

Synthesis report of Flagship III: Green innovations and utilization of smart technologies



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Abstract in Norwegian:

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Synteserapport Flaggskip III: Grønne innovasjoner og bruk av smart teknologi

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

I kapittel 1 er det en enkel beskrivelse av hovedtemaer, forskerledere og samarbeidspartnere. Kapittel 2 inneholder de viktigste forskningstemaene og resultatene. I kapittel 3 viser man til de viktigste artiklene som har vært skrevet i dette flaggskipet. I appendikset er det en oversikt over publiseringene.

Synthesis report of Flagship III: Green innovations and utilization of smart technologies

1. Overview

Achieving ambitious environmental and climate goals requires broad adoption of environmentally friendly and energy efficient technologies in homes and businesses. This Flagship aims 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 is led by senior researcher, Dr. Bente Halvorsen, and include a broad collaboration across research partners, user partners and contractors. The work on this Flagship has involved researchers from all CREE's four research partners, both national and international, as well as user partners and sub-contractors from multiple disciplines. The research spans from traditional economic analysis to multi- and coauthored interdisciplinary analyses. The Flagship constitutes of 13 independent projects applying a variety of analytical and empirical approaches. Four of these projects were conducted in close collaboration with user partners, five included researches who were not economists, contributing to interdisciplinary analysis within CREE, and two projects involved international research partners. The work on these projects has resulted in several publications (see Appendix). As of November 2019, a total of 65 publications have been produced, of which 20 has been published in international journals and four as contributions to international books. The collaboration with user partners has taken many forms and resulted in various meetings and presentations, collaborations on constructing novel data sets, as well as research proposals and project collaborations. The sections 3.1, 3.3 and 3.4 give closer descriptions of three of these collaborations; one with a user partner, one international collaboration and one interdisciplinary collaboration with a sub-contractor. The Flagship has also financed 7 Master students, and three of our PhD candidates has written publications on topics related to Flagship III.

We are also proud to report that the 2017 Erik Kempe Award for “the best paper in the field of environmental and resource economics, published in the previous two years in a refereed journal by an author affiliated to a European research institution” was given to the two CREE researchers, Mads Greaker and Kristoffer Midttømme, for an article published in Journal of Public Economics on topics related to Flagship III (see section 3.2 for more information).

2. 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.

2.1 Main results: 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.

2.2 Main results: 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 public's 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 permits 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.

3. Highlighted publications

The discussion above gives a broad overview of the research that has been conducted on topics related to Flagship III since CREE was established in 2011. Now, we will look closer at four of the publications, illustrating different aspects of our research. The first is the research of a PhD student who, in close collaboration with one of our user partners, has developed a novel panel data set which contains important information about how environmental regulations affect R&D activities in firms. The second example is an award-winning article, also coauthored by one of our PhD students. The third article is an example of how new networks built within CREE resulted in international collaborations. Finally, we describe an interdisciplinary article which is a result of the collaboration that was established between CREE and the MILEN center at the University of Oslo.

3.1 Direct regulations and environmentally friendly innovations

Marit Klemetsen is one of the three PhD candidates working on topics related to Flagship III. She used a novel data set containing information about direct environmental regulations at a firm level as well as information on the type and number of patent applications. She had a close collaboration with the Norwegian Environment Agency, which is one of CREE's user partners, when collecting information about the environmental regulations to construct the regulatory part of her data set. Based on this collaboration, she (co)authored four articles forming her PhD thesis "Impacts of policies on emissions and environmental innovation in Norway", which she defended 6. June 2016.



Marit Klemetsen

One of the articles looks at how direct regulations affect environmentally friendly innovations, see Klemetsen et al. (2018). It provides new evidence of the role of direct (command-and-control) regulations in relation to innovations in environmental technologies. While pricing is generally considered the first-best policy instrument, direct regulations, such as technology standards and non-tradable emission quotas, are common when a regulator faces multiple emission types and targets, heterogeneous recipients, or is uncertain about marginal damages. Using this rich Norwegian panel dataset, the article analyzes the effects of direct regulations on environmental patenting.



