	2012
Holtmark, B., M. Hoel and. K. Holtmark	Optimal harvest age considering multiple carbon pools – A comment.	Journal of Forest Economics, Vol. 19, Issue 1, 87–95.	2013
Hovi, J., M. Greaker, C. Hagem, B. Holtmark	A credible compliance enforcement system for the climate regime.	Climate Policy, Vol. 12, 2012 - Issue 6, 741-754	2012
Isaac T., P. G. Piacquadio	Equity and efficiency in an overlapping generation model	Social Choice and Welfare, Vol. 44, Issue 3, 549–565	2015
Isaksen, E.T., A. Richter	Tragedy, property rights, and the commons: investigating the causal relationship from institutions to ecosystem collapse	Journal of the Association of Environmental and Resource Economists, Vol. 6(4), 741-781	2019
Jaakkola, N., D. Spiro, A. A. van Benthem	Finders, keepers?	Journal of Public Economics, Vol. 169, 17-33	2019
Kaushal, K.R., Rosendahl, K.E.	Optimal REDD+ in the carbon market.	Revise-and-resubmit in Land Economics.	2020
Kaushal, K.R., Rosendahl, K.E.	Taxing Consumption to Mitigate Carbon Leakage	Environmental and Resource Economics. Vol. 75, Issue 1, 151-181	2020
Klemetsen M. E., B. Bye, A. Raknerud	Can Direct Regulations Spur Innovations in Environmental Technologies? A Study on Firm-Level Patenting	Scandinavian Journal of Economics, Vol. 120, Issue 2, 338-371	2018
Klemetsen, M.E., K.E. Rosendahl, A.L. Jakobsen	The impacts of the EU ETS on Norwegian plants' environmental and economic performance (CREE Working Paper 03/2016)	Revise-and-resubmit in Climate Change Economics	2020
Kverndokk, S.	Climate Policies, Distributional Effects and Transfers Between Rich and Poor Countries	International Review of Environmental and Resource Economics: Vol. 12: No. 2-3, 129-176.	2018
Kverndokk, S., E. Nævdal, L. Nøstbakken	The Trade-off between Intra- and Intergenerational Equity in Climate Policy.	European Economic Review, Vol. 69, 40-58.	2014
Kverndokk, S., Erik Figenbaum, Jon Hovi	Would my driving pattern change if my neighbor were to buy an emission-free car?	Resource and Energy Economics	2020

Appendix 3b Scientific Journals

Author	Title	Publication	Year
Kverndokk, S., K.E. Rosendahl	Effects of Transport Regulation on the Oil Market: Does Market Power Matter?	The Scandinavian Journal of Economics. Vol. 115, Issue 3, 662–694	2013
Leroux, J., D. Spiro	Leading the unwilling: Unilateral strategies to prevent arctic oil exploration	Resource and Energy Economics, Vol. 54. 125-149	2018
Lillemo, S.C., B. Halvorsen	The impact of lifestyle and attitudes on residential firewood demand in Norway.	Biomass and Energy. Vol. 57, October, 13–21.	2013
Lillemo, S.C., F. Alfnes, B. Halvorsen, M. Wik.	Households' Heating Investments: The effect of motives and attitudes on choice of equipment.	Biomass and Energy. Vol. 57, October, 4–12	2013
Lind, J. T., K. Nyborg, A. Pauls	Save the planet or close your eyes? Testing strategic ignorance in a charity context.	Ecological Economics, Volume 161, Pages 9-19	2019
Lindholt, L., S. Glomsrød	Phasing out coal and phasing in renewables - Good or bad news for arctic gas producers?	Energy Economics, 70: 1-11.	2018
Malcolm, J., B. Holtmark, P. W. Piascik	Forest harvesting and the carbon debt in boreal east-central Canada.	Revise and resubmit to Climatic Change	2020
Maria, C. Di, S. Smulders, E. van der Werf.	Absolute Abundance and Relative Scarcity: Environmental Policy with Implementation Lags.	Ecological Economics 74 (2012) 104–119.	2012
Maria, Corrado Di, S. Smulders, E. van der Werff	Climate Policy with Tied Hands: Optimal Resource Taxation under Implementation Lags.	Environmental and Resource Economics 66(3), 537-551.	2017
Maria, Corrado Di, S. Smulders.	A Paler Shade of Green: Environmental Policy under Induced Technical Change.	European Economic Review 99, 151-169.	2017
Meijden, G. van der, S. Smulders	Technical change during the energy transition.	Macroeconomic Dynamics 22: 805-836.	2018
Meijden, G. van der, S. Smulders.	Carbon Lock-In: the Role of Expectations.	International Economic Review 58(4), 1371-1415.	2017
Moe, T., K. Alfsen, M. Greaker	Sustaining Welfare for Future Generations: A Review Note on the Capital Approach to the Measurement of Sustainable Development.	Challenges in Sustainability, 1: 1, 16–26	2013
Moreno-Cruz, Juan. Sjak Smulders.	Revisiting the Economics of Climate Change: The Role of Geoengineering.	Research in Economics 71(2), 212-224.	2017
Nyborg, K	Social Norms and the Environment	Annual Review of Resource Economics, Vol. 10:405-423 , Oct 2018	2018
Nyborg, K.	Do responsible employers attract responsible employees?.	IZA World of Labor 2014	2014
Nyborg, K.	I Don't Want to Hear About it: Rational Ignorance among Duty-Oriented Consumers.	Journal of Economic Behavior and Organization Vol. 79, Issue 3, 263-274.	2011
Nyborg, K.	Project Evaluation with Democratic Decision-making: What Does Cost-Benefit Analysis Really Measure?.	Ecological Economics, 106, 124-131.	2014
Nyborg, K.	Reciprocal climate negotiators	Journal of Environmental Economics and Management Vol. 92, November 2018, 707-725	2018

