Synthesis report of Flagship IV:
Towards the low-emission society.

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Abstract in Norwegian:

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Synteserapport Flaggskip IV: Mot lavutslippssamfunnet

I denne artikkelen har vi en oppsummering av hva som er gjort av arbeid i Flaggskip IV.

I kapittel 1 er det en enkel beskrivelse av hovedtemaer og forskerledere. Kapittel 2 inneholder de viktigste forskningstemaene og resultatene. I appendikset er det en oversikt over publiseringene.

Synthesis report of Flagship IV:

Towards the low-emission society

1 Overview

While Flagship I, II and III focus on specific sectors and technologies, this flagship aims 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.

It is headed by Senior Researcher Taran Fæhn at Statistics Norway and benefits from contributions from all partners, international colleagues and from multiple disciplines. Due to its generic features, it often integrates research from the other three flagships and it is also the most complex and diverse..

2. Research questions and main results

2.1 Greening the economy

This mast addresses 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. However, subjects related to how to divert R&D and innovation into greener (less brown) activities belong to Flagship III. Furthermore, energy-related emissions in Norway and the EU are covered by the Emission-Trading System in the EU (EU-ETS), which is a main theme of Flagship I. Specifically, the decarbonisation of the electricity markets are thoroughly covered in that flagship.

In the present flagship, the insight among CREE's researchers in the functioning of the *fossil fuel markets* has been particularly exploited. The research on policies directed towards greening the energy use has

addressed fossil fuel saving from both the demand/consumption and the supply/extraction side.

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.

2.2 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 Holtsmark (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-á-vis the ETS, vis-á-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-á-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 OBA 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 Zeew (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).

2.3 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 disproportionally 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).

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Publications Flagship IV

1. Scientific Journals

Author	Title	Publication	Year
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
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 inNature Climate Change	2020
Harstad, B.	Technology and Time Inconsistency	Journal of Political Economy (accepted)	2020
Holtsmark B., M. L. Weitzman	On the Effects of Linking Cap-and-Trade Systems for CO2 Emissions	Environmental and Resource Economics, 1–16	2020
Malcolm, J., B. Holtsmark, P. W. Piascik	Forest harvesting and the carbon debt in boreal east-central Canada.	Revise and resubmit to Climatic Change	2020
Wethal, U.	Practices, provision and protest: Power outages in rural Norwegian households.	Energy Research and Social Science 62.	2020
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
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2. Popular Science Journals			
Author	**Title**	**Publication**	**Year**
Bye, B., T.Fæhn, O. Rosnes.	Marginal abatement costs under EU's effort sharing regulation-A CGE analysis	Rapporter 2019/10, Statistisk sentralbyrå	2019
Böhringer, C., K. E. Rosendahl, H. B. Storrøsten.	Smart hedging against carbon leakage.	Discussion Papers,No. 920 2019, Statistisk sentralbyrå	2019
Lindhjem, H. et al	Vindkraft i motvind – Miljøkostnadene er ikke til å blåse av.	Samfunnsøkonomen 2019 (4) s.6-17	2019
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
Nesje, F.	Cross-dynastic Intergenerational Altruism.	PDF	2019
Nyborg, K.	No Man is an Island - Social coordination and the Environment.	Memorandum from Department of Economics, University of Oslo(07/2019)	2019
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., P. E. Stoknes	Significant and plausible futures - Global surroundings of Norway's climate strategies	Rapporter 2018/2, Statistisk sentralbyrå	2018
Nesje, F., D. Lund	Risikojustering av kalkulasjonsrenta i samfunnsøkonomiske analysar	Samfunnsøkonomen,Nr 4 2018	2018
Weitzman, M. L., B. Holtsmark	On the effects of linking voluntary cap-and-trade systems for CO2 emissions	Discussion Papers,No. 883 2018, Statistisk sentralbyrå	2018
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., T. Fæhn	Makroøkonomisk analyse for Norge av klimapolitikken i EU og Norge mot 203.	Rapporter 2016/25, Statistisk sentralbyrå	2016
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
Borge, L.E., B. Bye, M. Hoel, K.E. Rosendahl	Oppfølging av Grønn skattekommisjon.	Samfunnsøkonomen, Nr 5 2016	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
Böhringer, C., K.E. Rosendahl, H.B. Storrøsten	Smarte virkemidler mot karbonlekkasje.	Samfunnsøkonomen, Nr 2 2016	2016
Fæhn, T.	Norske klimaløft etter Paris-løftene - En vurdering av Norges løfter og mål for 2030.	Samfunnsøkonomen, Nr 2 2016	2016
Fæhn, T., M. Greaker	Forslag til klimalov Samfunnsøkonomen.	Forslag til klimalov Samfunnsøkonomen, Nr 6 2016	2016