Brita Bye

Inspection violation status was used as a measure of regulatory stringency, while controlling for risk class. Violation status captures the probability that a firm might be sanctioned for violating its emission permit. Controlling for risk class captures firm heterogeneity related to dirtiness and inspection frequency. The analysis empirically identifies strong and significant effects on innovations resulting from the implicit regulatory costs of direct regulations.

3.2 Optimal taxation of network externalities

The 2017 Erik Kempe Award was given to the two CREE researchers Mads Greker 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*, see Greker and Midttømme (2016). This article is a part of Midttømmes PhD dissertation, which he defended 25. September 2015.



Mads Greker

The article studies the diffusion of a clean substitute to a dirty durable good in a dynamic model. Consumer utility of both durable goods increases in their respective market shares due to network effects. First, the optimal dirty good tax is characterized. The tax should achieve a long run optimal division of the market between the two goods. Along the transition path to this steady state the optimal tax depends on the current and future market shares of the clean durable. Thus, even if the marginal environmental damage from an additional dirty durable is constant, the optimal tax should not be constant. Second, the article studies whether excess inertia can occur if the emission tax is not optimally set. The authors find that a constant tax that only accounts for the environmental damage caused by the dirty good may lead to excess inertia. Excess inertia could happen even if the clean technology is proprietary, and the technology owner has incentives to sponsor the initial market diffusion of the technology.



*Kristoffer
Midttømme*

The Nomination Committee gives the following motivation for the award: “Mads Greker 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. As such, Greaker and Midttømme have contributed to the academic literature by examining optimal taxation of externality-generating goods in a novel and arguably important setting, and by addressing a timely policy problem of clear practical relevance.”

3.3 Using technology subsidies to avoid leakage



Carolyn Fischer

Several projects have a close collaboration between Norwegian and international researchers; both with our research partner at the Tilburg Sustainability Center as well as with other international researchers. One of these researchers is Carolyn Fischer, then working at Resources for the Future (currently working as a professor at the School of Business and Economics at Vrije Universiteit, Amsterdam). In a study recently published in *Journal of Environmental Economics and Management*, Fischer coauthored an article with CREE researchers Mads Greaker and Knut Einar Rosendahl discussing using technology subsidies to avoid carbon leakages, see Fischer et al. (2017).

Asymmetric regulation of a global pollutant between countries can alter the competitiveness of industries and lead to emissions leakage, which hampers countries' welfare. In order to limit leakage, governments consider supporting domestic trade-exposed firms by subsidizing their investments in abatement technology. The suppliers of such technologies tend to be less than perfectly competitive, particularly when both emissions regulations and advanced technologies are new. In this context of twin market failures, this article considers the relative effects and desirability of subsidies for abatement technology. It finds a more robust recommendation for upstream subsidies, that is, subsidies to the suppliers of technologies, than for downstream subsidies, that is, subsidies to the purchasers of the technologies. Downstream subsidies tend to increase global abatement technology prices, reduce pollution abatement abroad and increase emission leakage. On the contrary, upstream subsidies reduce abatement technology prices, and hence also emissions leakage.



*Knut Einar
Rosendahl*

3.4 Green technology investments and household energy practices

Throughout the entire period, CREE researchers have had a close interdisciplinary collaboration with anthropologists at Centre for Development and Environment (SUM) at the University of Oslo. SUM has been one of the main Norwegian sub-contractors in CREE from the start in 2011 until now. The main research topic analyzed in this collaboration is household behavior related to energy consumption. The collaboration has resulted in several multi- and interdisciplinary publications. Here, we present one of these papers, analyzing changes in energy



Harold Wilhite

practices resulting from the use of heat pumps in Norwegian households, and how this introduction of green technology affects household energy consumption, see Halvorsen et al. (2016).



