CenSES

CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH

Annual Report 2017

Centre for Sustainable Energy Studies

Message from the Chair of the Board

We are now approaching the last phase of CenSES. As an FME, CenSES has been very successful in building national building blocks in the cross-disciplinary activities between economy, technology and social sciences. Now, as the chair of the board of CenSES and director of NTNU Energy, I recognize that CenSES has continued to play a vital role in the Strategic Research Area Energy as well as Sustainability at NTNU and beyond.

CenSES has successfully conducted important research projects and topics both in a national as well as in an internationally context. In the process of conducting final reports from the research as a whole, it is important to put together and synthesize the various research results into a common message to the public.

It is of utmost importance to synthesize the results into understandable knowledge and tools for the politicians and industry to make framework and solutions and take actions to achieve the Paris agreement. It is now the partners will look into the return of their investments in CenSES according to new knowledge achieved, disseminated and taken into use as well as recruitment of Masters and PhD's in CenSES.

Johan Hustad
Chair of the Board, CenSES

Content

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Report from the Centre Director

2017 was an exciting year for CenSES. Approaching 2019 and the end of our FME budget, we have moved from emphasising PhD education in our research, to focus more on synthesis of the results and dissemination of what we have learned. In CenSES lifetime, we have educated 45 PhD students and 18 post docs, with 15 PhD's and 7 postdoc's still in work. These and the other CenSES researchers have contributed with a number of important results through the years. 277 papers are published, these have been presented in more than 370 conference presentations and over 400 presentations for user partners and the public.

We will now start a phase where we put a heightened focus on the consequences of our accumulated knowledge, for energy policy, climate policy and value creation. Part of this knowledge will be summarized in positon papers from the ongoing user cases in CenSES. More information can be found in a separate section. We welcome interaction with our user partners and other interested parties in the work on finishing these. Below I summarize the highlights for 2017.

In RA 1 Policy making and transition strategies, we have new insights on how the relations between individuals, households, new technologies and actors such as policy makers and researcher interplay in transition processes. A central topic is how technology can be a central tool to promote energy citizenship and new types of engagement in the transition process. This research has implications for how we should design policy instruments, technology and research strategies in the future.

RA 2 Energy systems and markets has focused on analysis of effects of existing policy, like the green certificates. In a position paper we conclude that it will contribute to meeting objectives of renewable production, but not in a cost efficient way. Additionally the risk allocation between government and private actors is not efficient. Both effects potentially leads to not picking the best projects.

RA 3 Economic analysis has in 2017 done studies of emissions in Norway. They have covered considerable areas with their analysis of maritime shipping, a sector where Norway's position as a world industry leader lends a chance to influence emissions and policies globally. That work has pointed at several possibilites, one of which is in non-tech ways: speed, size and slenderness.

RA 4 Innovation and commercialization has done research together with researchers from Nord University on how to create successful cooperation between industry and researchers, with a particular focus on the technological FME centres. Their data consists of 100 depth interviews with research and user partners and have interesting conclusions regarding the importance of issues like clarifications of expectations, arenas to create common ground, dedication of time and resources, power balance, and former experience with research cooperation.

In RA 5 Scenario development, the work on CenSES scenarios have now entered a new phase, moving from qualitative to quantitative descriptions in linking global models with Norwegian models. In the area of environmental effects, CenSES researcher Linda Ager-Wick Ellingsen from the Industrial Ecology Programme (IndEcol) at NTNU successfully defended her PhD thesis. Her thesis, entitled "Life cycle assessment of lithium-ion traction batteries", includes an early 2017 publication in Nature Climate Change on reviewing large-scale integrated assessment models from an industrial ecology perspective (co-written with CenSES researcher Anders Arvesen from IndEcol). Another 2017 publication in RA5 unpicks different factors explaining why carbon footprint estimates for lithium-ion vary across studies. You can read about these results and more, as well as CENSES international cooperation and dissemination in this annual report.

Our focus for future research is to be of relevance for the CenSES partners, as well as for society in general. An equal emphasis will be on high quality publications. We would like to thank our user partners and other collaborative partners in industry and public government for the cooperation in outlining our strategy for the next years. Concretizations of this will be developed further in new projects and centre proposals in 2018. We welcome further cooperation on future endeavours!

Asgeir Tomasgard
Centre Director, CenSES

About CenSES

Centre for Sustainable Energy Studies (CenSES) was established in 2011 as a national Centre for Environment-friendly Energy Research (FME) by the Norwegian Research Council. The objective of the FME initiative is the establishment of time-limited research centres which conduct concentrated, focused and long-term research of high international calibre in order to solve specific challenges in the field.

FME CenSES will develop fact-based knowledge for strategic decisions, relevant both for government and industry. The focus is knowledge for a national energy policy, for national and international climate policy, and for strategies of innovation and commercialization.

CenSES research integrates the following disciplines: energy systems and markets, industrial ecology, economics, political science, sociology, innovation studies and science and technology studies.

The CenSES consortium includes research groups from Institute for Energy Technology (IFE), Institute for Research in Economics and Business Administration (SNF), Norwegian School of Economics (NHH), Norwegian University of Science and Technology (NTNU) , SINTEF, Sogn og Fjordane University College, Vestlandsforsking and University of Oslo (UiO).

Research partners

Høgskulen på Vestlandet

NTNU

IFE Institutt for energiteknikk

VESTLANDSFORSKING

SNF Et selskap i NHH-miljøet

UiO : Universitetet i Oslo

SINTEF

NHH

Main Research Objective

CenSES' main research objective is to conduct research that supports public and private decision makers in strategic decisions and policies that will promote environment-friendly energy technologies and lead to a sustainable energy system.

The research will result in new policy recommendations, tools and models, strategies and scenarios supporting the transition to a sustainable energy system.

Key objectives

Objectives for education and recruitment

- Develop master courses and a PhD school in social scientific energy studies
- Educate 40 PhD candidates and post docs under the FME budget
- Supervise at least 20-30 master students every year

Relevance objectives

- CenSES will perform a number of scenario studies and user cases in cooperation with the user partners

Dissemination objectives

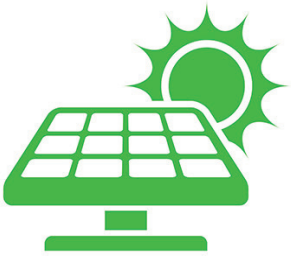
- Disseminate results to the public through:
  - Yearly conferences
  - Workshops and seminars
  - Quarterly newsletter
  - High visibility in the news media
- Establish Innovation Forum in cooperation with the technology-oriented FMEs
- Establish an Energy Strategy Board together with Technoport
- Establish a public website www.censes.no

Publication objectives

- Present 150 papers on international conferences
- Publish 120 articles in academic journals with peer review
- Write 3 scientific books and 40 book chapters in edited books

In addition to strictly academic dissemination through journals and scientific conferences, CenSES have high goals concerning publishing results that will be useful tools for energy policy making and can contribute to creating a better and broader energy discussion in society.

CenSES in numbers 2017



Publications

Articles published in academic journals and anthologies: 40

Monographs: 1

Reports: 6

Presentations

Conference presentations: 57

Dissemination & presentation for partners: 83

Partners

User partners: 20

National research partners: 8

International research partners: 10

Research

PhD Dissertations: 3

Master degrees: 25

Events

Conferences and workshops: 21

Leadership

CenSES Management Group


Asgeir Tomasgard
NTNU


Marianne Ryghaug
NTNU


Knut H. Sørensen
NTNU


Kari Aamodt Espegren
IFE


Gunnar Eskeland
NHH


Roger Sørheim
NTNU


Erling Holden
HiSF


Hans Jakob Walnum
Vestlands-forsking


Stefan Jaehnert
SINTEF


Olav Wicken
UiO


Kjetil Midthun
SINTEF


Tomas Moe Skjølsvold
NTNU


Tove Svenning
NTNU


Marie Antonsen
NTNU

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Frode Rømo
Research Director, SINTEF


Fulvio Castellacci
Centre Director, UiO


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Head of Department, Norsk Hydro