Fæhn, T., C. Hagem, L. Lindholt, K.E. Rosendahl	Er oljekutt god klimapolitikk?	Forskningsnytt, Samfunnsøkonomen, Nr 2 2016	2016
Golombek, R., S. Kverndokk	Paris-avtalen: Konsekvenser for EU og Norge.	Samfunnsøkonomen, Nr 2 2016	2016
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Greaker, M., O. Rosnes	Robuste norske klimamålsetninger.	Samfunnsøkonomen, Nr 1 2015	2015
Harstad, B.	På jakt etter den beste utslipsavtalen.	Samfunnsøkonomen, Nr 1 2015	2015
Heggedal, T.R., K.E. Rosendahl	Norsk klimapolitikk i et globalt perspektiv.	Magma 05/2015, 65-77	2015
Fæhn, T.	Den vriene klimapolitikken. Finnes det råd for et lite land med god råd?	Samfunnsøkonomen, Nr 3 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., B. Holtsmark, T. Sterner	NOx-fondet gir ikke en kostnadseffektiv løsning.	Samfunnsøkonomen, Nr 5 2014	2014
Hauge, K. E.	Når Viljar, Egil og Rasmus skal investere i energibesparende teknologi.	Samfunnsøkonomen, Nr 1 2014	2014
Kverndokk, S., E. Nævdal, L. Nøstbakken	Rettferdige klimaavtaler.	Samfunnsøkonomen, Nr 2 2014	2014
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
Bye, B., K.P. Hagen	Gjennomgang og revisjon av rammeverket for samfunnsøkonomiske analyser.	Samfunnsøkonomen, Nr 1 2013	2013
Bøeng, A.C., O. Rosnes	Virkinger av Energieffektiviseringsdirektivet i Norge.	Økonomisk analyse 5/2013	2013
Greaker, M., C. Hagem, J. Hovi	Hvordan kan en internasjonal klimaavtale håndheves?.	Samfunnsøkonomen, Nr 2 2013	2013
Grimsrud, K.M., M. Greaker	Hvordan sikre bærekraftig forvaltning av økosystemer?.	Samfunnsøkonomen, Nr 4 2013 (127), 25-33	2013
Grimsrud, K.M., K.E. Rosendahl, H.B. Storrøsten	Skifergassrevolusjonen og det europeiske gassmarkedet.	Økonomisk analyser, 4/2013	2013
Hoel, M.	Bør vi subsidiere fornybar energi?.	Samfunnsøkonomen, Nr 2 2013	2013
Bye, B., K.E. Rosendahl	Karbonlekkasje: Årsaker og virkemidler.	Samfunnsøkonomen nr 1 2012	2012
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
Hagem, C.	Klimameldingen – svake mål og svake virkemidler.	Samfunnsøkonomen Nr 5 2012	2012
Holtsmark, B.	Bioenergi fra skog gjør trolig mer skade enn fossil olje – et tilsvar.	Samfunnsøkonomen Nr 6 2012	2012
Rosnes, O.	Wind power requires flexible market and subsidy design.	IAEE Energy Forum Third Quarter 2012	2012

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
Kverndokk, S.	Nytt senter for samfunnsøkonomisk energiforskning.	Klima, 3-11, 32-33.	2011