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Author	Title	Publication	Year
Nyborg, K. et al.	Social Norms as Solutions.	Science 07 Oct 2016, Vol. 354, Issue 6308, 42-43	2016
Nyborg, K., T. Zhang	Is Corporate Social Responsibility Associated with Lower Wages?	Environmental and Resource Economics , Vol. 55, 107-117	2013
Nævdal, E.	Catastrophes and ex post shadow prices—How the value of the last fish in a lake is infinity and why we should not care (much)	Journal of Economic Behavior & Organization, Vol. 132, Part B, 153-160.	2016
Piacquadio, P. G.	A Fairness Justification of Utilitarianism	Econometrica, Vol. 85, Issue 4, 1261-1276	2017
Piacquadio, P. G.	Intergenerational egalitarianism	Journal of Economic Theory, Vol. 153, 117-127	2014
Quaas, M., S. Smulders	Brown Growth, Green Growth, and the Efficiency of Urbanization.	Environmental and Resource Economics 71, 529-549.	2018
Rosendahl, K.E.	EU ETS and the waterbed effect.	Nature Climate Change 9, 734-735.	2019
Rosendahl, K.E., H. Storrøsten	Allocation of emission allowances: impacts on technology investment.	Climate Change Economics. Vol.06, Issue 03, August 2015.	2015
Rosendahl, K.E., J. Strand	Carbon Leakage from the Clean Development Mechanism.	The Energy Journal, Vol 32(4), 27-50.	2011
Rosendahl, K.E., J. Strand	Emissions Trading with Offset Markets and Free Quota Allocations.	Environmental and Resource Economics. Vol. 61, Issue 2, 243-271	2015
Rosnes, O.	Subsidies for Renewable Energy in Inflexible Power Markets.	Journal of Regulatory Economics 46, 318–343.	2014
Schubert, K., S. Smulders	How important are uncertainty and dynamics for environmental and climate policy? Some analytics.	Journal of Environmental Economics and Management 97, 1-22.	2019
Skjerpen, T., Storrøsten, H.B., Rosendahl, K.E., P. Osmundsen	Modelling and forecasting rig rates on the Norwegian Continental Shelf.	Resource and Energy Economics, 53, 220-239.	2018
Smulders, S.	Developing the economics of change.	Environment and Development Economics 19 / Special Issue 03 / June 2014, pp 311 – 314.	2014
Smulders, S., L. Bretschger, H. Egli.	Economic Growth and the Diffusion of Clean Technologies: Explaining Environmental Kuznets Curves.	Environmental and Resource Economics (2011) 49:79–99.	2011
Smulders, S., M. Toman, C. Withagen.	Growth theory and ‘green growth’.	Oxford Review of Economic Policy (2014) 30 (3): 423-446.	2014
Smulders, S., Y. Tsur, A. Zemel.	Announcing climate policy: Can a Green Paradox arise without scarcity?	Journal of Environmental Economics and Management 64 (2012), 364–376 (with Yacov Tsur and Amos Zemel).	2012
Spiro, D.	Resource prices and planning horizons.	Journal of Economic Dynamics and Control, vol. 48, November, 159-175,	2014
Staffell, I., R.J. Green	Is there merit in the Merit Order Stack?.	IEEE Transactions on Power Systems, Vol. 31, Issue 1, 43-53	2016

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Author	Title	Publication	Year
Staffell, I., R.J. Green	How does wind farm performance decline with age?.	Renewable Energy, vol. 66, June, 775-786,	2014
Storrøsten, H.B.	Prices vs. quantities with endogenous cost structure and optimal policy.	Resource and Energy Economics, Vol. 41, August 2015, 143-163	2015
Storrøsten, H.B.	Prices Versus Quantities: Technology Choice, Uncertainty and Welfare.	Environmental and Resource Economics, Vol. 59 - Issue 2, p 275-293	2014
Strand, J., K.E. Rosendahl	Global Emissions Effects of CDM Projects with Relative Baselines.	Resource and Energy Economics Vol. 34, Issue 4, 533-548.	2012
Strbac, G., M. Pollitt, C.V. Konstantinidis, I. Konstantelos, R. Moreno, D.M. Newbery, R.J. Green	Electricity transmission arrangements in Great Britain: Time for change?.	Energy Policy, Vol. 73, 298-311	2014
Tahvonen, O., A. Rautiainen	Economics of forest carbon storage and the additionality principle	Resource and Energy Economics 50, p. 124-134	2017
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, A.J. de Zeeuw	Does aquaculture add resilience to the global food system?	PNAS Vol. 111, no 37, 13257-13263	2014
van der Ploeg, F., A. de Zeeuw	Non-cooperative and Cooperative Responses to Climate Catastrophes in the Global Economy: A North-South Perspective.	Environmental and Resource Economics, Vol. 65, Issue 3, 519-540	2016
Vogelsang, T.J., M. Wagner	Integrated Modified OLS Estimation and Fixed-b Inference for Cointegrating Regressions.	Journal of Econometrics, 39, Vol. 178, Issue 2, February 2014, 741-760	2014
Voigt, C.	Equity in the 2015 climate agreement: Lessons from differential treatment in multilateral environmental agreements.	Climate Law, Vol. 4, Issue 1-2, 2014, 50-69.	2014
von der Fehr, N.H.M.	Transparency in Electricity Markets.	Economics of Energy & Environmental Policy , 2 (2), 71-89	2013
von der Fehr, N.H.M., S. Ropenus	Renewable Energy Policy Instruments and Market Power.	Scandinavian Journal of Economics, Vol. 119, Issue 2, p 312-345	2016
Westskog, H., T. Winther, H. Sæle	The effects of In-Home Displays - Revisiting the Context.	Sustainability, Vol. 7, Issue 5, 5431-5451	2015
Wethal, U.	Practices, provision and protest: Power outages in rural Norwegian households.	Energy Research and Social Science 62.	2020

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Author	Title	Publication	Year
Winther, T., H. Wilhite	An analysis of the household energy rebound effect from a practice perspective: spatial and temporal dimensions.	Energy Efficiency, Vol. 8, Issue 3, 595-607	2015
Winther, T., S. Bell	Domesticating In Home Displays in selected British and Norwegian households.	Journal of Science and Technology Studies	2018
Zeeuw, A. de	International environmental agreements.	Annual Review of Resource Economics, 7, 151-168	2015
Zhu, X., S. Smulders, A. de Zeeuw	Discounting in the presence of scarce ecosystem services	Journal of Environmental Economics and Management , Vol 98,	2019