Bodil Larsen

In this article, an interdisciplinary team of economists and anthropologists, study the case of Norwegian households' use of heat pumps. The heat pump is a technology that has the potential to reduce household electricity consumption by up to 25% compared to conventional electric heating, but, as demonstrated in this study, when taken into use it results in little or no change in electricity consumption. To explain this large rebound effect, we use a quantitative economic analysis combined with qualitative interviews attuned towards examining the effect of heat pumps on people's everyday practices. We find that, on average, households with and without a heat pump use approximately the same amount of electricity. The main sources of rebound identified were higher indoor temperature and heated living space, less firewood and fuel oil use and less use of night set-backs and reduced temperature while away from the home. This implies that welfare and the energy efficiency of residential space heating have increased and that total residential energy consumption is reduced because of increased use of heat pumps in Norwegian homes.



Tanja Winther

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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.

Fischer, C., M. Greaker and K.E. Rosendahl (2018): Strategic technology policy as a supplement to energy standards. *Resource and Energy Economics*, Vol. 51, 84-98.

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

Golombek, R., M. Greaker, S. Gaure, S.A.C. Kittelsen and K.E. Rosendahl (2016): Promoting CCS in Europe: A case for green strategic trade policy? CREE WP 05/2016.

Golombek, R., M. Greaker and M. Hoel (2020): Should environmental R&D be prioritized? *Resource and Energy Economics*. Forthcoming.

Greaker, M. and M. Hoel. (2011): Incentives for environmental R&D. CREE WP 01/2011.

Greaker, M. and K. Midttømme (2016): Network effects and environmental externalities: Do clean technologies suffer from excess inertia? *Journal of Public Economics*, Vol. 143, 27-38.

Greaker, M., T. R. Heggedal and K. E. Rosendahl (2017): Environmental Policy and the Direction of Technical Change. *Scandinavian Journal of Economics*, Vol. 120, No. 4, 1100-1138.

Halvorsen, B. and B.M. Larsen (2013): Hvem eier varmepumpe og hva gjør det med strømforbruket? *Økonomiske analyser*, No. 2.

Halvorsen, B., B. Larsen, H.L. Wilhite and T. Winther (2016): Revisiting household energy rebound: Perspectives from a multidisciplinary study. *Indoor and Built Environment*, Vol. 25, No. 7, 1114-1123.

Lillemo, S.C., F. Alfnes, B. Halvorsen and M. Wik (2011): Nordmenns holdninger til forskjellige oppvarmingssystemer, *Bioenergi: fagtidsskrift for bioenergiforeningen*, No. 5, 28-29.

Lillemo, S.C., F. Alfnes, B. Halvorsen and M. Wik. (2013): Households' Heating Investments: The effect of motives and attitudes on choice of equipment. *Biomass and Energy*. Vol. 57, October, 4–12.

Westskog, H., T. Winther and H. Sæle (2015): The effects of In-Home Displays - Revisiting the Context. *Sustainability*, Vol. 7, Issue 5, 5431-5451.

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.

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.

Publications Flagship III

1. Scientific Journals			
Author	Title	Publication	Year
Golombek, R., M. Greaker M. Hoel.	Should environmental R&D be prioritized?	Resource and Energy Economics.Forthcoming	2020
Dengler S., R. Gerlagh, S. T. Trautmanna, G. van de Kuilen	Climate policy commitment devices	Journal of Environmental Economics and Management, Vol. 92, November 2018, 331-343	2018
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
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
Winther, T., S. Bell	Domesticating In Home Displays in selected British and Norwegian households.	Journal of Science and Technology Studies	2018
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
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
Fæhn, T., E. T. Isaksen	Diffusion of climate technologies in the presence of commitment problems.	Energy Journal, Vol. 37, No 2, 155-180	2016
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
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
Dalen H.M., B.M. Larsen	Residential End-use Electricity Demand: Development over Time.	The Energy Journal Vol. 36, No. 4, 165-182	2015
Westskog, H., T. Winther, H. Sæle	The effects of In-Home Displays - Revisiting the Context.	Sustainability, Vol. 7, Issue 5, 5431-5451	2015
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
Eggert, H., M. Greaker	Promoting Second Generation Biofuels: Does the First Generation Pave the Road?.	Energies 7, 1-16	2014
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
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