Mette Bjørndal
Professor, NHH

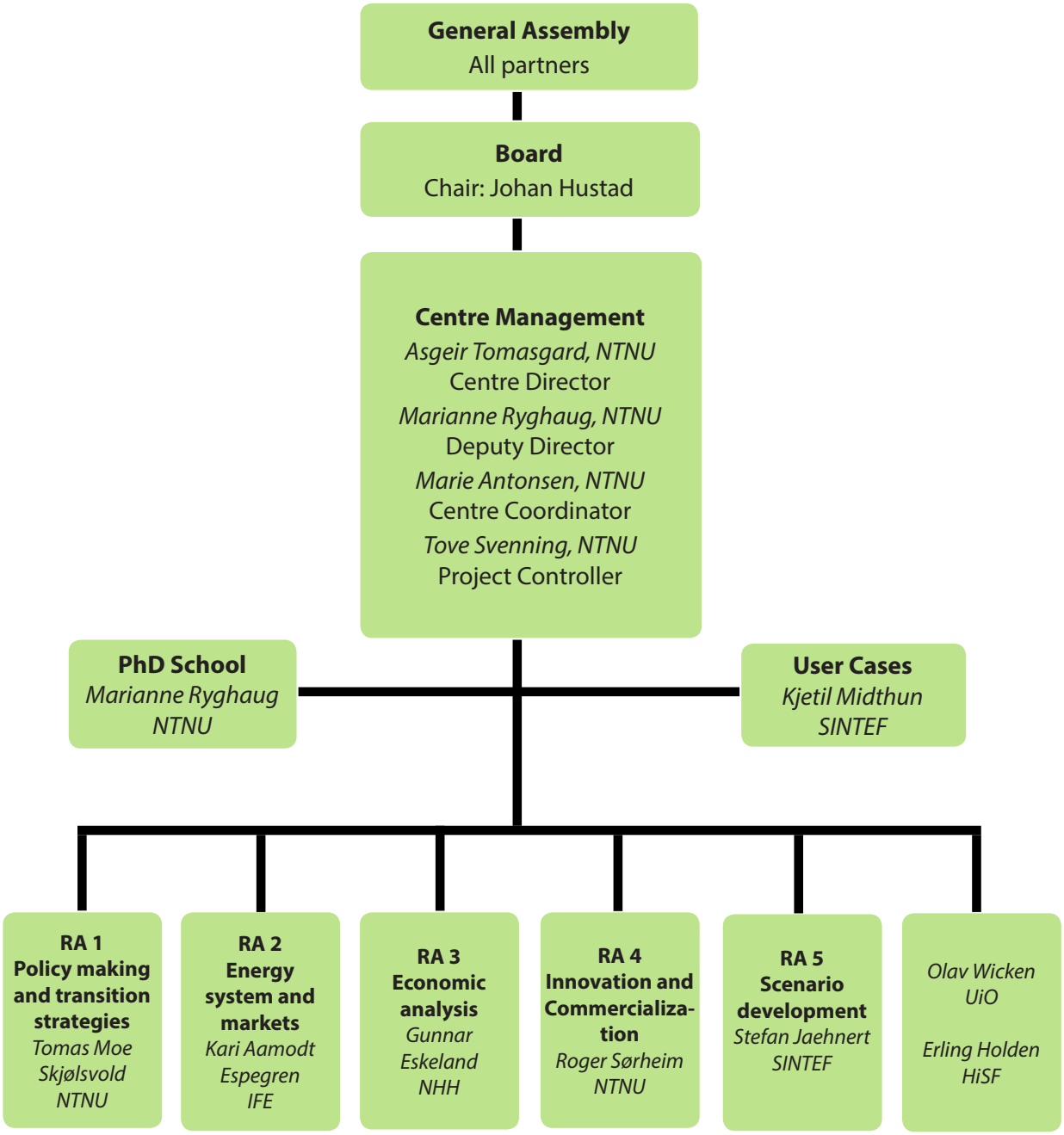

Ola Lingaas
Vice President, SFE


Mattias Hoffman
Research and Development Program Leader, Statnett


Arne Lind
Deaprtment Head, IFE


Petter Hersleth
Head of Strategy, Enova

Organisational chart



Partners

National research partners

Høgskulen på Vestlandet
SINTEF
IFE Institutt for energiteknikk
SNF Et selskap i NHH-miljøet
UNIVERSITETET I OSLO
NTNU Det skapende universitet
VESTLANDSFORSKING
NHH

User partners

powel Helping utilities work smarter
BKK
DIFFER
enova
HYDRO
Innovasjon Norge
Norges vassdrags- og energidirektorat NVE
MILJØ-DIREKTORATET
NORWEA VIND BØLGE TIDEVANN
sparebanken sogn og fjordane
SØR-TRØNDELAG FYLKESKOMMUNE
SFE
Statoil
intpow Norwegian Renewable Energy Partners
BERGEN KOMMUNE
Statnett
Sognekraft
SOGN OG FJORDANE FYLKESKOMMUNE
TrønderEnergi
Jernbane-direktoratet

International research partners

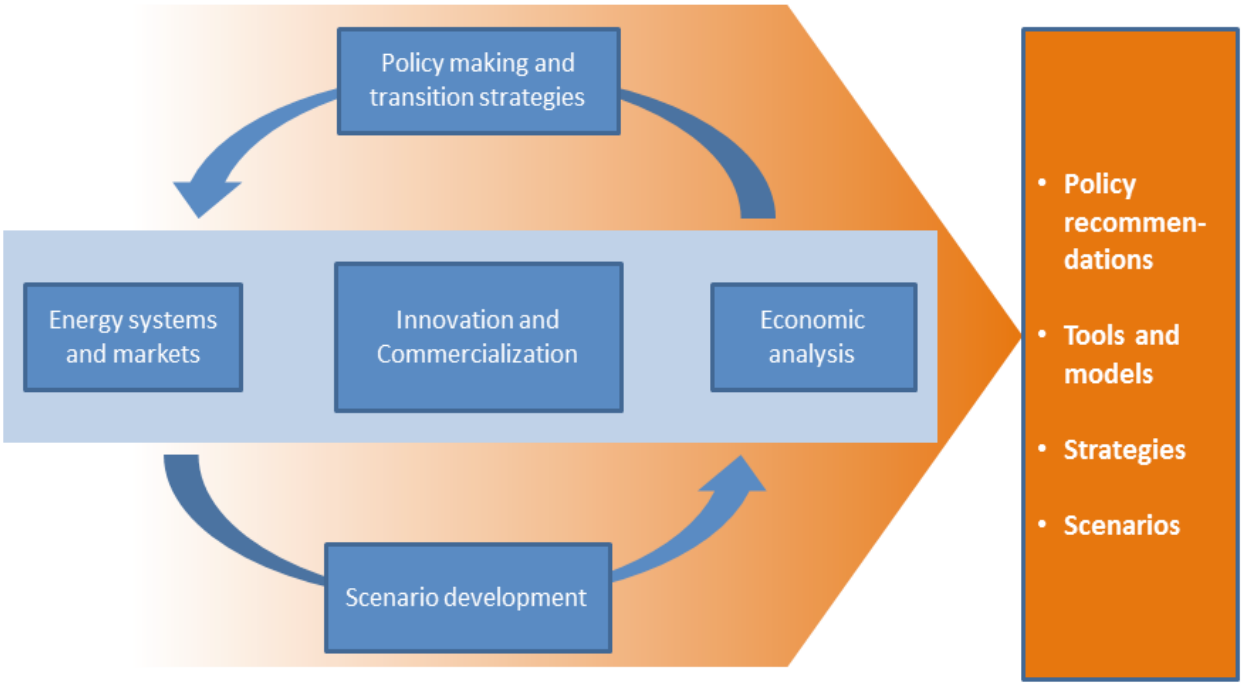
Lancaster University Management School
Linköpings universitet
清華大学 Tsinghua University
The University of Edinburgh
University of Maryland
TNO
DIW Berlin
Fraunhofer ISI
Joint Global Change Research Institute
iea Energy Technology Network ETSAP

Main Research Areas

CenSES is divided in five major research areas, which includes policy recommendations, tools and models, strategies and scenarios. Each research area consist of several specific work packages.

Research Area 1: Policy making and transition strategies
Research Area 2: Energy systems and markets
Research Area 3: Economic analysis
Research Area 4: Innovation and commercialization
Research Area 5: Scenario development

Scenario development is an arena of integration where policy and framework conditions, technology strategies, investment strategies and impacts are to be coupled in a consistent way. In addition, selected user cases are implemented across the research areas.



Research Areas and Work Packages

RA 1
Policy making and transition strategies

- **WP 1** Low carbon energy transition policies in Norway - assessments and strategies
- **WP 2** Comparative analysis of governance and public policy for energy system transformations
- **WP 3** Public engagement to build energy citizenship
- **WP 4** Synthesis and interaction with the other research areas

RA 2
Energy systems and markets

- **WP 1** Modelling technology learning, energy demand and energy efficiency
- **WP 2** Including new functionality in energy system and market models
- **WP 3** Analysis of European, Norwegian and regional energy system

RA 3
Economic analysis

- **WP 1** Electricity market design and Economic Incentives
- **WP 2** National policy: Regulation, incentives and efficiency
- **WP 3** Regional economic Implications of Energy Policies

RA 4
Innovation and commercialization

- **WP 1** Commercialization of research based technology
- **WP 2** Innovation systems and processes
- **WP 3** Local and regional barriers and strategies

RA 5
Scenario development

- **WP 1** Scenario definition and user interaction
- **WP 2** Scenario analysis and supervision
- **WP 3** Combined LCA and energy scenario modelling
- **WP 4** Scenario dissemination and networking

RA 1 Policy Making and Transition Strategies

Research in 2017

During 2017 researchers from RA1 have been involved in the start-up and consolidation of several new European projects. Important activities in this respect include stakeholder workshops, data collection and literature review exercises. In 2017 we have especially focused on the intersection of energy/climate policies, innovation and citizen engagement. We have done this through studying the activities of several pilot and demonstration projects working with smart energy technologies, battery technologies, small scale renewable energy generation (typically PV solar cell panels), and in some instances new power tariffs. Thus, we are studying the governance aspects of such technologies, and we examine critically how such configurations enable flexible consumption, as well as other, often unintended consequences.

We have also become increasingly interested in the effects of what we can call infrastructure bundling, as well as the coupling of sectors through energy related innovation. An example of this are the social and technical implications of transport electrification. As transport becomes part of the electricity system, this changes how one thinks about supply and demand in two large and hegemonic regimes (automobile production and electricity generation), while it also creates a range of new challenges, primarily related to balancing supply and demand of electricity. It also opens for new everyday practices on behalf of both traditional electricity users and drivers of electric vehicles, as well as the development of innovative services and business models. On the one hand, such bundling is promising because it is an indication of movement towards the kind of deep and sector-transgressing energy transition that is needed. On the other hand, it is also a challenge, because it is tricky to study and govern.

In total, we have published 11 peer reviewed research papers in international journals, as well as six research reports, which are stepping stones for future articles. We expect the hard work in 2017 to yield results in the form of several landmark publications in 2018. Below we highlight two publications, from the peer-reviewed international forefront and from an important European research project.In their paper "Planning story lines in smart grid road maps (2010-2014). Three types of maps for coordinated time travel", Thomas Berker and William Throndsen examine the role of smart grid development as system building, and consider how this is managed using planning tools called roadmaps. The material consists of 13 smart grid roadmaps written between 2010 and 2014, which were subject to a word correspondence analysis. A close reading of each document was performed and was presented as an in-depth analysis of the roadmaps of the United States, the United Kingdom, and China. In continuation of the map analogy, the paper borrows from geography the concept of the "base map", a slowly changing fundament onto which more arbitrary overlays can be configured.

The paper argues that the individual system builder, is replaced by a complex of relational activities that involve many actors, such as supranational organizations, governments, regulators, research institutions and universities, legal bodies, and industry organizations. Although the efforts are heterogeneous, they are not isolated from each other; rather, they overlap both in terms of topic and geography, as they are undertaken at levels above, below and beyond the nation-state. The paper concludes that this likely produces robust and open-ended approaches, even though some blind spots are identified. Overall, the analysis reveals that the creation and maintenance of the roadmap becomes a practice unto itself. The roadmap was in this case found to cater for three different kinds of planning, a) standardization as due process, b) top-down deterministic technology cataloguing, and c) political regulation of markets.

Another important contribution came from Martin Anfinsen and Sara Heidenreich who produced a theme report on the literature in the intersection between gender and energy research for the large H2020 project SHAPE ENERGY (Social Sciences and Humanities for Advancing Policy in European Energy). Energy studies are still very much dominated by engineers, ICT-specialists and economists, but the authors found highly interesting endeavours in including gender in such studies. The report concludes that gender is indeed a relevant, but understudied category when discussing energy consumption, energy production, technological pursuits of household energy conservation (smart technologies), and the decarbonisation of the transport sector. Moreover, this approach to energy studies seems ripe for further exploration by academics from the Social Sciences and Humanities, well equipped in dealing with such questions. The outcome of this theme report was formulated as concrete guidelines for policy makers and other researchers, on how and why we should include gender in energy research, with implications for the funding of such research. ■

RA 1's highlights in 2017

In 2017, Researchers from RA1 hosted several high profile streams and sessions at key international research events. Our presence at the bi-annual conference of the European council for an energy efficient economy (ECEEE) in France can be noted. Marianne Ryghaug had the prestigious task of leading a panel, focusing on mobility, energy efficient transportation and the development of smart and sustainable cities and communities. Beyond this, researchers from RA1 presented papers discussing how living labs can be used as a method, the practices of EV drivers, and the way ordinary people sometimes work very hard to become parts of technology demonstration projects. Further, RA1 researchers hosted a panel on sustainable urban transformations at the annual 4S conference in Boston and a stream on sustainability transitions and practice at the Nordic environmental Social Science conference in Tampere.