Appendix 3c Popular Scientific Journals

Popular Scientific Journals

Author	Title	Publication	Year
Aune, F.R. , A.C. Bøeng, S. Kverndokk, L. Lindholt, K.E. Rosendahl	Fuel efficiency improvements – feedback mechanisms and distributional effects in the oil market.	Discussions papers 839, Statistisk sentralbyrå	2016
Aune, F.R. , K. Grimsrud, L. Lindholt, K.E. Rosendahl, H.B. Storrøsten	Oil consumption subsidy removal in OPEC and other Non-OECD countries.	Discussions papers 846, Statistisk sentralbyrå	2016
Aune, F.R., A.C. Bøeng, S. Kverndokk, L. Lindholt, K.E. Rosendahl	Drivstoffeffektivisering – fører det til mindre bruk av olje?	Økonomiske analyser, 4/2015 S69-73	2015
Aune, F.R., R. Golombek, A. Moe, K.E. Rosendahl, H.H. Le Tissier	Ekssport av russisk gass til Europa.	Samfunnsøkonomen, Nr 1 2016	2016
Aune, F.R., R. Golombek, H.H. Le Tissier, S. Jaehnert, S. Völler, O. Wolfgang	Mot et grønnere Europa: Virkninger av EUs klimapolitikk for 2030.	Samfunnsøkonomen, Nr 3 2015	2015
Aune, F.R., T. Fæhn	Makroøkonomisk analyse for Norge av klimapolitikken i EU og Norge mot 203.	Rapporter 2016/25, Statistisk sentralbyrå	2016
Baldursson, F.M., E. Lazarczyk, M. Ovaere, S. Proost	Cross-border exchange and sharing of generation reserve capacity.	IAEE Energy Forum, Bergen Special Issue 2016, 29-30.	2016
Bjertnæs, G. H. M.	Efficient taxation of fuel and road use	Discussion Papers, No. 905 2019, Statistisk sentralbyrå	2019
Bjertnæs, G., H.	Effektive bilavgifter og bruk av bompenger.	Samfunnsøkonomen 2019 (4) s.20-28	2019
Borge, L.E., B. Bye, M. Hoel, K.E. Rosendahl	Oppfølging av Grønn skattekommissjon.	Samfunnsøkonomen, Nr 5 2016	2016
Brekke, K.A., R. Golombek, M. Kaut, S.A.C. Kittelsen, S.W. Wallace	Modellering av usikkerhet i numeriske likevektsmodeller med stokastisk scenariometode.	Samfunnsøkonomen, Nr 2 2013	2013
Bruvoll, A., H.M. Dalen	Mange motiver i klimapolitikken.	Samfunnsøkonomen, Nr 1 2015	2015
Bye, B., C. Hagem, B. Halvorsen og B.M. Larsen	Evaluering av virkemidler for å fremme energieffektivisering. En oversikt over økonomisk litteratur	Rapporter 2016/16, Statistisk sentralbyrå.	2016
Bye, B., K. Espegren, T. Fæhn, E. Rosenberg, O. Rosnes	Energiteknologi og energiøkonomi: Analyser av energipolitikk i to ulike modelltradisjoner	Samfunnsøkonomen, Nr. 6, 2016	2016
Bye, B., K.E. Rosendahl	Karbonlekkasje: Årsaker og virkemidler.	Samfunnsøkonomen nr 1 2012	2012
Bye, B., K.P. Hagen	Gjennomgang og revisjon av rammeverket for samfunnsøkonomiske analyser.	Samfunnsøkonomen, Nr 1 2013	2013

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Author	Title	Publication	Year
Bye, B., M. E. Klemetsen, A. Raknerud.	The impact of public R&D support on firms' patenting.	Discussion Papers, No. 911 2019, Statistisk sentralbyrå	2019
Bye, B., T. Fæhn, O. Rosnes.	Marginal abatement costs under EU's effort sharing regulation-A CGE analysis	Rapporter 2019/10, Statistisk sentralbyrå	2019
Bøeng, A.C., B. Halvorsen, B.M. Larsen	Vil subsidiering av energieffektivt utstyr løse miljøproblemene?.	Økonomiske Analyser 5/2011, Statistisk sentralbyrå.	2011
Bøeng, A.-C., B. Halvorsen, B.M. Larsen	Fører effektiviseringstiltak til uønskede adferdsendringer?.	RØST nr 1 2013	2013
Bøeng, A.C., O. Rosnes	Virkinger av Energieffektiviseringsdirektivet i Norge.	Økonomisk analyse 5/2013	2013
Böhringer, C., B. Bye, T. Fæhn, K.E. Rosendahl	Karbontoll som virkemiddel mot karbonlekkasje – en sammenlikning av ulike tollscenarioer.	Økonomiske Analyser 2/2012, Statistisk sentralbyrå.	2012
Böhringer, C., K. E. Rosendahl, H. B. Storrøsten.	Smart hedging against carbon leakage.	Discussion Papers, No. 920 2019, Statistisk sentralbyrå	2019
Böhringer, C., K.E. Rosendahl, H.B. Storrøsten	Smarte virkemidler mot karbonlekkasje.	Samfunnsøkonomen, Nr 2 2016	2016
Dietz, D.J. Frame, R. Hahn, J.K. Hammitt, C. Hepburn, M. Hoel, C.D. Kolstad, A. Lange, R. Mendelsohn, K. Nyborg, I.W.H. Parry, P. Passell, K. Richards, R. Ritz, T.C. Schelling, M. Tavoni, A. Ulph, H.R.J. Vollebergh, A. Xepapadeas	Thinking through the climate change challenge.	Open letter, 16 January, VoxEU: Research-based policy analysis and commentary from leading economists.	2011
Fæhn, T.	Den vriene klimapolitikken. Finnes det råd for et lite land med god råd?	Samfunnsøkonomen, Nr 3 2014	2014
Fæhn, T.	Norske klimaløft etter Paris-løftene - En vurdering av Norges løfter og mål for 2030.	Samfunnsøkonomen, Nr 2 2016	2016
Fæhn, T.	Utvikling av klimateknologier - hvordan kan Norge bidra?.	Økonomiske analyser 6/2012, Statistisk sentralbyrå	2012
Fæhn, T., C. Hagem, K.E. Rosendahl	Norsk olje- og gassproduksjon: Effekter på globale CO2-utslipp og energisituasjonen i lavinntektsland.	SSB Rapporter 31/2013	2013
Fæhn, T., C. Hagem, L. Lindholt, K.E. Rosendahl	Er oljekutt god klimapolitikk?	Forskningsnytt, Samfunnsøkonomen, Nr 2 2016	2016
Fæhn, T., C. Hagem, L. Linholt, S. Mæland, K.E. Rosendahl	Oljekutt og klimapolitikk.	Samfunnsøkonomen, Nr 9 2013	2013

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Author	Title	Publication	Year
Fæhn, T., G. Asheim, M. Greaker, C. Hagem, B. Harstad, M. Hoel, D. Lund, K. Nyborg, K. E. Rosendahl, H. Storrøsten	Parisavtalen og oljeeksporten	Samfunnsøkonomen, Nr 3 2018	2018
Fæhn, T., G. Asheim, M. Greaker, C. Hagem, B. Harstad, M. Hoel, D. Lund, K. Nyborg, K. E. Rosendahl, H. Storrøsten	Parisavtalen og oljeeksporten	Energi og klima 21.6.18	2018
Fæhn, T., M. Greaker	Forslag til klimalov Samfunnsøkonomen.	Forslag til klimalov Samfunnsøkonomen, Nr 6 2016	2016
Fæhn, T., P. E. Stoknes	Significant and plausible futures - Global surroundings of Norway's climate strategies	Rapporter 2018/2, Statistisk sentralbyrå	2018
Førsund, F.R.	Innfasing av vindkraft.	Samfunnsøkonomen nr 3 2011, 46-54	2011
Gavenas, E., K.E. Rosendahl	Hva påvirker CO2-utslippene på norsk sokkel?.	Samfunnsøkonomen Nr. 8 2014, 22-31.	2014
Golombek, R., F.R. Aune, H.H. Le Tissier	Phasing out nuclear power in Europe.	IAEE Energy Forum Index, Bergen Special Issue 2016, 11-12	2016
Golombek, R., M. Greaker and S. Kverndokk	Hva er framtiden for CCS?	Samfunnsøkonomen 2019 (5) s.54-65	2019
Golombek, R., S. Kverndokk	Paris-avtalen: Konsekvenser for EU og Norge.	Samfunnsøkonomen, Nr 2 2016	2016
Golombek, R., S.A.C. Kittelsen, K.E. Rosendahl	Tildeling av klimavoter i Europa.	Samfunnsøkonomen Nr 2 2012	2012
Greaker, M.	Innretning av støtte til biodrivstoff.	Økonomiske Analyser 5/2011, Statistisk sentralbyrå.	2011
Greaker, M. og M. Kristoffersen	Lading av elbiler: Bør vi godta flere standarder?	Samfunnsøkonomen, Nr 4 2017	2017
Greaker, M., C. Hagem, J. Hovi	Hvordan kan en internasjonal klimaavtale håndheves?.	Samfunnsøkonomen, Nr 2 2013	2013
Greaker, M., C. Hagem, S. Proost.	Vehicle-to-Grid: Impacts on the electricity market and consumer cost of electric vehicles.	Discussion Papers, No. 903 2019, Statistisk sentralbyrå	2019
Greaker, M., O. Rosnes	Robuste norske klimamålsetninger.	Samfunnsøkonomen, Nr 1 2015	2015
Grimsrud, K., I. V. Sem, H. Lindhjem, K. E. Rosendahl.	Preferanser for Grønn skattekommisjons foreslåtte avgifter på rødt kjøtt og veitrafikk.	Samfunnsøkonomen 2019 (2) s.40-53	2019
Grimsrud, K., I. Vestre Sem, H. Lindhjem, K. E. Rosendahl.	Public acceptance and willingness to pay costeffective taxes on red meat and road traffic in Norway.	Discussion papers, No. 909 2019, Statistisk sentralbyrå	2019
Grimsrud, K.M., K.E. Rosendahl, H.B. Storrøsten	Skifergassrevolusjonen og det europeiske gassmarkedet.	Økonomisk analyser, 4/2013	2013
Grimsrud, K.M., M. Greaker	Hvordan sikre bærekraftig forvaltning av økosystemer?.	Samfunnsøkonomen, Nr 4 2013 (127), 25-33	2013