3. Other publications

Author	Title	Publication	Year
Fæhn T.	Klimasamarbeidet med EU: Lindring eller hindring for Norges grønne skifte?.	SSB analyse 2019 Statistisk sentralbyrå	2019
Holtsmark, Katinka Kristine; Midttømme, Kristoffer.	The Dynamics of Linking Permit Markets.	CESifo Working Paper No. 7548	2019
Nesje, F., G.B. Asheim	Intergenerational Altuism: 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
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
Strøm, S., J.Vislie	Wealth Management and Uncertain Tipping Points.	CESifo Working Paper No. 7487	2019
Karp L. S. C. Traeger	Prices versus Quantities Reassessed	CESifo Working Paper No. 7331	2018
Nyborg, K.	Skriftlige kommentarer til Vismandsrapporten Økonomi og miljø 2018	Danmarks Miljøøkonomiske råd. 2018, s. 251-253	2018
Greaker, M. A., og K. E. Rosendahl	Petroleumsvirksomhet i Barentshavet sørøst–om klima, økonomi og sysselsetting	GREENPEACE	2017
Battaglini, M., B. Harstad	The Political Economy of Weak Treaties.	NBER working paper w22968	2016
Holtsmark, B.	Seven essays on policies and international cooperation ta abate emissions of greenhouse gases.	Doctoral thesis, University of Oslo.	2016
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
Nyborg, K.	Skriftlige kommentarer til Vismandsrapporten 2016.	Danmarks Miljøøkonomiske råd.	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
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	Smart hedging against carbon leakage.	SSB Discussion Papers No. 822	2015
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
Hagem, C., M. Hoel, B. Holtsmark, T. Sterner	Refunding Emissions Payments.	RFF Discussion paper No. 15-05	2015
Harstad, B., F. Lancia, A. Russo	Compliance Technology and Self-Enforcing Agreements	CESifo WP no. 5562	2015
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
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
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
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
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
Bråten, J.	En kostnadseffektiv og virkningsfull klimapolitikk.	Norsk Klimastiftelse, Rapport nr. 04/2014	2014
Fischer, C., M. Greaker, K.E. Rosendahl	Robust Policies against Emission Leakage: The Case for Upstream Subsidies	CESifo Working Paper No. 4742	2014

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
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
Kverndokk, S., C. Hagem	Klimaendringer.	chapter 8 in O. Flåten and A. Skonhoft (eds.): Naturressursenes økonomi, Gyldendal.	2014
Nyborg, K.	Reciprocal Climate Negotiators: Balancing Anger against Even More Anger	Memorandum, 17/2014, Department of Economics, University of Oslo	2014
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
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
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
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
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
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

Harstad, B., M. Liski	Games and Resources.	Encyclopedia of Energy, Natural Resource, and Environmental Economics, , Vol. 2, 2013, 299-308	2013
Hoel, M.	Supply Side Climate Policy and the Green Paradox	CESifo Working Paper No. 4094	2013
Holtsmark, B.	International cooperation on climate change: why is there so little progress?.	Chapter 13 in R. Fouqet (ed) Handbook on Energy and Climate Change. Edward Elgar Publishing Ltd.	2013
Kverndokk, S.	Moral positions on tradable permit markets - Handbook on Energy and Climate Change.	Chapter 22 in R. Fouqet (ed) Handbook on Energy and Climate Change. Edward Elgar Publishing Ltd. .	2013
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
Nævdal, E.	Safe Minimum Standard (SMS).	Encyclopedia of Sustainability, Vol. 5, 352-353	2013
Roine, J., D. Spiro	Utvinning för allmän vinning – en ESO-rapport om svenska mineralinkomster.	Expertgruppen för studier i offentlig ekonomi 2013: 9	2013
Spiro, D.	Ändliga resurser.	Chapter in Nationalekonomi för miljöintresserade, ed. Stavlöt U. Ivrig förlag, ISBN 91-87379-09-0	2013
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
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
Fæhn, T., K. Jacobsen	Makroanalyser i tilknytning til Klimameldingen 2012.	Rapporter 22/2012, Statistisk sentralbyrå.	2012
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.	Klimatpolitik och ledarskap – vilken roll kan et lita land spela?	Rapport til Expertgruppen for miljøstudier (2012: 3)	2012
Nyborg, K.	The Ethics and Politics of Environmental Cost-Benefit Analysis.	Routledge Explorations in Environmental Economics series	2012
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