Marius Korsnes and energy sociologist Elisabeth Shove at the ECEEE conference in France . Photo: Marianne Ryghaug.

Numerous RA1 highlights from 2017 has come in the form of fieldwork experiences. Many of our projects currently study innovation processes or the lives of technology users who are currently experiencing the energy transition first hand. Thus, what many of the RA1-scholars are currently doing is to pursue an interest in the work of the multitude of actors who enact the political visions of the energy transition, to study the practical implications. This will be essential as the transition deepens and accelerates towards 2050.

On the one hand, it is important, because it gives us first hand insights into the challenges and opportunities, the motivations and aspirations of innovators, as well as the many ways that citizens engage in the transition process. It also serves to highlight the many ways in which policies work, as well as give important glimpses into processes of policy production. Such activities allows us to see potential unexpected consequences of activities that are typically framed as win-win solutions. An example of the opposite was found through our 2017 fieldwork at Hvaler, a site where experiments with new and differentiated power tariffs has served to produce valuable lessons. While it seems clear that these tariffs do serve to impact electricity demand patterns in ways that are desirable from an energy systems perspective, it is also clear that there are examples of socially problematic outcomes from such tariffs, where the socially and economically most vulnerable groups are also the ones that are the most heavily affected by the new schemes. As we collectively push harder for a needed energy transition, it is crucial that we as social scientists also probe ways to keep this process as fair and inclusive as possible.

An interesting case of innovation that we have been studying in 2017 is the work of the grocery wholesaler ASKO. This company has built around 9000 square meters of solar panels at their storage facilities at Tiller, Trondheim. These solar panels will amongst other things be used for electrolysis, producing hydrogen fuel cells on site. These fuel cells will power forklifts and large trucks, serving to tackle one of the largest challenges in terms of Norwegian climate emissions: road transport.

Snapshot from fieldwork at Tiller, Trondheim. Photo: Marianne Ryghaug.

The case is interesting in many ways. It serves to highlight the dynamic relationship between supply and demand of new, renewable electricity, and proposes a form of storage that allows demand for transportation services to be catered in part by solar power. The case also illustrates the hard work needed to convince a relatively conservative automobile production regime about the merits of innovating in a new field. Further, it shows the importance of innovators working to improve their own framework conditions through political work. Perhaps most importantly though, it illustrates that the energy transition does not only entail switching fuels and technologies, but that the roles, business models and strategies of actors can change dramatically. ■

RA 2 Energy Systems and Markets

Research in 2017

The main outcome from the research is education of PhD students, development of new functionality in energy system and market models, improved data for analysis, and use of the new and improved models to analyse user cases, scenarios, specific energy policy options or impact of development in new technologies. Analysis in this research area is related to the impact of electrification of petroleum and transport sector, to the electricity market, to the increased share of intermittent energy, and to the impact of energy and climate policy on the energy system.

The research in RA2 is ranging from analysis of details in the energy system or in the electricity market to analysis of global energy systems. Research groups from CenSES have been actively involved in the analysis performed by the European Energy Modelling Forum (EMF) and in IEAs Energy Technology Systems Analysis Program (ETSAP).

The study a carbon neutral Scandinavia demonstrates a cost-optimal transition towards a carbon neutral energy system in Scandinavia (Denmark, Norway and Sweden) in 2050. The analysis is done with a stochastic TIMES model that considers the short-term uncertainty of renewable electricity generation and heat demand. With more renewables in the electricity generation mix, the focus on how to handle the short-term uncertainty, related to intermittent generation, in strategic planning has increased. Stochastic Programming is a modelling framework that is developed to explicitly consider short-term uncertainty and to value flexibility. As far as we know, TIMES is the only energy system model that has an established methodology to represent short-term uncertainty by stochastic programming. The methodology was introduced in 2012 but has previously not been used to address a low-carbon transition of the energy system.
The Scandinavian electricity sector is already highly renewable and carbon neutrality requires extensive changes in other parts of the energy system, including the building, transport and industry sectors. We analyse a development of the Scandinavian energy system which is to a minimum extent dependent on external markets. This implies that we assume no import of bio fuels, no CCS in the power sector and no hydrogen production from natural gas steam methane reforming. We also assume a conservative expectation of the future implementation of energy efficiency.

Our results show that a transition to a carbon neutral Scandinavia requires major changes to the energy system. It will involve a significant electrification of the end-use sectors, especially the transport sector. The electricity capacity needs to be about double the size compared to the current capacity level, and the share of intermittent wind power and PV in the electricity generation mix will increase considerably. Hydrogen is the dominant fuel used in the transport sector, and it is cost-optimal to both invest in inflexible hydrogen production and more costly flexible hydrogen production. Due to the increased electricity consumption in the end-use sectors, there will be no net electricity export to the remaining Europe in a carbon neutral energy system in Scandinavia.

A cost-optimal transition towards a carbon neutral energy system in Scandinavia; Denmark, Norway and Sweden have been performed. The analysis are done by using a stochastic TIMES model that considers the short-term uncertainty in renewable electricity generation and heat demand. The Scandinavian electricity sector is already highly renewable and carbon-neutrality can thus require extensive changes in other energy sectors as the building, transport and industry. Norway and Sweden have significant share of flexible hydropower and Denmark has a large share of intermittent electricity generation from wind power. The analysis illustrates the adaption of all energy sectors for a carbon-neutral future, and shows how this policy affects the future interaction of the Scandinavian and European electricity sector. ■

RA 2's highlights in 2017

The work with the position papers related to prosumers has been an important activity in the research area. Researchers in RA2 have contributed with analysis in the position paper focusing on impacts of prosumers on the energy system. With a significant share of prosumers, the impact on the surrounding energy system through the local electricity generation and by changing the demand for electricity needs to be assessed. The interaction between prosumers and the electricity grid will influence the electricity price, which will further change the prerequisites for investment in the energy supply and energy demand technologies. Analysis of two cases have been performed; Impact of prosumers on the electricity and building sector in Scandinavia, and Design and cost analysis of prosumer energy systems for peak shaving with examples from retail sector and agricultural sector.

IFE and CIEMAT arranged a workshop on Sustainability Performance of the Energy Systems in Madrid, on the 29th and 30th of May 2017 in cooperation with ETSAP. In total, 19 researchers from 10 European countries participated in the workshop. The main objective was to bring energy modellers with experience on sustainability performance of the energy systems together to share knowledge, exchange and discuss methodologies and recent work, and to discuss proposals in the subject. Energy system models often include only direct GHG emissions, and the first step to be able to further study environmental impacts is to include also indirect emission as well as other non GHG emissions, such as NOx, particulates, SO_2, etc. Once environmental aspects have been identified, quantified and included into the energy models, there are other relevant issues that have to be taken into account to achieve a sustainable energy system such as socioeconomic and social aspects. Sustainability indicators are a measure of sustainability performance of the energy systems and can deal with different aspects of sustainability: economic, social and environmental. Several sustainability indicators have been proposed in the literature. While environmental sustainability indicators have been broadly investigated and applied to energy systems, the research on the applications of socioeconomic and social indicators are still lagging behind in their incorporation.

There are different methodologies to estimate socio-economic and social indicators. In the case of socio-economic sustainability indicators, Input-Output methodology (I-O) as well as other tools such as Social Accounting Matrices (SAM) can be used to provide results on value added, investment, job creation and so on, of different energy technologies. Social sustainability indicators, such as child labour, gender issues, working conditions, etc., can be estimated extending the I-O methodology with additional information. In this matter, the Social Hotspot database, which provides relevant data to analyse potential social impacts of economic activities at the country and sector level. Connecting those and other methodologies allows getting indicators for the different energy technologies. ■

RA 3 Economic Analysis

Research in 2017

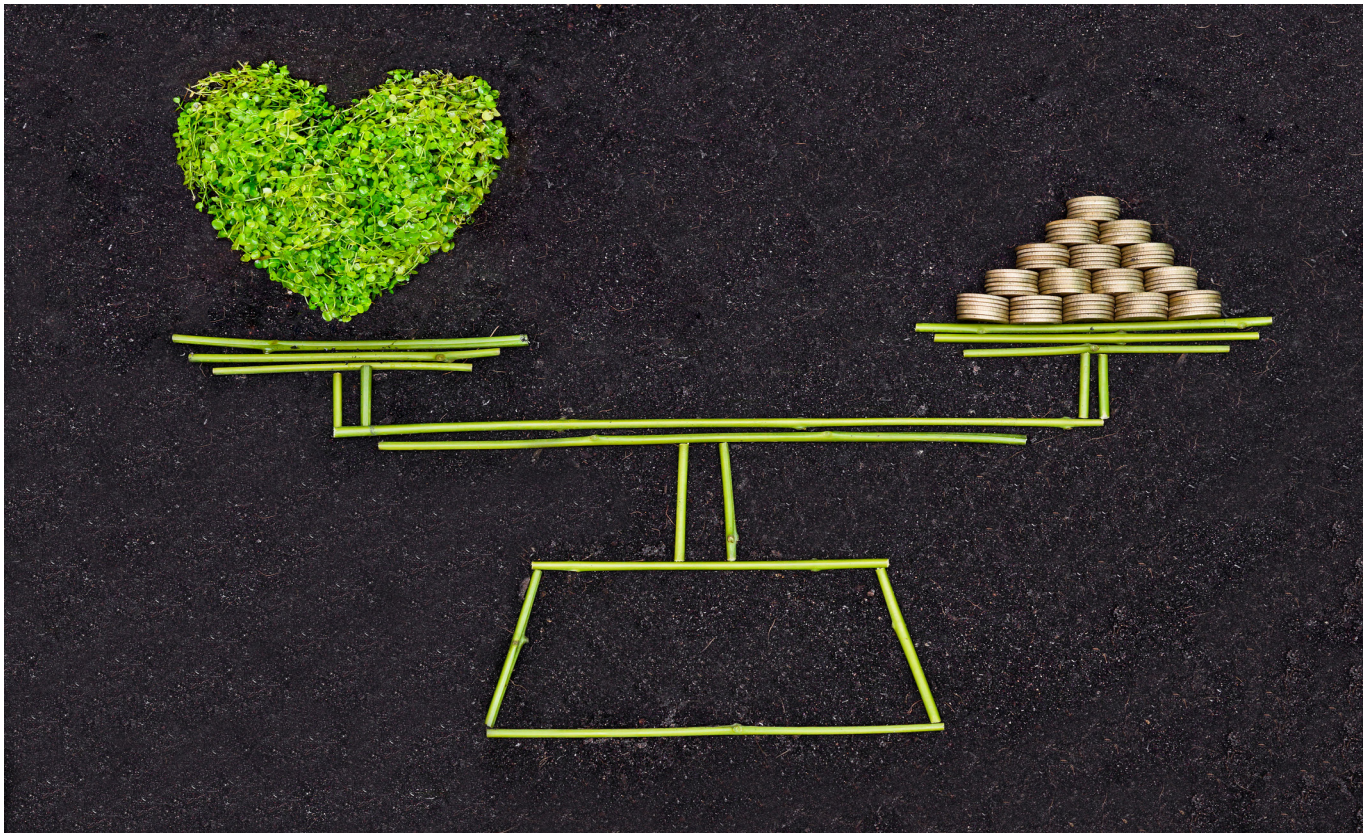
RA3 has, in its focus on reducing territorial emissions (i.e. emissions in Norway) now covered quite a lot of analysis in transport. Part of this has been in maritime shipping, a sector where Norway's position as a world industry leader lends the country a chance to influence emissions and policies globally. That work has pointed in several directions, one of which is in non-tech ways: speed, size and slenderness, work especially with Elizabeth Lindstad and Gunnar S. Eskeland. A general finding in this body of work is an old topic in energy economics: how substitutable is capital and other inputs for energy – and emissions?