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Author	Title	Publication	Year
Hagem, C.	Energieffektivisering erstatter fornybarmål: Fra vondt til verre.	Leder Samfunnsøkonomen, Nr 3 2016	2016
Hagem, C.	Grønn bølge.	Leder Samfunnsøkonomen, Nr 6 2016	2016
Hagem, C.	Klimameldingen – svake mål og svake virkemidler.	Samfunnsøkonomen Nr 5 2012	2012
Hagem, C.	Vindkraft.	Samfunnsøkonomen, Nr 3 2015	2015
Hagem, C., B. Holtsmark, T. Sterner	NOx-fondet gir ikke en kostnadseffektiv løsning.	Samfunnsøkonomen, Nr 5 2014	2014
Hagem, C., B. Holtsmark, T. Sterner	Om den norske politikken for reduksjon av utslipp av NOx.	Samfunnsøkonomen, Nr 2 2014	2014
Hagem, C., H.B. Storrøsten	Supply versus demand-side policies in the presence of carbon leakage and the green paradox.	Discussion paper, Nr 836 Statistics Norway	2016
Halvorsen, B.	Vi fryser for å spare energi.	Økonomiske analyser, 2/2013	2013
Halvorsen, B., B.M. Larsen	Hvem eier varmepumpe og hva gjør det med strømforbruket?.	Økonomiske analyser, 2/2013	2013
Harstad, B.	På jakt etter den beste utslipsavtalen.	Samfunnsøkonomen, Nr 1 2015	2015
Hauge, K. E.	Når Viljar, Egil og Rasmus skal investere i energibesparende teknologi.	Samfunnsøkonomen, Nr 1 2014	2014
Heggedal, T.R., K.E. Rosendahl	Norsk klimapolitikk i et globalt perspektiv.	Magma 05/2015, 65-77	2015
Hoel, M.	Bør vi subsidiere fornybar energi?.	Samfunnsøkonomen, Nr 2 2013	2013
Holtsmark, B.	Bioenergi fra skog gjør trolig mer skade enn fossil olje – et tilsvarende.	Samfunnsøkonomen Nr 6 2012	2012
Holtsmark, B.	Elbilpolitikken – virker den etter hensikten?.	Samfunnsøkonomen Nr 5, 8 og 9 2012	2012
Holtsmark, B.	Skog, bioenergi og klima.	Samfunnsøkonomen Nr 4 2012	2012
Kaushal, K. R., L. Lindholt, H. Yonezawa.	Effects of changes in electricity prices on the power-intensive industries and other sectors in Norway towards 2030.	Rapporter 2019/43, Statistisk sentralbyrå	2019
Kverndokk, S.	Nytt senter for samfunnsøkonomisk energiforskning.	Klima, 3-11, 32-33.	2011
Kverndokk, S., E. Nævdal, L. Nøstbakken	Rettferdige klimaavtaler.	Samfunnsøkonomen, Nr 2 2014	2014
Kverndokk, S., K.E. Rosendahl	Oil price effects of transport regulation.	EAERE Newsletter, European Association for Environmental and Resource Economists, 9-12	2012
Lindhjem, H. et al	Vindkraft i motvind – Miljøkostnadene er ikke til å blåse av.	Samfunnsøkonomen 2019 (4) s.6-17	2019

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Author	Title	Publication	Year
Lindholt, L.	Dragkampen mellom knapphet og teknologisk fremgang i oljemarkedet.	Økonomisk analyser, 4/2013	2013
Lindholt, L.	Effects of higher required rates of return on the tax take in an oil province.	Discussion papers, No. 892 2019, Statistisk sentralbyrå	2019
Lindholt, L.	Energy in the SNOW model: Description of production and consumption of energy in Norway in the base year 2013.	Rapporter 2019/22, Statistisk sentralbyrå	2019
Lund, D.	Er petroleumsvirksomheten subsidiert?.	Samfunnsøkonomen Nr 4 2012	2012
Nesje, F.	Cross-dynastic Intergenerational Altruism.	PDF	2019
Nesje, F., D. Lund	Risikojustering av kalkulasjonsrenta i samfunnsøkonomiske analysar	Samfunnsøkonomen,Nr 4 2018	2018
Nyborg, K.	No Man is an Island - Social coordination and the Environment.	Memorandum from Department of Economics, University of Oslo(07/2019)	2019
Rosendahl, K.E.	Elektrifisering og klimapolitikk.	Samfunnsøkonomen Nr. 5 2014, 14-17.	2014
Rosnes, O.	Wind power requires flexible market and subsidy design.	IAEE Energy Forum Third Quarter 2012	2012
Traeger, C., Perino, G., Pittel, K., Requate, T. Schmitt, A.	Das Flexcap – eine innovative CO2-Bepreisung für Deutschland	ifo Institut, München, 2019 ifo Schnelldienst, 2019, 72, Nr. 18, 38-45	2019
Weitzman, M. L., B. Holtmark	On the effects of linking voluntary cap-and-trade systems for CO2 emissions	Discussion Papers,No. 883 2018, Statistisk sentralbyrå	2018