4. CREE Working Papers

Author	Title	Publication	Year
CREE	Synthesis report of Flagship IV: Towards the low-emission society	CREE WP 02/2020	2020
Bye, B., T. Fæhn, O. Rosnes	Marginal Abatement Costs under EU's Effort Sharing Regulation - A CGE analysis	CREE WP 03/2019	2019
Casoria F., A. Ciccone	Do upfront investments increase cooperation? A laboratory experiment	CREE WP 02/2019	2019
Gaure S., R. Golombek	True or not true: Carbon-Free electricity generation is possible	CREE WP 11/2019	2019
Jelsness,S.	Vind eller forsvinn - I hvilken grad blir miljøhensyn vektlagt i avgjørelsen om konsesjon for vindkraft?	CREE WP 06/2019	2019
Skulstad, A.	Environmental goods for sale - An analysis of Geitfjellet wind power plant with an offset scheme for ecosystem services	CREE WP 10/2019	2019
Storrøsten, H. B.	Emission regulation of markets with sluggish supply structures	CREE WP 07/2019	2019
Aune, F. R., R. Golombek	Carbon prices are redundant in the 2030 EU climate and energy policy package	CREE WP 10/2018	2018
Bye, B. K.Espegren, 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
Fæhn, T. et. al.	Parisavtalen og oljeeksporten	CREE WP 05/2018	2018
Harstad, Bård	Pledge-and-review bargaining	CREE WP 07/2018	2018
Nesje, F., D. Lund	Risikojustering av kalkulasjonsrenta i samfunnsøkonomiske analysar	CREE WP 03/2018	2018
Storrøsten, H.	Regulation of markets with sluggish supply structures	CREE WP 02/2018	2018
Crépin, S. A., E. Nævdal	Inertia in risk; improving economic models of catastrophes	CREE WP 02/2017	2017
Drupp, M., M.C. Freeman, B. Groom, F. Nesje	DISCOUNTING DISENTANGLED	CREE WP 06/2017	2017
Fæhn, T., P. E. Stoknes	Significant and plausible futures - Global surroundings of Norway's climate strategies	CREE WP 10/2017	2017
Grimsrud, K., L. Lindholt, M. Greaker	Resource Rent in Norwegian Fisheries - Trends and policies	CREE WP 01/2017	2017
Strand, J.	Unconditional and conditional NDCs under the Paris Agreement: Interpretations and their relations to policy instruments	CREE WP 09/2017	2017
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
Ciccone, A.	Voluntary contributions to bargaining: hold-up problem in the lab	CREE WP 08/2016	2016
Hagem, C., H.B. Storrøsten	Supply versus demand-side policies in the presence of carbon leakage and the green paradox	CREE WP 04/2016	2016
Hjort I.	Potential Climate Risks in Financial Markets: A Literature Overview	CREE WP 10/2016	2016

Hjort I.	Potential Climate Risks in Financial Markets: Report from a workshop, January 20, 2016	CREE WP 11/2016	2016
Jiang S.	Pareto improving Climate Policies for the Main CO2 Emitting Countries/Regions	CREE WP 06/2016	2016
Nesje, F., G.B. Asheim	Intergenerational altruism: A solution to the climate problem?	CREE WP 09/2016	2016
Syrstad, R.S.	Climate and Energy Security Policies in the EU: Conflict or Cohesion?	CREE WP 01/2016	2016
Tahvonen, O., A. Rautiainen	Economics of forest carbon storage and the additionality principle	CREE WP 13/2016	2016
Aune, F.R., R. Golombek, H. Hallre Le Tissier	Phasing out nuclear power in Europe	CREE WP 05/2015	2015
Bråten, R.H., P. Martinsson	Experimental measures of household decision power	CREE WP 02/2015	2015
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
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., B. Bye, T. Fæhn, K.E. Rosendahl	Targeted carbon tariffs – Carbon leakage and welfare effects	CREE WP 09/2015	2015
Böhringer, C., N. Rivers, H. Yonezawa	Vertical fiscal externalities and the environment	CREE WP 16/2015	2015
Ciccone, A., R. Bråten, O. Røgeberg	Fairness preferences in a bilateral trade experiment	CREE WP 10/2015	2015
Harstad, B.	Investment Policy for Time-Inconsistent Discounters	CREE WP 21/2015	2015
Hassler, J., P. Krusell, A. Shifa, D. Spiro	Sovereign wealth funds and spending constraints in resource rich developing countries – the case of Uganda	CREE WP 06/2015	2015
Hoel, M., S.A.C. Kittelsen, S. Kverndokk	Pareto Improving Climate Policies: Distributing the benefits across generations and regions	CREE WP 12/2015	2015
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
Bijgaart, I. van den	The Unilateral Implementation of a Sustainable Growth Path with Directed Technical Change	CREE WP 15/2014	2014
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
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
Eggert, H., M. Greaker	Promoting second generation bioethanol: Does the first generation pave the road?	CREE WP 07/2014	2014
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
Førsund, F.	Hveding's Conjecture: On the Aggregation of a Hydroelectric Multiplant – Multireservoir System	CREE WP 17/2014	2014