Emissions in transport fall if speeds are slowed, a topic covered in the thesis by Lisa Assmann. Emissions also go down if vessels are larger, carrying more cargo per trip, but these ties up more cargo and vessel capital, so this too, can be seen as emission substitutable with capital, feasible when capital costs are low, the economy is in a downturn, or emission costs are high. Emissions also fall if one accelerates fleet renewal and technological change, or build slender hulls, again substituting capital for emissions.

Over the years, RA3 has completed and contributed to the completion of an impressive series of dissertations:

- Johannes Mauritzen (defended, then postdoc, now at BI)
- Patrick Narbel (defended, now in consulting firm Oslo)
- Tunc Durmaz (defended, now at faculty, Istanbul)
- Hong Cai (almost ready)
- Xiaomei Cheng (defended)
- Victoria Gribkovskaia (defended, now Sintef)
- Mario Guajardo (defended, now in NHH postdoc position)
- Lisa M. Assmann (almost ready, not defended yet, now in maritime shipping)
- Shiyu Yan (in process, emissions from transport)
- Evan Kyritsis (in process, empirical research on energy markets)
- Yuanming Niu (in process, renewable resource management)

In closing 2017 – beginning 2018, it is interesting to report that no less than three dissertations these months relate to the energy/emission economics in transport. Yan, Assmann and RA 3 runs with somewhat reduced resource inputs through 2018 (since a post-doc position has cost more than a Ph.D. would), and there is a bunching of organizational activities and outreach and communication around IAEE 2016 and towards closing of this research in 2018. ■



RA 3's highlights in 2017

A part of the 'transport in transition' work has been the dissertation by Shyiu Yan, alongside with single works in other dissertations. The thesis "Automobile in Transition: An Economic and Environmental Analysis of Policies for Reducing CO2 Emissions from Transport" asks: What is the role of politics in protecting the local and global environment? Very interesting from a Norwegian perspective - but also internationally - is Yan's study of how the one-time charge in Norway affects car choices, and thus emissions. The study identifies the effect - without including electric cars - on choice a car model and segment. The method excludes the effects of other developments, such as technology development and policy in Europe. The model has the strength of being able to utilize a very rich dataset of Norwegian car purchases without strong assumptions about how car types are affected. This is important because the welfare cost of turning the car purchases towards those leaner in CO2 grams per vehicle kilometer is a combination of consumers renouncing some qualities they want in a car and that manufacturers produce such qualities but at a higher cost (with less CO2).

Yan's findings are that a price increase of CO2 that raises the price of the average car by ten percent makes the 'average car' five percent less co2 intensive. The model implies that car segments with high CO2 intensity both become 'CO2-leaner' and lose market share, while the CO2-leanest segments increase their market share. The study finds that the policy explains the major part of the strong CO2 slimming we see in Norwegian new car sales, but also that these are expensive CO2 reductions assessed internationally. In pushing new-car purchases to be less CO2 intensive, the study finds that substitution within segments (between midsize cars, for instance) is about as important as between segments (from large to midsize, for instance).

The study also shows that the charge on car choice is not a given conclusion: emissions can be taxed directly through fuel taxes, and the one-time fee will raise the need for increases in motorists' user costs. The fact that CO2-slimmer cars - electrical and other - will cause traffic problems if user costs are not raised, has been communicated in other arenas, as in the literature focusing on rebound effects, inter alia by Sogndal researchers in CenSES. Among other works in transport and urban are some that focus on logistics: how do logistics firms respond to area fees and taxes in their fleet composition and routing, and urban development when public transport expansion also requires densification, partly in Work Package 2 (national policy instruments) and partly in work package 3 (local and regional). The local and regional work package also entails work on the regional dimension through the resource base, as when locations of renewable resources interact with transmission in supply and demand for flexibility and storage for the electricity system. This work has yet to conclude in bringing together what has been done on energy market design and transmission (Work package 1, and Intreped) with treatment of variability in supply and demand, especially in the intermittency of wind resources. Work that has started is on a trading platform for flexibility.

The 2017 Beeer conference (Bergen Economics of Energy, Environment and Resources Research, one and a half days) combined with an Energy Market symposium in honor of Einar Hope, to celebrate the emeritus also acknowledged as the godfather of the Energy Law (energiloven), initiating many of the reforms associated with a liberalized and decentralized electricity sector that is now proceeding beyond the Nordic countries. ■

State secretary Jens Frølich Holte and Gunnar Ekseland. Photo: Natalia Flórez Mejía.

RA 4 Innovation and Commercialization

Research in 2017

RA 4's overall aim is to create knowledge on the process of making a transition to sustainable and renewable energy sources. Such a process is complex and multifaceted, and implies the development of novel technologies and user practices, the introduction of policy measures and regulations, as well as the entry of new firms and industries that produce and adopt new technologies.

RA 4 uses insights from the field of innovation and entrepreneurship studies to examine how new technologies emerge; how they become commercialized, produced and marketed; and how they are used in Norway or internationally. We address questions such as: How do innovation processes in Norway contribute to the ongoing energy transition nationally and internationally? How does this open up new industrial opportunities? In which sectors are Norwegian research communities and industry internationally competitive? How can energy projects balance their impacts on local economies, local communities, and local environments in pursuing a sustainable energy policy?

These questions relate to how multi-scalar energy transition processes involve change on several levels. These changes encompass the entry of new firms, formation of new industries and embedding new technologies in differing regional (local), national and supranational contexts.

RA 4's highlights in 2017

A research team from CenSES with researchers from NTNU and Nord University has over a 5 year period done a longitudinal study of university – industry cooperation in research centers (6 technical FMEs). This unique study is based on more than 100 interviews with research and industry partners and secondary sources like yearly reports, web pages and mid way evalutions. Key findings are:

- Cooperation between industry and researchers is demanding and early clarifications of expectations is of vital importance.
- Formal and informal arenas to create common ground facilitates long term fruitful cooperation.
- Industry actors and research centers must dedicate time and resources at strategic and operative level.
- Industry actors with previous cooperation with universities and research institutes are better in implementing knowledge from the centers.
- Power balance between center and industry actors is a key issue in order to facilitate co-creation of innovations.

The CenSES affiliated project GREENFLEET - Sustainability Transitions in the Maritime Shipping Sector started out in 2017. With a technological innovation systems (TIS) approach at its core, the primary objective of GREENFLEET is to analyse the systemic, contextual and actor-level drivers and barriers confronting a transition from fossil-based energy technologies to low- or zero-carbon technologies in the Norwegian maritime shipping sector (MSS). Preliminary results indicate:

- Battery technology is rapidly introduced in several segments. This is mainly hybrid solutions combining conventional diesel and battery, but the industry expects a rapid introduction battery as a single source in some segments.
- Biofuels is not a «hot topic» among the industry actors, bio diesel related to sustainability and biogas because of the lack of infrastructure and availability.
- Very mixed views on hydrogen as a source for energy transition in the industry. ■

Yara Birkeland is a collaboration between Kongsberg Gruppen and Yara, with a goal of becoming the worlds first autonomous and fully electric vessel. Photo: Kongsberg Maritime.

Viking Energy was the worlds first PSV with LNG propulsion. Now she is installed with batteries as an approved 'spinning reserve' inDP-operasjoner. Photo Eidesvik Offshore.

RA 5 Scenario Development

Research in 2017

The main objective of RA5 is to provide scenario driven knowledge and analyses to policy- and decision makers to aid in the development and evaluation of sustainable energy strategies. After the CenSES scenarios have been designed on a qualitative basis, quantification is the next step. To start the quantification process, a workshop for researchers was held in March to identify potential sources, required data and potential methodologies for the quantification. The developed CenSES scenarios are largely based on the Shared Socioeconomic Pathways developed for Intergovernmental Panel on Climate Change, IPCC. These pathways were defined for and analysed with a number of Integrated-Assessment-Models (IAM), amongst others GCAM. For the quantification of the CenSES scenarios a coupling of the IAM GCAM and energy and power system models, such as EMPIRE and EMPS, will be performed. The coupling of GCAM and the power system expansion model EMPIRE, has therefore been re-established as initially developed in the KPN project LINKS under CenSES.

In parallel to the scenario development within CenSES, the KPN project "Norwegian Energy Roadmap 2050", which is strongly linked to RA5, took a starting point in the scenario development process of CenSES to establish a number of Norwegian strategies to achieve a Norwegian low-emission society. The project comes up with two distinct future scenarios for the Norwegian development, a Norwegian society based on services and a society based on industrial development. In addition, significant efforts have been put into the development of common datasets and a coupling of the economic / energy / power system models REMES, TIMES and EMPS, which will also be applied in analyses within RA5.