Appendix 3d Other Scientific Publications

Other Scientific Publications

Author	Title	Publication	Year
Aune, F.R., A.C. Bøeng, S. Kverndokk, L. Lindholt, K.E. Rosendahl	Fuel Efficiency Improvements - Feedback Mechanisms and Distributional Effects in the Oil Market.	CESifo Working Paper No. 5478 (August 2015)	2015
Banet C.	Electricity Network Tariffs Regulation and Distributive Energy Justice: Balancing the Need for New Investments and a Fair Energy Transition	In del Guayo et al (eds.) Energy Justice and Energy Law: Distributive, Procedural, Restorative and Social Justice in Energy Law, Chapter 6. (forthcoming)	2019
Banet C.	Prosumers regulation in Norway: a First Step for Empowering Small Energy Consumers	in Roggenkamp and Banet (eds.), European Energy Law Report XII, Intersentia, 2018, Chapter 8, ISBN 9781780686721	2018
Battaglini, M., B. Harstad	The Political Economy of Weak Treaties.	NBER working paper w22968	2016
Bjertnæs, G.H.M., C. Hagem	Utviklingen i energiforbruket.	Oppdragsrapport for OED I forbindelse med deres arbeid med Energimeldingen.	2015
Boucekkine, R., P.G. Piacquadio, F. Prieur	A Lipsetian Theory of Institutional Change.	Aix-Marseille School of Economics. working paper No. 12/2015	2015
Brekke, K. A., A. Ciccone, T. R. Heggedal, L. Helland	Reference points in sequential bargaining: theory and experiment.	CESAR Working paper No. 3/15	2015
Brekke, K.A., J. Konow, K. Nyborg	Cooperation is Relative: Income and Framing Effects with Public Goods.	Memorandum 16/2012, Department of Economics, University of Oslo.	2012
Brekke, K.A., R. Golombek, M. Kaut, S.A.C. Kittelsen, S.W. Wallace	The Impact of Uncertainty on the European Energy Market: A Scenario Aggregation Approach.	CESifo Working Paper No. 4500, November 2013.	2013
Bråten, J.	En kostnadseffektiv og virkningsfull klimapolitikk.	Norsk Klimastiftelse, Rapport nr. 04/2014	2014
Bye, B., C. Hagem, B. Halvorsen, B.M. Larsen	Effekter av virkemidler for å fremme energieffektivisering.	Oppdragsrapport for OED I forbindelse med deres arbeid med Energimeldingen.	2015
Bye, B., M. E. Klemetsen	The impacts of alternative policy instruments on environmental performance: A firm level study of temporary and persistent effects	Discussion Papers No. 788, Statistics Norway	2014
Bye, B., S. Kverndokk, E. Verdolini	Summary of some ENTRACTE/CREE papers.	ENTRACTE Newsletter No. 3, 5-7	2015
Bye, B., T. Fæhn, O. Rosnes	Residential energy efficiency and European carbon policies: A CGE-analysis with bottom-up information on energy efficiency technologies	Discussion Papers No. 817, Statistics Norway	2015
Böhringer, C., K.E. Rosendahl, H.B. Storrøsten	Mitigating Carbon Leakage: Combining Output-Based Rebating with a Consumption Tax.	CESifo Working Paper No. 5459 (July 2015)	2015
Böhringer, C., K.E. Rosendahl, H.B. Storrøsten	Smart hedging against carbon leakage.	SSB Discussion Papers No. 822	2015

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Author	Title	Publication	Year
Böhringer, C., K.E. Rosendahl, H.B. Storrøsten	Smart hedging against carbon leakage.	Working Papers No. 14/2015, School of Economics and Business, Norwegian University of Life Sciences	2015
Ciccone, A.	Decision making in environmental-related dilemmas: From natural to laboratory experiments	PhD thesis, University of Oslo 2015	2015
Ciccone, A.	Environmental effects of a vehicle tax reform: evidence from Norway.	Memorandum 3/15	2015
Dengler S., R. Gerlagh, S. Trautman, G. van der Kuilen	Climate Policy Commitment Devices	FEEM WP 49.2017	2017
Fischer, C., M. Greaker, K.E. Rosendahl	Are Renewable Energy Subsidies in Need of Reform?.	J. Strand (eds.): The Economics and Political Economy of Energy Subsidies, CESifo Seminar Series, Cambridge, MA: The MIT Press.	2016
Fischer, C., M. Greaker, K.E. Rosendahl	Robust Policies against Emission Leakage: The Case for Upstream Subsidies	CESifo Working Paper No. 4742	2014
Fæhn T.	Klimasamarbeidet med EU: Lindring eller hindring for Norges grønne skifte?.	SSB analyse 2019 Statistisk sentralbyrå	2019
Fæhn, T., B. Strøm	Modellering av klimavotesystem for fremskrivninger i MSG6, Dokumentasjon og veiledning.	Notater 53/2012, Statistisk sentralbyrå.	2012
Fæhn, T., K. Jacobsen	Makroanalyser i tilknytning til Klimameldingen 2012.	Rapporter 22/2012, Statistisk sentralbyrå.	2012
Førsund, F.	Hydropower Economics.	(Authors: F. Førsund). Second Edition. New York; Springer Science & Business Media	2015
Gabriel, S.A., A. Moe, K.E. Rosendahl, M. Tsygankova	The Likelihood and Potential Implications of a Natural Gas Cartel.	in R. Fouquet (ed.): Handbook on energy and climate change, Cheltenham, UK: Edward Elgar Publishing.	2013
Gavenas, E., K.E. Rosendahl, T. Skjerpen	CO2-emissions from Norwegian oil and gas extraction.	SSB Discussion Papers, NR 806	2015
Gerlagh, R., Bijgaart, I. van den, H. Nijland, T. Michielsen	Fiscal policy and CO2 emissions of new passenger cars in the EU.	CPB Discussion Papers, NR 302	2015
Golombek, R., F.R. Aune, H. Hallre, B. Knopf, P. Nahmmacher, E. Schmid	Renewable energy supply in Europe addressing technological and political preconditions.	Entracte Report	2015
Golombek, R., M. Greaker, S. Kverndokk	Virkemidler som kan fremme utvikling og bruk av miljøteknologi, (Policy measures that can promote the development and use of green technology)	Attachment 3 to the report by the Green Tax Commission (NOU 2015:15), Ministry of Finance, Norway	2015