Greaker, M.	Strategic Environmental Policy.	Encyclopaedia of Energy, Natural Resource and Environmental Economics, Vol. 3, 313-320	2013
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.M. Larsen	How serious is the aggregation problem? An empirical illustration.	Applied Economics, 45: 26, 3786-3794	2013
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

2. Popular Science Journals

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., 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
Bøeng, A.-C., B. Halvorsen, B.M. Larsen	Fører effektiviseringstiltak til uønskede adferdsendringer?.	RØST nr 1 2013	2013
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
Fæhn, T.	Utvikling av klimateknologier - hvordan kan Norge bidra?.	Økonomiske analyser 6/2012, Statistisk sentralbyrå	2012
Bøeng, A.C., B. Halvorsen, B.M. Larsen	Vil subsidiering av energieffektivt utstyr løse miljøproblemene?.	Økonomiske Analyser 5/2011, Statistisk sentralbyrå.	2011

3. Other publications

Author	Title	Publication	Year
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
Klemetsen, M.	Policy incentives for firm behaviour. 4 articles on environmental innovation and emissions.	Doctoral thesis, University of Oslo.	2016
Rosendahl, K.E.	Miljøgevinsten 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
Wilhite, H.	The Political Economy of Low Carbon Transformation: Breaking the Habits of Capitalism.	London: Routledge.	2016
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
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
Klemetsen, M. E.	The effects of innovation policies on firm level patenting	Discussion paper no 830, Statistics Norway	2015
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
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4. CREE Working Papers

Author	Title	Publication	Year
CREE	Synthesis report of Flagship III: Green innovations and utilization of smart technologies	CREE WP 09/2018	2018
Khan, Ahmer Zaman	Why Say No to Solar Energy? - An Exploration of Residential Reluctance towards Solar Energy	CREE WP 04/2018	2018
Lorentzen, Linnea	Grønn teknologi eller klimakrise: En teoretisk studie med to stokastiske terskler	CREE WP 06/2018	2018
Golombek, R., M. Greaker, S. Gaure, S.A.C. Kittelsen, K.E. Rosendahl	Promoting CCS in Europe: A case for green strategic trade policy?	CREE WP 05/2016	2016
Klemetsen, E. M., K.E. Rosendahl, A. Lund Jakobsen	The impacts of the EU ETS on Norwegian plants' environmental and economic performance	CREE WP 03/2016	2016
Gerlagh R., E. van der Heijden	Going Green: Framing effects in a Dynamic Coordination Game	CREE WP 23/2015	2015
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Halvorsen, B., B.M. Larsen, T. Winther, H. Wilhite	Revisiting household energy rebound: perspectives from a multidisciplinary study	CREE WP 04/2015	2015
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Klemetsen, M.E.	The effects of innovation policies on firm level patenting	CREE WP 24/2015	2015
Weyer, S.I.	Directed technical change in clean and dirty technologies: Is it possible to redirect R&D in a multi-region world?	CREE WP 17/2015	2015
Fæhn, T., E. Thuestad Isaksen	Diffusion of climate technologies in the presence of commitment problems	CREE WP 01/2014	2014
Jemsek, M.	Heat Pumps and Household Energy Consumption in Norway	CREE WP 03/2014	2014
Winther, T., H. Wilhite	The use of heat pumps in Norwegian homes: Accounting for the comfort rebound effect.	CREE WP 02/2014	2014
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Dalen, H.M., B.M. Larsen	Residential end-use electricity demand - Development over time	CREE WP 17/2013	2013
Halvorsen, B., B.M. Larsen	How do investments in heat pumps affect household energy consumption?	CREE WP 06/2013	2013

Hoel, M., A. de Zeeuw	Technology Agreements with Heterogeneous Countries	CREE WP 01/2013	2013
Klemetsen, M.E., B. Bye, A. Raknerud	Can non-market regulations spur innovations in environmental technologies? A study on firm level patenting	CREE WP 16/2013	2013
Heggedal, T.R.	A Comment on the Environment and Directed Technical Change	CREE WP 13/2012	2012
Greaker, M., M. Hoel.	Incentives for environmental R&D	CREE WP 01/2011	2011