In June 2017, CenSES researcher Linda Ager-Wick Ellingsen from the Industrial Ecology Programme (IndEcol) at NTNU successfully defended her PhD thesis, entitled "Life cycle assessment of lithium-ion traction batteries". Early 2017 saw the publication of a perspective article in Nature Climate Change on reviewing large-scale integrated assessment models from an industrial ecology perspective, co-authored by CenSES researcher Anders Arvesen from the Industrial Ecology Programme (IndEcol) at NTNU. The article calls for more interaction between the integrated assessment and industrial ecology research fields to the benefit of sustainability science as a whole. Another 2017 publication, authored by Linda Ager-Wick Ellingsen, Christine Roxanne Hung and Anders Hammer Strømman, reviewed existing life cycle assessment studies of lithium-ion traction batteries. The study unpicks different factors explaining why carbon footprint estimates for lithium-ion vary across studies. For example, the study finds that one major factor explaining differences between studies, is whether studies rely on primary industry data or own estimations to establish numbers for energy use in cell manufacture and pack assembly. Finally, during 2017 three other life cycle assessment studies on the environmental impacts of electricity systems were published, in part thanks to support from CenSES. ■

RA 5`s highlights in 2017

Combining LCA and energy system modelling perspectives

Life cycle assessment (LCA) offers a systematic framework for attributing environmental impacts that occur in product supply chains to the product itself. In this way, LCA captures potentially important indirect (i.e., supply chain) impacts that are neglected in other types of assessment tools that only cover direct impacts. Furthermore, LCA is powerful as a tool for holistic environmental assessment, building on decades of experience of the LCA community in developing procedures for accounting for effects of hundreds of pollutants and resource uses on a wide range of environmental problems. At the same time, LCA has traditionally been static and micro-oriented, lacking the forward-looking optimization perspective and macro-orientation of many energy system models (ESMs).

Within CenSES RA5 and co-supported by other projects (NFR ESBLET, EU FP7 ADVANCE), researchers at the Industrial Ecology Programme (IndEcol) at NTNU have explored various approaches for LCA and ESMs to interact. The interaction can go in both directions: ESM procedures or results can be incorporated into LCA, and coefficients derived from LCA can be incorporated into ESMs. An example of the former is the development of the THEMIS LCA model (Gibon et al., 2015).
In further publications, THEMIS was employed to perform macro-oriented LCAs of scenario results emanating from ESM runs. For example, Hertwich et al. (2015) applied LCA to assess global ESM scenario results for electricity supply. This was achieved by augmenting THEMIS with vintage capital modelling, so that life cycle stages of individual power plants were treated explicitly in time. Another example is Berrill et al. (2016), which combined THEMIS and results from a detailed power system optimization model in order to specifically explore the effects of wind and solar variability on power losses, energy storage requirements and power transmission requirements.

Finally, in collaboration with Potsdam Institute of Climate Impact Research, IndEcol developed a method for LCA-ESM interaction in the opposite way: that is, where LCA coefficients are incorporated into ESMs. This work was reported in one paper on the derivation of LCA coefficients (Arvesen et al., 2018), and another on applying the coefficients in an ESM (Pehl et al., 2017). ■

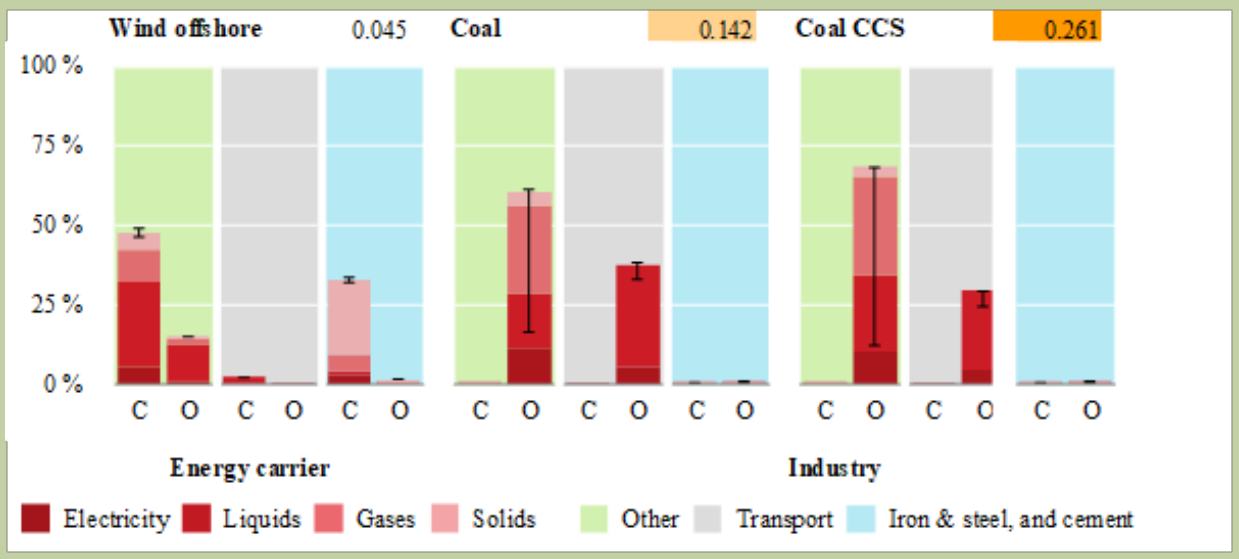


Figure: Examples of indirect energy coefficients derived from LCA for use in ESMs. Coefficients distinguish construction (C) and operation (O), energy carrier and industry. The data are structured in a way that both the timing, fuel type and industry are considered; ESM modellers can directly use the data. Values above plots give total indirect energy (excluding losses in power production itself) in units of MJ indirect energy input per MJ electricity output. Source: Arvesen et al. (2018).

User cases

Prosumers in the future energy system

Prosumers are active participants in the energy system. In addition to consuming energy, they can both provide flexibility to the system in terms of flexible loads as well as selling their own production to the market. An example of a technology that enables prosumers to sell power to the grid is solar power. The corresponding position paper is under development. Since the start, the user case has been discussed with partners in several CenSES meetings and in dedicated meetings for the user case in 2017. A first draft of the position paper has been prepared on basis of the research that has been carried out by the research partners in CenSES. Among other things, the planned topics of the position paper include discussions of: What are the important motivating factors for people to become prosumers, how are prosumers incentivized, and what are the practical considerations that must be dealt with, how should prosumers' energy systems be designed, and what are the energy system impacts of prosumers. We have invited those partners that have signalled interest in contributing to the position paper to join in the further process of developing the position paper. Our goal is to finalize the position paper before summer 2018.

Fossil free mobility

There are ambitious targets for reduction of Norwegian emissions both on a national and regional level. The largest cities in Norway have put forward goals for drastic reductions in emissions from the transportation sector. In this user case, we will gather these regional goals and strategies to present a comparable overview of the similarities and differences between the cities. Based on this, barriers and opportunities for successful implementation and transition to a fossil free mobility in the largest cities will be discussed and presented for policy makers and other decision makers. Important elements in the discussion include emissions, rebound effects, consequences for the energy system, economic effects and technology choices. Based on workshops and discussions, the scope for the user case is determined to be the climate plans in Oslo, Bergen, Trondheim and Stavanger. These plans have been collected together with other relevant documents for the four cities. A joint workshop with CICERO was arranged in November 2017, with participation from the four cities, universities, research institutes and representatives from different governmental institutions. Based on the discussion on the workshop, and the collected documents, an analysis of strategies, policies and targets has been performed. The objective of the analysis has been to compare the efforts in the different cities to highlight similarities, differences and learning potential. The positon paper is currently being written, and is expected to be finished before summer 2018.

The hydrogen value-chain

There is an increased interest for hydrogen in the Norwegian energy system. This is true both for the potential of large scale production of hydrogen (either from natural gas or renewable sources), and for the possibility of using hydrogen in the transportation sector. There is also notable interest in hydrogen internationally, and the potential for the hydrogen society will be demonstrated in the upcoming Olympics in Japan. In this user case we will summarize the experiences with hydrogen in other countries and regions. Additionally, we will discuss the potential for profitable value-chains based on hydrogen and the current market outlooks.

The kick-off meeting for the user case was held the 13th of March in Kunnskapsbyen (Kjeller) together with the kick-off meeting for the user case "Green Factory". Participants from SINTEF, IFE, NVE, Enova, Statoil, Yara, Hydro, Oslo Havn, TrønderEnergi, Miljødirektoratet, Innovasjon Norge og Norsk Industri discussed contents, definitions and scope for the user case. Both hydrogen produced from natural gas and renewables will be included in the work. The workshop provided valuable input in terms of expectations and recommendations for the user case. New workshops, both internal with CenSES' researchers, and external with user partners will be held in 2018 before the position paper is written.

Green factory

Norway has substantial amounts of valuable, flexible energy resources that have been the backbone of industry development over the last hundred years. In this user case, we will examine the most efficient utilization of these energy resources from an environmental and value creation viewpoint. One important element in this discussion is the potential impact of increased exchange capacity with the European power system. The trade-off between utilizing the flexibility in the Norwegian power system for providing flexibility services to the European energy system, and utilizing the renewable energy for national value creation through large-scale industry development will be an important part of the analysis. The kick-off meeting for the user case was held the 13th of March in Kunnskapsbyen (Kjeller) together with the kick-off meeting for the user case on hydrogen value-chains. Participants from SINTEF, IFE, NVE, Enova, Statoil, Yara, Hydro, Oslo Havn, TrønderEnergi, Miljødirektoratet, Innovasjon Norge og Norsk Industri discussed how to maximize the value of Norwegian energy resources in a broad context. The workshop provided valuable input in terms of expectations and recommendations for the user case. New workshops, both internal with CenSES' researchers, and external with user partners will be held in 2018 before the position paper is written. ■

Position papers

Do they work? Instruments for energy efficiency in buildings.

By Knut Sørensen

This report consists of four main parts. Chapter 2 gives a short overview of some trends in the development of the Norwegian policy for energy efficiency, and discusses the current energy policy instruments. Chapter 3 summarizes research about how energy efficiency is safeguarded by the construction business, included how the policy instruments are perceived and the effects that they have. Chapter 4 shifts the perspective by looking at the users, that is, how energy efficiency is understood and implemented in commercial buildings and households. Chapter 5 concludes regarding the effect of policy instruments for energy efficiency, while chapter 6 discusses possible alternative policy instruments. The main results as presented in this report may be summarized in the following way:

1) Buildings have become more energy efficient over time, but the causes for this development are complex. Partly, the development is a result of policy instruments, and especially the stricter "Regulations on technical requirements for construction works" (Byggteknisk forksrift). Partly, the development is caused by home improvement/renovation of buildings, partly by demographic change, and partly by technological development.
2) The policy for energy efficiency has to a large extent been dominated by the principle that such investments should be profitable or cost efficient, and by arguments for energy efficiency that have been one-sidedly oriented towards economic benefit. This way of thinking has resulted in an inadequate understanding of the dynamics in the energy efficiency activities.
3) Many energy efficiency measures have happened as an indirect consequence of building improvement for better comfort.
4) A stricter regulation on technical requirements for construction works (byggteknisk forskrift) is probably the most efficient instrument, but it is constrained by the fact that it works primarily for new buildings.