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Author	Title	Publication	Year
Greaker, M.	Strategic Environmental Policy.	In: Shogren, J.F., (ed.) Encyclopedia of Energy, Natural Resource, and Environmental Economics, Vol. 3, 313-320 Amsterdam: Elsevier	2013
Greaker, M. A., og K. E. Rosendahl	Petroleumsvirksomhet i Barentshavet sørøst-om klima, økonomi og sysselsetting	GREENPEACE	2017
Green, R.J.	Markets, Governments and Renewable Energy.	n (ed.) C. Donovan, Renewable Energy Finance, 105-129, London, Imperial College Press, ISBN 978-1-78326-776-7	2015
Green, R.J., T.O. Leautier	Do costs fall faster than revenues? Dynamics of renewables entry into electricity markets.	TSE Working Papers, n. 15-591, July 2015.	2015
Green, R.J., Y. Mulugetta, Z.X. Zhang	Sustainable Energy Policy.	in (eds) G. Atkinson, S. Dietz, E. Neumayer and M. Agarwala, Handbook of Sustainable Development, 2nd Edition, 532-550, Cheltenham, Edward Elgar, ISBN 978-1-78254-469-2.	2014
Grimsrud, K., K. E. Rosendahl, H. B. Storrøsten, M. Tsygankova	Short run effects of bleaker prospects for oligopolistic producers of a nonrenewable resource.	Discussion Papers, Statistics Norway Research department, No. 733	2013
Hagem, C., M. Hoel, B. Holtmark, T. Sterner	Refunding Emissions Payments.	RFF Discussion paper No. 15-05	2015
Halvorsen, B.	Utviklingen i strømforbruket, prisfølsomheten og strømmarkedet.	SSB Publikasjoner - rapporter	2012
Halvorsen, B., H. M. Dalen	"Ta hjemmetempen" : rapport fra Forskningskampanjen 2012.	Rapporter 13/2013, Statistisk sentralbyrå.	2013
Harstad, B., F. Lancia, A. Russo	Compliance Technology and Self-Enforcing Agreements	CESifo WP no. 5562	2015
Harstad, B., M. Liski	Games and Resources.	Encyclopedia of Energy, Natural Resource, and Environmental Economics, , Vol. 2, 2013, 299-308	2013
Hoel, M.	Carbon taxes and the green paradox.	In R. Hahn and U. Ulph (eds.): Climate Change and Common Sense: Essays in Honour of Tom Schelling, Oxford University Press, ch. 11, 203-224.	2012
Hoel, M.	Supply Side Climate Policy and the Green Paradox	CESifo Working Paper No. 4094	2013
Hoel, M.	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.	The Rise and Fall of Bioenergy	CESifo Working Paper No. 6971	2018

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Author	Title	Publication	Year
Hoel, M.	Klimatpolitikk og ledarskap – vilken rolle kan et lite land spille?	Rapport til Expertgruppen for miljøstudier (2012: 3)	2012
Hoel, M., A. de Zeeuw	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
Hoel, M., S.A.C. Kittelsen, S. Kverndokk	Pareto Improving Climate Policies: Distributing the benefits across generations and regions.	CESifo Working Paper No. 5487 (August 2015)	2015
Holtmark, B.	International cooperation on climate change: why is there so little progress?.	Chapter 13 in R. Fouquet (ed) Handbook on Energy and Climate Change. Edward Elgar Publishing Ltd.	2013
Holtmark, B.	Seven essays on policies and international cooperation to abate emissions of greenhouse gases.	Doctoral thesis, University of Oslo.	2016
Holtmark, Katinka Kristine; Midttømme, Kristoffer.	The Dynamics of Linking Permit Markets.	CESifo Working Paper No. 7548	2019
Horn, J.P.	Fornybársatsingen og lov om elsertifikater - en rettsøkonomisk analyse.	PrivIus- Journal of private law, Nr 198-2015	2015
Jaakkola, N., D. Spiro, A. van Benthem	Finders Keepers.	NBER working paper w22421	2016
Karp L. S. C. Traeger	Prices versus Quantities Reassessed	CESifo Working Paper No. 7331	2018
Klemetsen, M.	Policy incentives for firm behaviour. 4 articles on environmental innovation and emissions.	Doctoral thesis, University of Oslo.	2016
Klemetsen, M. E.	The effects of innovation policies on firm level patenting	Discussion paper no 830, Statistics Norway	2015
Klemetsen, M.E., K.E. Rosendahl, A.L. Jakobsen	The impacts of the EU ETS on Norwegian plants' emissions, value added and productivity	Discussion Paper 833, Statistics Norway	2015
Kverndokk, S.	Moral positions on tradable permit markets - Handbook on Energy and Climate Change.	Chapter 22 in R. Fouquet (ed) Handbook on Energy and Climate Change. Edward Elgar Publishing Ltd. .	2013
Kverndokk, S.	Økonomiske virkemidler i miljøpolitikken.	P. Hagen and G.Holst Volden (eds.): Investeringsprosjekter og miljøkonsekvenser. En antologi med bidrag fra 16 forskere, Concept rapport nr 48, NTNU, Trondheim: Ex ante akademisk forlag, 100-113.	2016
Kverndokk, S., C. Hagem	Klimaendringer.	chapter 8 in O. Flåten and A. Skonhoft (eds.): Naturressursenes økonomi, Gyldendal.	2014
Kverndokk, S., E. Nævdal, L. Nøstbakken	The Trade-off between Intra- and Intergenerational Equity in Climate Policy.	CESifo Working Paper No. 4285, June 2013	2013

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Author	Title	Publication	Year
Kverndokk, S., S. Schjølset, J.B. Skjærseth, B. Tennbakk, J. Wolst, A. Bolle, A.M. Knudsen, L.E. Omland, D.R. Christensen, K. Kroepelien, J. Stene	Measures to reduce GHG-emissions in non-ETS sectors in Norway towards 2030 – the role of flexibility mechanisms in Europe.	THEMA Memo 2015-06	2015
Nesje, F., G.B. Asheim	Intergenerational Altruism: A Solution to the Climate Problem?	Handbook on the Economics of Climate Change, Vol. 2.	2019
Nyborg K.	Skriftlige kommentarer fra særskilt sakkyndig til Økonomi og Miljø 2019, formannskapets diskusjonsopplegg til Danmarks Miljøøkonomiske Råds møte 30.04.19	De Økonomiske Råd København s 193-194	2019
Nyborg, K.	Reciprocal Climate Negotiators: Balancing Anger against Even More Anger	Memorandum, 17/2014, Department of Economics, University of Oslo	2014
Nyborg, K.	Skriftlige kommentarer til Vismandsrapporten 2016.	Danmarks Miljøøkonomiske råd.	2016
Nyborg, K.	Skriftlige kommentarer til Vismandsrapporten Økonomi og miljø 2018	Danmarks Miljøøkonomiske råd. 2018, s. 251-253	2018
Nyborg, K.	The Ethics and Politics of Environmental Cost-Benefit Analysis.	Routledge Explorations in Environmental Economics series	2012
Nævdal, E.	Catastrophes and ex post shadow prices—How the value of the last fish in a lake is infinity and why we should not care (much)	Memo 8/2015, Department of Economics, UiO	2015
Nævdal, E.	Safe Minimum Standard (SMS).	Encyclopedia of Sustainability, Vol. 5, 352-353	2013
Parchomovsky, G., E. Stavang	The Green Option.	Minnesota Law Review. Vol. 99, Nr 3-2015.	2015
Piacquadio, P.G.	The Ethics of Intergenerational Risk.	Memorandum 15/2015	2015
Roine, J., D. Spiro	Utvinning för allmän vinning – en ESO-rapport om svenska mineralinkomster.	Expertgruppen för studier i offentlig ekonomi 2013: 9	2013
Rosenberg, E.	Energieffektivisering i bygninger – norske potensialstudier.	Institutt for energiteknikk, rapport IF/KR/F-2012/079	2013
Rosendahl, K.E.	Miljøgevinster av å subsidiere fornybar energiteknologi.	P. Hagen and G.Holst Volden (eds.): Investeringsprosjekter og miljøkonsekvenser. En antologi med bidrag fra 16 forskere, Concept rapport nr 48, NTNU, Trondheim: Ex ante akademisk forlag, 147-159.	2016
Rosendahl, K.E., O. Schenker	Efficiency, feasibility and effectiveness of various BTA designs.	Entracte-rapport.	2015