Gars, J., D. Spiro	Uninsurance through trade	CREE WP 10/2014	2014
Gars, J., D. Spiro	Should Foresters Forecast?	CREE WP 11/2014	2014
Hauge, K.E., O. Røgeberg	Contributing to Public Goods as Individuals versus Group Representatives: Evidence of Gender Differences	CREE WP 16/2014	2014
Nyborg, K.	Reciprocal climate negotiators: Balancing anger against even more anger	CREE WP 20/2014	2014
Spiro, D.	Resource prices and planning horizons	CREE WP 12/2014	2014
Valseth, Å.S.	Competing Climate Policies	CREE WP 04/2014	2014
Weidle, M. W.	Is low carbon taxation optimal climate policy for a developing country? A numerical simulation of technology adoption	CREE WP 05/2014	2014
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
Böhringer, C., J.C. Carbone, T.F. Rutherford	The Strategic Value of Carbon Tariffs	CREE WP 24/2013	2013
Böhringer, C., J.C. Carbone, T.F. Rutherford	Embodied carbon Tariffs	CREE WP 25/2013	2013
Böhringer, C., K.E. Rosendahl, J. Schneider	Unilateral Climate Policy: Can OPEC resolve the leakage problem?	CREE WP 05/2013	2013
Eyckmans, J., S. Fankhauser, S. Kverndokk	Development Aid and Climate Finance	CREE WP 15/2013	2013
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., 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, O. Rosnes	Kostnadseffektive tilpasninger til togradersmålet i Norge og EU fram mot 2050	CREE WP 22/2013	2013
Greaker, M., K. Midttømme	Optimal environmental policy with network eects: Is lock-in in dirty technologies possible?	CREE WP 27/2013	2013
Grimsrud, K., K.E. Rosendahl, H. Briseid Storrøsten, M. Tsygankova	Short run effects of bleaker prospects foroligopolistic producers of a nonrenewable resource	CREE WP 26/2013	2013
Hoel, M.	Supply side climate policy and the green Paradox	CREE WP 02/2013	2013

Nesje, F.	Distrust, but verify? Theoretical insights into auditing carbon sequestration in tropical forests	CREE WP 18/2013	2013
Parchomovsky G., E. Stavang	The Environmental Option	CREE WP 03/2013	2013
Parchomovsky, G., E. Stavang	Contracting around tort defaults: The knock-for-knock principle and accident costs	CREE WP 14/2013	2013
Storrøsten, H.B.	Prices vs. quantities with endogenous cost structure	CREE WP 19/2013	2013
Bruvoll, A., H.M. Dalen, B.M. Larsen	Political motives in climate and energy policy	CREE WP 18/2012	2012
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., C. Fischer, K.E. Rosendahl	Cost-Effective Unilateral Climate Policy Design: Size Matters	CREE WP 05/2012	2012
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
Greaker, M., P.E. Stoknes, K.H. Alfsen, T. Ericson	A Kantian approach to sustainable development indicators for climate change	CREE WP 17/2012	2012
Hagem, C., B. Holtsmark, T. Sterner	Mechanism design for refunding emissions payment	CREE WP 19/2012	2012
Hoel, M., B. Holtsmark	Haavelmo on the climate issue	CREE WP 10/2012	2012
Hoel, M.	Second-best climate policy	CREE WP 02/2012	2012
Hoel, M., B. Holtsmark, K. Holtsmark	Faustmann and the Climate	CREE WP 08/2012	2012
Holtsmark, B., M. Hoel, K. Holtsmark	Optimal harvest age considering multiple carbon pools – a comment	CREE WP 11/2012	2012
Kverndokk, S.	Moral positions on Tradable Permits Markets	CREE WP 04/2012	2012
Kverndokk, S., E. Nævdal, L. Nøstbakken	The Trade-off between Intra- and Intergenerational Equity in Climate Policy: Can Carbon Leakage be Justified?	CREE WP 09/2012	2012
Storrøsten, H.B.	Prices vs. quantities: Techology choice, uncertainty and welfare	CREE WP 03/2012	2012
Carbone, J., R.S. Gazzale	A Shared Sense of Responibility: Money versus Effort Contributions in the Voluntary Provision of Public Goods	CREE WP 05/2011	2011
Gerlagh, R., S. Kverndokk, K.E. Rosendahl	Timing of environmental R&D policy	CREE WP 02/2011	2011
Godal, O., B. Holtsmark	On efficiency gains from emissions trading: Have they been exaggerated?	CREE WP 06/2011	2011