There is a need for new thinking about instruments for energy efficiency; especially concerning how these instruments should be shaped in order to address more explicitly what we have called the social potential for energy efficiency. The report argues that it is not easy to identify alternative instruments that can contribute to a stronger stimulation of energy efficiency in buildings. One evident possibility is requirements for renovations. Another interesting kind of measures would be to find ways of engaging the municipalities to a larger extent.

The report can be downloaded here. ■

Striving for a Norwegian Low Emission Society post 2050: Three scenarios.

By Marius Korsnes & Knut Sørensen

In this report, we outline briefly three scenarios describing three paths with distinctively different dynamics regarding the development of a low emission society post 2050. We have tried to highlight some consequences of three options we believe are present at the crossroads that Norway and the Norwegian government and Parliament face: (1) to continue to pursue oil and gas as the dominant economic activity ('the last oil' scenario), (2) to pursue a green shift towards low emission society through so-called cost effective measures like green taxes ('green tax' scenario), or (3) to go for more radical change including active and engaging forms of governance ('collective engagement' scenario). In this manner, we cultivate particular mind-sets to explore what they may come to mean with respect to a Norwegian transition towards a low emission society.

In reality, the future will probably see a mix of all three scenarios since it is possible to combine several of their features. Judging from present-day policy-making, the most likely development would be some kind of mix of 'last oil' and 'green taxation' – a top down transition that is more robust, but nevertheless, failing to engage the public and thus facing problems of lack of popular support for climate mitigation measures. The long time horizon of the scenarios raises particular challenges. For example, in a (functioning) democracy it is not likely that a government would continue with the same type of policy if citizens discover that the chosen policy-direction is not working. However, the exercise that these three scenarios provide is useful since it invites a discussion about the direction that Norwegian society ought to take.

Put in a different way, the 'last oil' scenario is a business as usual scenario, where Norway tries to get as much out of the oil and gas resources as possible. This scenario reflects the strong belief that oil and gas is of such great economic importance to Norway that this industry will remain important at least to 2050, even if it may be considered as a detour to a low emission society. The risk of increasing inflexibilities in the Norwegian economy is disregarded, and the risk of a fossil fuel endgame is overlooked. The 'green tax' scenario follows from mainstream economics that argues that the use of cost-effective, market-based instruments (green taxes) will make people and companies reduce their carbon footprint due to the unavoidable enactment of economic rationality. We highlight as a main challenge that effective green taxes may cause protest and the election of politicians that reduce these taxes, due to lack of climate policy leadership and public engagement. Cost efficiency is prioritised over governance effectiveness, which is not wise.

Based on the methodology we have used, a low emission society may not be in place in 2050. In terms of reduced greenhouse gas emissions, the 'last oil' fails because of a longstanding optimism on behalf of the oil and gas industry. In this scenario, Norway fails to prepare for a situation where the demand for oil and gas drops dramatically, resulting in an economic and social crisis that hampers the necessary changes towards low emission practices. The 'green tax' scenario describes Norway as closer to the low emission goal, but failing because the lack of climate change focused political leadership paves the way for a kind of tax populism and resistance towards the level of taxation needed to achieve the goals. Thus, the 'last oil' Norway will continue to struggle in its realisation of low emission society goals also after 2050. Also 'green tax' Norway still has a job to do after 2050, but EU regulations that set more concrete targets for emission reducing measures may kick in. This could undermine the scenario by forcing government to play a more active role in supporting innovations, technologies and practices needed to satisfy EU requirements and emission goals. In our outline, only the 'collective engagement' scenario will have succeeded in meeting low carbon society goals. This happens above all because government and the public, in this scenario, are aligned in the effort of curbing climate change.

The report can be downloaded here. ■

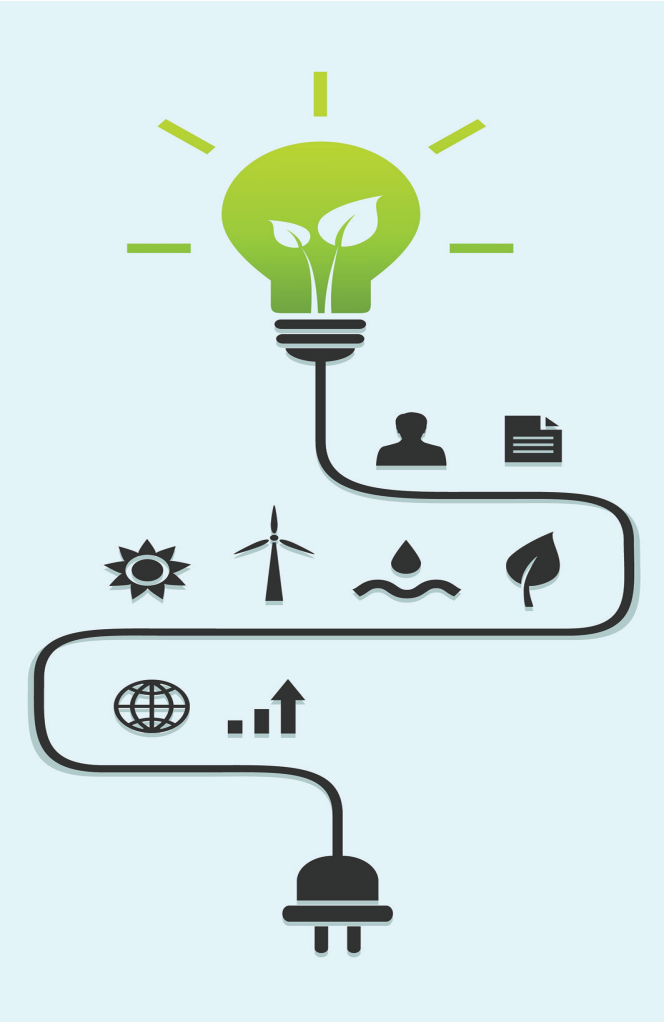
International Cooperation

Sustainability Performance of the Energy System

In late May 2017 the Institute for Energy Technology, in collaboration with Spanish CIEMAT (a public research institute), arranged a workshop called «Sustainability Performance of the Energy Systems». The workshop took place in Madrid, with participant from 12 research centres and in universities in Europe. The workshop consisted of four sessions:

1) Assessment of the energy systems sustainability
2) Energy Systems Modelling and Life Cycle Assessment
3) Input-Output Assessment
4) Impacts of energy policies

All participants presented own research related to methods for improvements in sustainability modelling. The collaborative efforts at the workshop contributed to improved analysis of the interactions between energy systems and society, by taking into account environmental, social and social economics. ■



Implications of Paris

CenSES partner Joint Global Change Research Institute has invited both CenSES and CREE to join an international project called Implications of Paris. The goal of this project is to identify the most important research challenges in the wake of the Paris agreement and to inform politicians and stakeholders of potential gaps in knowledge and research.

The projects consists of three sequential workshops. The first was in Maryland (2016). In March 2017, the second workshop was arranged by CenSES and CREE and took place in Trondheim. In October 2017 the third workshop was in Tokyo, where CenSES participated.
https://www.ntnu.edu/censes/implications-of-paris

http://www.globalchange.umd.edu/implications-of-paris-project/ ■

PhD Winter School in Italy

On January 15-21 2017 the PhD Winter School on Stochastic programming with applications in energy, logistics and finance was held in Passo del Tonale, Italy. The seminar was organized by the University of Bergamo, CenSES, the Norwegian University of Science and Technology (NTNU), and the Norwegian School of Economics (NHH). 85 participants spent the week attending morning and evening sessions on topics such as applications of stochastic optimization, modeling in energy, logistics and finance, multistage stochastic programming, and risk management. In between lectures, the participants had the possibility to explore the downhill pistes or cross-country trails of this winter holiday resort situated inbetween the regions of Lombardy and Trentino in the Alps of Northern Italy. The 86 participants at the winter school had an instructive and useful week, at a very beautiful location. The participants came mainly from Europe, but the school attracted participants from almost all continents. Lecturers came from NHH, University of Bergamo, University of Maryland, Vienna University of Economics and Business, EPFL, Université Paris Sud, UFSC, University of Vienna, Univeristy of Auckland, Berkeley, Ohio State University, UCL, NTNU.

Read all presentations here. ■

Photos: Francesca Maggioni.

SET-Nav: Navigating the Roadmap for Clean, Secure and Efficient Energy Innovation

The SET-Nav project objective is to support the strategic decision-making in Europe's energy sector, enhancing innovation towards a clean, secure and efficient energy system. The project findings and recommendations are in line with the European Union's SET-Plan goals. The SET-Nav project rest on three pillars: modelling, policy and pathway analysis, and dissemination. To this end, SET-Nav has developed a broad and technically advanced portfolio of energy system models.

SET-Nav has implemented eleven case studies focused on the evolution of key energy sectors. For each case study, state-of-the-art modelling analysis have been performed which lead to innovative insights and sector specific recommendation. For example, findings from the case studies have provided rich information to formulate pathways that can address the multiple dimensions of the energy transition. This has provided a unique setting to harness multi-disciplinary understandings and to find synergetic solutions to recommend EU policies for the energy transition. The case studies have proven to be a great setting for collaboration and have produced important dissemination activities (publications, various events and presentations in Brussels and across Europe). Moreover, this has contributed to create a web-based database to support the dissemination of results. This database will be open to the wider research community and has facilitated harmonizing the data workflow among SET-Nav models.

As the project enters on its last year, the work plan is to propose four energy transition pathways. NTNU (Pedro Crespo del Granado and Ruud Egging) is leading this endeavor. These EU pathways will inform policy dialogue and provide insights into ways to achieve decarbonisation by answering key questions, such as: how do policies (e.g. energy efficiency, carbon price, renewables support) complement each other to achieve the EU's 2030 and 2050 targets? For each pathway, what are the important elements, drivers and factors of the energy transition and their cost-effective solutions? ■

International collaboration

CenSES researchers has been active in several international forums this year. Professor Marianne Ryghaug (above left) has been invited keynote at the establishment of Urban Institute at University of Sheffield, and subsequently participant in collaborations on urban automation. Researcher Tomas Moe Skjølsvold (above right) is a part of the Smart Grid – Smart Cities? project network, wherein he participated at a workshop in the NTNU office in Brussels.