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Author	Title	Publication	Year
Rosnes, O., B. Bye og T. Fæhn	SNOW-modellen for Norge - Dokumentasjon av framskrivningsmodellen for norsk økonomi og utslipp	Notater 2019/01, Statistisk sentralbyrå	2019
Rønneberg, S., A. Lind	Comparison of Various Energy Storage Technologies & Operation, Costs and Technological Maturity	IFE - Institute for Energy Technology Report IFE/KR/F-2015/111	2015
Searchinger, T. D., T. Beringer, B. Holtsmark, D. M. Kammen, E. F. Lambin, W. Lucht, P. Raven, J.-P. van Ypersele	Europe's renewable energy directive poised to harm global forests	Comment, Nature Communications 9 (1):3741	2018
Smulders, S.	Making green sources of growth more inclusive.	in Luiz De Mello and Mark Dutz (ed.) Promoting Green Growth: Challenges and policies, Chapter 4, pp. 119-145. Paris: OECD, 2012.	2012
Smulders, S., Y. Tsur, A. Zemel.	Uncertain climate policy and the green paradox	in Elke Moser, Willi Semmler, Gernot Tragler, Vladimir Veliov (eds) Dynamic Optimization in Environmental Economics . Berlin/Heidelberg: Springer-Verlag, 2014, Chapter 7.	2014
Spiro, D.	Ändliga resurser.	Chapter in Nationalekonomi för miljöintresserade, ed. Stavlot U. Ivrig förlag, ISBN 91-87379-09-0	2013
Staffell, I., I.G. Hamilton, R.J. Green	Risk The Residential Energy Sector.	in (eds.) I. Staffell, D.J.L. Brett, N.P. Brandon and A.D. Hawkes, Domestic Microgeneration: Renewable and Distributed Energy Technologies, Policies and Economics, 18-48, London, Routledge, ISBN 978-0-415-81041-8	2015
Strøm, S., J. Vislie	Wealth Management and Uncertain Tipping Points.	CESifo Working Paper No. 7487	2019
Ulfstein, G., C. Voigt	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	2014
Voigt, C.	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.	2014
Voigt, C.	The Principle of Sustainable Development: Integration and Ecological Integrity.	in: C. Voigt (ed.) 'Rule of Law for Nature', Cambridge University Press, 146-157.	2013

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von der Fehr, N.H.M.	Under pressure: European electricity markets and the need for reform.	In Ian Parry; Karen Pittel & Herman R. J. Vollebergh (ed.), Energy Tax and Regulatory Policy in Europe: Reform Priorities. MIT Press. ISBN 978-0-262-02788-5. Kapittel. s 67 - 94	2016
von der Fehr, N.H.M., S. Ropenus	Green Certificates, Vertical Relations and Market Power	Paper, Department of Economics, University of Oslo	2013
Webb, R., R.J. Green	Impact on Electricity Markets.	in Liu, C.C., S. McArthur and S-J. Lee Handbook of Smart Grids, Chichester, Wiley. Vol. 3 - 78, ISBN 978-1-118-75548-8	2016
Wessman, S., B. Halvorsen, B.M. Larsen	Statlige og kommunale tilskuddsordninger for elektrisitetssparing i husholdninger - Dokumentasjon 1970-2012.	Notater 67/2012, Statistisk sentralbyrå.	2012
Wessman, S., B. Halvorsen, B.M. Larsen	Statlige og kommunale tilskuddsordninger for elektrisitetssparing i husholdninger.	Dokumentasjon 1970-2012. Notater 67/2012, Statistisk sentralbyrå.	2012
Wessman, S., B. Halvorsen, B.M. Larsen	Sørggifter relatert til husholdningenes energiforbruk, Dokumentasjon 1970-2012.	Notater 66/2012, Statistisk sentralbyrå.	2012
Wilhite, H.	The Political Economy of Low Carbon Transformation: Breaking the Habits of Capitalism.	London: Routledge.	2016
Winther, T., H. Wilhite, K. Standal	Strømbrok i husholdninger: Effekter av display.	CICERO	2014

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Author	Title	Publication	Year
Aakenes, S.	From Moon-walking towards Moon-landing: How might CCS leave the Launch Pad?	CREE WP 13/2014	2014
Andersen, J. J., M. Greaker	The Fiscal Incentive of GHG Cap and Trade: Permits May Be Too Cheap and Developed Countries May Abate Too Little	CREE WP 08/2014	2014
Aune, F. R., R. Golombek	Carbon prices are redundant in the 2030 EU climate and energy policy package	CREE WP 10/2018	2018
Aune, F.R., A.C. Bøeng, S. Kverndokk, L. Lindholt, K.E. Rosendahl	Fuel efficiency improvements – feedback-mechanisms and distributional effects in the oil market	CREE WP 11/2015	2015
Aune, F.R., R. Golombek, A. Moe, K.E. Rosendahl, H. Hallre Le Tissier	Eksport av russisk gass til Europa	CREE WP 02/2016	2016
Aune, F.R., R. Golombek, H. Hallre Le Tissier	Phasing out nuclear power in Europe	CREE WP 05/2015	2015
Aune, F.R., R. Golombek, H. Hallre Le Tissier, S. Jaehnert, S. Völler, O. Wolfgang	Mot et grønnere Europa: Virkninger av EUs klimapolitikk for 2030	CREE WP 01/2015	2015
Baldursson, F., N.H.M. von der Fehr	Natural Resources and Sovereign Expropriation	CREE WP 07/2015	2015
Baldursson, F.M., E. Lazarczyk, M. Ovaere, S. Proost	Cross-border exchange and sharing of generation reserve capacity	CREE WP 14/2016	2016
Beisland, C.S.	From Targets and Timetables to Technology Investments	CREE WP 12/2013	2013
Bijgaart, I. van den	The Unilateral Implementation of a Sustainable Growth Path with Directed Technical Change	CREE WP 15/2014	2014
Birkelund, H.	Oppvarming og innetemperaturer i norske barnefamilier: En analyse av husholdningenes valg av innetemperatur	CREE WP 13/2013	2013
Bjertnæs, G.H.	Are tax exemptions for electric cars an efficient climate policy measure?	CREE WP 21/2013	2013
Bjertnæs, G.H.	Biofuel mandate versus favourable taxation of electric cars: The case of Norway	CREE WP 20/2013	2013
Bjørnebye, H. C. Hagem, A. Lind	Optimal location of renewable power	CREE WP 04/2017	2017
Brekke, K.A., R. Golombek, M. Kaut, S.A.C. Kittelsen, S. Wallace	The Impact of Uncertainty on the European Energy Market: The scenario aggregation method	CREE WP 04/2013	2013

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Brekke, K.A., R. Haugli Braaten, O. Røgeberg	Buying the right to do wrong - An experimental test of moral objections to trading emission permits	CREE WP 19/2014	2014
Bruvoll, A., H.M. Dalen, B.M. Larsen	Political motives in climate and energy policy	CREE WP 18/2012	2012
Bråten, R.H., E. Berge, H. Wiig, D. Kambewa, S. Khaila	Using trust games to predict tree planting in Malawi	CREE WP 03/2015	2015
Bråten, R.H., P. Martinsson	Experimental measures of household decision power	CREE WP 02/2015	2015
Bye, B. K.Espgren, T. Fæhn, E. Rosenberg, O. Rosnes	Energy technology and energy economics: Analyses of energy efficiency policy in two different model traditions	CREE WP 01/2018	2018
Bye, B., M.E. Klemetsen	The impacts of alternative policy instruments on environmental performance: A firm level study of temporary and persistent effects	CREE WP 14/2014	2014
Bye, B., T. Fæhn, O. Rosnes	Marginal Abatement Costs under EU's Effort Sharing Regulation - A CGE analysis	CREE WP 03/2019	2019
Bye, B., T. Fæhn, O. Rosnes	Residential energy efficiency and European carbon policies: A CGE-analysis with bottom-up information on energy efficiency technologies	CREE WP 18/2015	2015
Böhringer, C. K. E. Rosendahl, H. B. Storrøsten	Smart hedging against carbon leakage	CREE WP 09/2019	2019
Böhringer, C., B. Bye, T. Fæhn, K.E. Rosendahl	Alternative Designs for Tariffs on Embodied Carbon: A Global Cost-Effectiveness Analysis	CREE WP 01/2012	2012
Böhringer, C., B. Bye, T. Fæhn, K.E. Rosendahl	Output-based rebating of carbon taxes in the neighbor's backyard Competitiveness, leakage and welfare	CREE WP 06/2014	2014
Böhringer, C., B. Bye, T. Fæhn, K.E. Rosendahl	Targeted carbon tariffs – Carbon leakage and welfare effects	CREE WP 09/2015	2015
Böhringer, C., C. Fischer, K.E. Rosendahl	Cost-Effective Unilateral Climate Policy Design: Size Matters	CREE WP 05/2012	2012
Böhringer, C., J.C. Carbone, T.F. Rutherford	Embodied carbon Tariffs	CREE WP 25/2013	2013
Böhringer, C., J.C. Carbone, T.F. Rutherford	The Strategic Value of Carbon Tariffs	CREE WP 24/2013	2013
Böhringer, C., K.E. Rosendahl, J. Schneider	Unilateral Climate Policy: Can OPEC resolve the leakage problem?	CREE WP 05/2013	2013
Böhringer, C., N. Rivers, H. Yonezawa	Vertical fiscal externalities and the environment	CREE WP 16/2015	2015

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Carbone, J., R.S. Gazzale	A Shared Sense of Responsibility: Money versus Effort Contributions in the Voluntary Provision of Public Goods	CREE WP 05/2011	2011
Casoria F., A. Ciccone	Do upfront investments increase cooperation? A laboratory experiment	CREE WP 02/2019	2019
Ciccone, A.	Voluntary contributions to bargaining: hold-up problem in the lab	CREE WP 08/2016	2016
Ciccone, A.	Environmental effects of a vehicle tax reform: empirical evidence from Norway	CREE WP 09/2014	2014
Ciccone, A., R. Bråten, O. Røgeberg	Fairness preferences in a bilateral trade experiment	CREE WP 10/2015	2015
Crampes C., N.-H. M. von der Fehr	Decentralised Cross- Border Interconnection	CREE WP 11/2018	2018
CREE	Synthesis report of Flagship I: Radical emissions reductions in ETS sectors	CREE WP 08/2018	2018
CREE	Synthesis report of Flagship II: Environmentally friendly transport	CREE WP 01/2020	2020
CREE	Synthesis report of Flagship III: Green innovations and utilization of smart technologies	CREE WP 09/2018	2018
CREE	Synthesis report of Flagship IV: Towards the low-emission society	CREE WP 02/2020	2020
Crépin, S. A., E. Nævdal	Inertia in risk; improving economic models of catastrophes	CREE WP 02/2017	2017
Dalen, H.M., B.M. Larsen	Residential end-use electricity demand - Development over time	CREE WP 17/2013	2013
Drupp, M., M.C. Freeman, B. Groom, F. Nesje	DISCOUNTING DISENTANGLED	CREE WP 06/2017	2017
Eggert, H., M. Greaker	Promoting second generation bioethanol: Does the first generation pave the road?	CREE WP 07/2014	2014
Elkadi, Nour-Eddine	Husholdningenes transport og miljøpolitikk - Modellering og virkemidler	CREE WP 08/2017	2017
Eyckmans, J., S. Fankhauser, S. Kverndokk	Development Aid and Climate Finance	CREE WP 15/2013	2013
Fischer, C., M. Greaker, K.E. Rosendahl	Emissions leakage and subsidies for pollution abatement. Pay the polluter or the supplier of the remedy?	CREE WP 12/2012	2012
Framstad, N.C.	The effect of small intervention costs on the optimal extraction of dividends and renewable resources in a jump-diffusion model	CREE WP 18/2014	2014

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Framstad, N.C.	When can environmental profile and emissions reductions be optimized independently of the pollutant level?	CREE WP 10/2013	2013
Framstad, N.C., J. Strand	Energy Intensive Infrastructure Investments with Retrofits in Continuous Time: Effects of Uncertainty on Energy Use and Carbon Emissions	CREE WP 09/2013	2013
Fæhn, T. et. al.	Parisavtalen og oljeeksporten	CREE WP 05/2018	2018
Fæhn, T., C. Hagem, L. Lindholt, S. Mæland, K.E. Rosendahl	Climate policies in a fossil fuel producing country: Demand versus supply side policies	CREE WP 11/2013	2013
Fæhn, T., E. Isaksen, K. Jacobsen, B. Strøm	MSG-TECH: Analysis and documentation of a general equilibrium model with endogenous climate technology adaptations	CREE WP 23/2013	2013
Fæhn, T., E. Thuestad Isaksen	Diffusion of climate technologies in the presence of commitment problems	CREE WP 01/2014	2014
Fæhn, T., E. Thuestad Isaksen, O. Rosnes	Kostnadseffektive tilpasninger til togradersmålet i Norge og EU fram mot 2050	CREE WP 22/2013	2013
Fæhn, T., P. E. Stoknes	Significant and plausible futures - Global surroundings of Norway's climate strategies	CREE WP 10/2017	2017
Førsund, F.	Hveding's Conjecture: On the Aggregation of a Hydroelectric Multiplant – Multireservoir System	CREE WP 17/2014	2014
Førsund, F.	Phasing in large-scale expansion of wind power in the Nordic countries	CREE WP 06/2012	2012
Førsund, F.	Pumped-Storage Hydroelectricity	CREE WP 14/2012	2012
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