The network is financed by the Academia für Raumforschung und Landesplanung (ARL) and consists of prominent international researchers: Harriet Bulkeley (Durham University), Harald Rohracher (Linköping University), Rob Raven (Utrecht University) and Simon Marvin (Durha University). ■

Summer school in Beijing

Photo: Marius Korsnes.

Researcher Marius Korsnes is active in SINopse (Sino-Norwegian Partnership on Sustainable Energy). In 2017 he was one of the organisers of a summerschool in Beijing: Sustainable Energy in Cities. One of the topics was the design of the olympic village for the Winter Olympics in Beijing 2022. While in Beijing, Korsnes discussed future projects with Dr. Chengwei Wang (Institute of Science, Technology and Society, Tsinghua University), Assistant Professor Yixin Dai (School of Public Policy and Management of Tsinghua University) and Fei Teng, Associate Professor (Institute of Energy, Environment and Economy, Tsinghua University). Fei Teng is now a partner in a new project partly financed by NTNU Energy. ■

Paris, February 2017. *Photo: Marianne Ryghaug.*

Trans-Atlantic consortium on energy markets modelling (TACEMM)

This project is an INTART project funded by the Norwegian Research Council to support excellent research and education through international networks. Research area 2: Energy Systems and Markets, and 3: Economic Analysis, address the transition to a sustainable energy system and research on how the main drivers will affect its design and operation. Today's market designs and corresponding planning and scheduling tools are not adequate to manage the complex future energy system currently under development. The focus areas of TACEMM are 1) Models, theory and studies that look at the design and operation of modern energy systems. 2) Theory and analysis that supports markets that will ensure efficient resource utilization, a fair welfare distribution, and incentives to invest in new capacity. TACEMM plays an important role in increasing our capability to integrate new research knowledge into master and PHD level courses.

Project partners:

- Norwegian University of Science and Technology (NTNU)
- Norwegian school of economics (NHH)
- University of Maryland (UMD), USA
- Technische Universität Berlin (TUB), Germany
- Universidade Federal de Santa Catarina (UFSC), Brazil
- Universidade Federal do Rio de Janeiro (UFRJ), Brazil
- State University of Campinas (UNICAMP), Brazil
- Instituto Nacional de Matemática Pura e Aplicada (IMPA), Brazil
- Johns Hopkins University (JHU), USA. ■

Early Career Research School

In February 2017, CenSES researchers Marianne Ryghaug, Tomas Moe Skjølsvold and Marius Korsnes arranged an "Early career research school" at the The Norwegian University Centre in Paris. NUCP is a French-Norwegian centre for the humanities and social sciences. Jonathan Rutherford, a prominent city and energy researcher from Ecole des Ponts ParisTech was keynote. ■

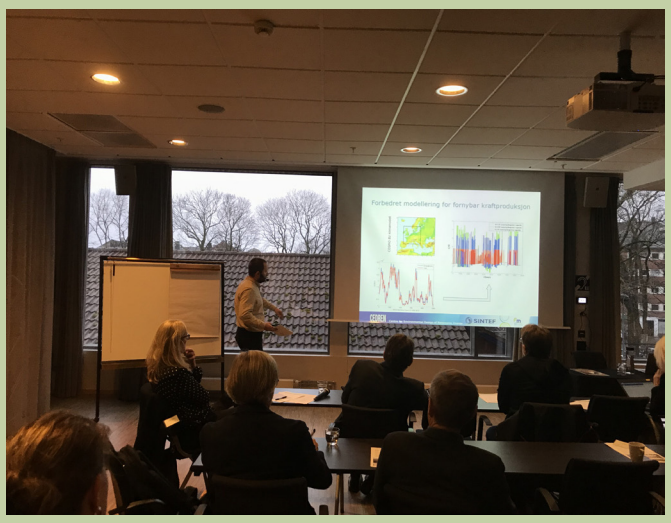
Dissemination

CenSES Annual Conference 2017

In December 7-8 2017, the annual CenSES conference was held at Scandic Solli in Oslo. 70 participants was engaging in presentations from CenSES researchers and user partners. Papers on newly published research was given from a broad range of researchers, on topics such as transitions in the energy sector towards 2030 and 2050, the future energy system, sustainable transport systems, the development of a sustainable society in relation to the 1,5 degree target, and sustainable investments and new business models in the energy sector.
All presentations here. ■

The participants were engaging in debate during the sessions. Photo: Solveig Lien.

Marianne Ryghaug (NTNU) and Allan Dahl Andersen (UiO) enjoying a session break.
Photo: Solveig Lien.



Presentation of models for new energy production. Photo: Solveig Lien.

Masterclass with Nature

In November 2016 two editors from the renowned scientific journal Nature held a masterclass workshop at NTNU. The participants were ph.d-students and researchers. The two-day workshop contained lectures on article writing, what makes a good title, abstracts and models, as well as the publication process and how to make informative models and diagrams. ■

Editors Micky Dean and Eithne Tynan in Nature Masterclass. Photo: Solveig Lien.

Round-table conference in Oslo

In October 2017, CenSES organized a round-table conference with researchers and representatives from industry and public administration in order to create good dialogue around central research challenges at the interface between social sciences. Both CenSES partners and others were invited.

The backdrop for such a conference was that CenSES and its partners has conducted research for about 10 years, and in the period between 2008 and 2018 has educated between 40 and 50 PhDs and postdocs in the center or in connected projects. Now, CenSES and its research partners work to develop the strategy for the next 10-years period, and input from industry and public administration will be of great value when identifying the most important fields for the social science research within energy and climate for the 10 years to come.

The seminar consisted of introductions from industry, business and public management, followed by group and plenary discussions. ■

Snapshot from round-table conference. *Photo: Solveig Lien.*

Snapshot from round-table conference. *Photo: Solveig Lien.*

Dissemination

Energy Transition 2017

In 2016, NTNU and Statoil initiated a new research programme on Energy Transition Strategies. The ambition is to recruit international experts on the topics and strengthen cooperation with leading research groups. So far, Statoil and NTNU both financed the new programme with 25 mill each over 5 years. However, this is an open research programme were also other participants from industry, public offices and government will be invited.

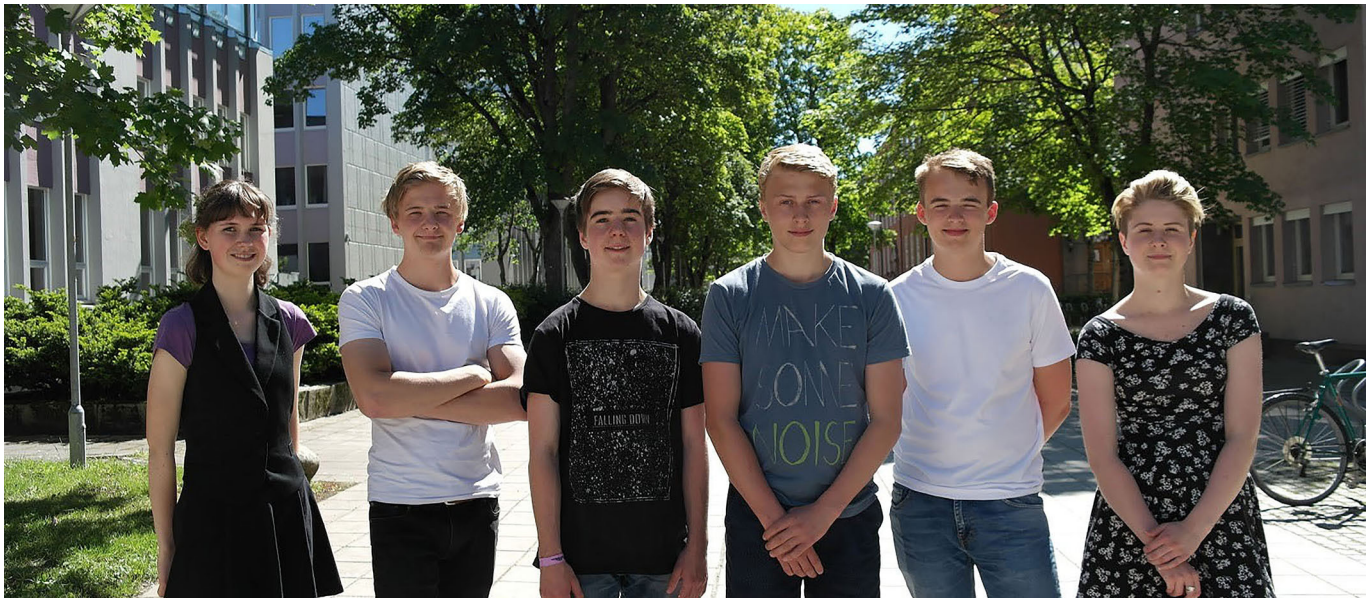
In March 2017, the programme organized its first Energy Transition conference in Trondheim with more than 400 participants, and around 1200 following the live stream. The speakers were Norwegian and international experts from IIASA, TU Berlin, DIW Berlin, Joint Global Change Research Institute, NTNU and SINTEF as well as policy makers and representatives from NGOs and industry. The conference stream as well as presentations from the keynotes can be found here: https://www.ntnu.edu/web/energytransition-conference/previous. This is to be a yearly conference, and the next one will be in February 2018.

https://www.ntnu.edu/web/energytransition-conference/energytransition-conference.

In November, the programme organized a 2-day workshop in order to identify and develop research projects within the area of energy transition in a joint effort between industry and researchers. Leading experts from MIT, National Renewable Energy Laboratory and University of Maryland participated together with experts from NTNU and Statoil, as well as representatives from Norske Shell and Norsk Hydro. The workshop resulted in the development of three project themes: 1) The role of natural gas in the European energy system, 2) The transition to low carbon transport, and 3) Flexibility and system integration. These proposed projects will be further developed in a series of workshops during the Energy Transition Week 2018.

https://www.ntnu.edu/energytransition/transitionweek. ■

Energy Transition Conference 2017. *Photo: Ole Martin Wold.*



From left: Martine Klock Fleten, Sondre Duna Lundemo, Thor Ivar Helgesen, Sigve Lysne, Markus Valås Hagen, Marianne B. Eid. Photo: Kristine Klock Fleten.

UNG ENERGI

Ung Energi is a group of students who seek to improve secondary school students' understanding and interest in renewable energy. FME CenSES established Ung Energi in 2012. Our main goal is to encourage teachers to include information about renewable energy in their teaching lessons. In the summer of 2017, Ung Energi hired five new employees to create new content for the website, and revise the old. Since then, Ung Energi has produced texts about nuclear power, innovative energy solutions, international climate agreements and much more. This past year we have experienced an increase in the number of visitors to our website ungenergi.no. In autumn of 2016 our monthly average of visitors was around 6000, while in autumn 2017 it was around 11 000. This is, of course, a development we are very happy with, and it is great to see that we can reach out to more and more people. In our statistics, we can also see that our most popular text of autumn 2017 was our text on hydrogen-powered cars, which is also interesting to note.Although most of our articles and other projects are written and developed during the summer, we have also finished some articles and projects in the autumn. An article about "the future of airplanes", as well as an article about Klimasøksmål Arktis, are some of these. We have also developed a teaching program about hydropower, which we look forward to try out in a high school class this spring. In addition to the teaching program itself, we have made a video explaining how to make a hydropower plant. Finally, we have worked for a long time with a project regarding the life cycle of a mobile phone, named UseITSmartly. This project has been further developed this autumn, with the addition of a website, as well as more texts and exercises. ■

Tweet tweet!

In April 2018 CenSES had 733 followers, an increase of 100 followers since 2017. We were following 1050, all key national and international stake-holders such as industry, decision makers, politicians, scientists, researchers and NGOs. We use twitter to present our research and to communicate with people that are sharing the same passion about sustainable energy.

Follow us on twitter! @FMECenSES

Joint seminar for usepartners and researchers: Presenting four new usercases

Ove Wolfgang, Stein Erik Fleten and Tyson Weaver. *Photo: Stine Mari Skeide.*

In August, CenSES invited user partners and researchers for a seminar at Radisson Blu Hotel Trondheim Airport. In January the CenSES board passed decided about four new user cases, and the purpose of this seminar was to present the new user cases, and to have some discussion about the goal for each of the cases. Researchers and user partners held initial presentations as a point of departure for discussions about how to carry out the work with the following user cases:

1. Electrification of transport
2. Green factory: The interaction between industrial value creation, power production and power exchange with Europe.
3. Value chains for hydrogen
4. The prosumers' role in the future energy system

The program and presentations are available here. ■

Coffee break at Radisson Blu Hotel Trondheim Airport. *Photo: Stine Mari Skeide.*

Education

Master students

In 2017 approximately 25 master students wrote their thesis on environmentally friendly energy systems and markets in CenSES. Key researchers, post docs and phd students from the center supervised the master students.

PhD students

There were 15 PhD students funded by CenSES in 2017. Three of these students finished their thesis during the year:

Linda Ager-Wick Ellingsen

Karen Byskov Lindberg

Håkon Endresen Normann

Master thesis: "Norwegian Energy Scenarios" by Audun Tynset (NTNU)

The penetration of renewable energy sources is increasing in the European power system. Their interaction with the power market is fundamentally different from that of traditional thermal power production. This thesis aims to highlight the consequences this development has for the Nordic power system. The consequences studied are mainly related to power flows, power prices and storage handling. To that a dataset using the overall data and consistency from ENTSO-E TYNDP Vision 4 2016 is created, but applies a different geographic resolution than that of TYNDP Visions.

The Nordic areas have been found to push low summer prices to its neighbouring areas, driven by the risk of spillage and coherent low water values. The Nordic areas does however absorb daily price differences from its neighbours. So much so that the lowest average price of the day is at noon, and the highest average price of the day is in the evening, even in the Nordics. ■

Master thesis: "Between Straw and Technology - a study of users in green houses" by Line Lyndstad (NTNU)

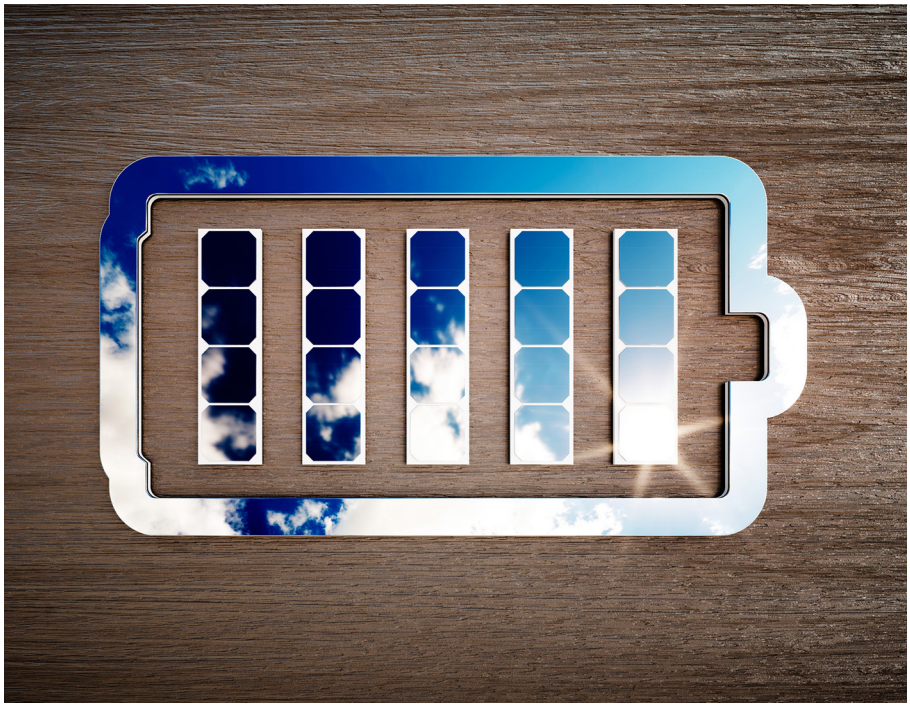
The green change is a strategy for reducing the human made climate change. In the Norwegian building industry, the green change resulted in demands and requirements for new houses. These demands caused a large controversy among experts, but did not include the users opinions and experiences. This thesis is a qualitative study of residents' experiences in three different "green houses": straw houses in Kilden Økosamfunn, active houses in Hurdalen Økolandsby and Zeb Living Lab in Trondheim. Through interviews with the residents, the thesis aims to describe the users' experiences with living in such houses. Which understandings and logics of sustainability are the different houses based on? What kind of negotiation arises between the sustainability understanding built into the houses the users own understandings and their quality of living? One finding is that the active houses as they are defined by the demands by TEK 10 are not feasible. However, the active house functions as a compromise between different logics of sustainability and the users everyday lives and wishes. The analysis and findings supports arguments for redefining the sustainability goal for houses, towards a more holistic and clearly defined society goal. The social and cultural aspects of living and user experiences must be emphasized and included in order to emphasize energy reduction and CO2 emissions. ■

2017 dissertation: Techno-economic models in Smart Grids: Demand side flexibility optimization for bidding and scheduling problems.

By Stig Ødegård Ottesen.

Introduction of power-intensive appliances such as electric vehicle chargers and induction cooktops, as well as technologies for local renewable electricity generation from solar panels and wind turbines will provide challenges for distribution grids in the coming years. High power peaks, rapid power changes and less predictability will increase the need for transmission capacity and reserves. Traditionally, such problems are met with costly investments in new capacity. An alternative approach is to use flexibility from the end users, which means that generation and consumption of electricity is changed as a response to prices or other signals. Introduction of batteries in buildings, advanced metering infrastructure (AMI) and the Internet of Things (IoT) increase the potential for demand side flexibility. Altogether, these technologies constitute the concept denoted the Smart Grid. To realize this increased flexibility potential, financial incentives must be introduced. Major changes are therefore expected in the electricity market in the coming years, including introduction of new, innovative contract types and business models, changes in market designs and the establishment of new market roles.To maximize the benefit of demand side flexibility, there is a need for development of new decision support models. This thesis proposes and analyzes models for trading in different markets and for the scheduling of flexible devices in an operational situation. The models are based on operations research. The decision problems are mathematically formulated, and a particular focus is on how to handle uncertain parameters, such as consumption, generation and market prices. Stochastic programming is used for this purpose. The thesis consists of four articles. In Article 1 a basic model is established where flexibility is divided into different classes. The article analyzes a prosumer in the retail market, where flexibility gives cost savings by exploiting price variations over a day, between energy carriers and by reducing the demand charge at the grid tariffs. In Article 2 several prosumers are coordinated via an aggregator who buys and sells electricity in a spot market and where imbalances are settled in a balancing market. Article 3 focuses on flexibility trade, where the value of an aggregated flexibility portfolio is maximized by trading in three sequential markets. The last article analyzes the decision problem to a service provider who operates a charging site for electric vehicles, where the capacity is limited. All articles contain case studies that have been conducted in close cooperation with companies in the Norwegian electricity market. ■

Stig Ødegård Ottesen, NTNU.



Lina Ager-Wick Ellingsen, NTNU.

2017 dissertation: Life cycle assessment of lithium-ion traction batteries.

By Linda Ager-Wick Ellingsen.

Battery electric vehicles (BEVs) have been promoted as a promising alternative to conventional vehicles due to their zero tailpipe emissions and higher powertrain efficiency. However, the change in powertrain technology may introduce unfavourable environmental trade-offs. Because lithium-ion traction batteries are the core of BEVs, understanding their environmental impacts is essential. This thesis assesses the environmental characteristics of lithium-ion traction batteries and evaluates how these influence the overall environmental profile of BEVs.

We find that the life cycle environmental impacts of a lithium nickel-cobalt-manganese oxide traction battery pack are considerable. The production phase is particularly impact intensive due to the significant use of metals and energy. Three production chains associated with the battery cells are found to be particularly impact intensive: manufacture of battery cells, copper in the negative current collector, and nickel sulphate in the positive active material. The other cell and battery pack components have smaller contributions. Impacts associated with the use phase and end-of-life treatment are less significant than those pertaining to production. The indirect impacts associated with the electricity use during operation largely depend on the conversion losses, battery weight, and the energy sources used to generate the electricity that charges the battery. Environmental impacts associated with end-of-life treatment may differ, as there are several different industrial recycling schemes for lithium-ion batteries. The large environmental impacts of traction batteries holds repercussions for BEVs. The production of the battery pack alone can result in higher environmental loads in some impact categories than the production of a conventional vehicle. However, BEVs are more energy efficient than conventional vehicles and can compensate for the higher production impacts by having lower use phase impacts, but this depends on the impact intensity of the electricity. As such, BEVs introduce environmental trade-offs between life cycle benefits and disadvantages. Because increasing battery pack size and range result in higher life cycle impacts, BEVs with longer driving ranges generally tend to have larger life cycle environmental impacts than those with shorter driving ranges. In terms of GHG emissions, the ability of BEVs to compensate for the higher production impact depends on the carbon intensity of the electricity used for charging. To ensure and maximize the environmental benefits of the electric powertrain, it is imperative that batteries last as long as the vehicles they power. Production of replacement cells may compromise the ability of BEVs to compensate for higher production impact. ■

Karen Byskov Lindberg, NTNU.

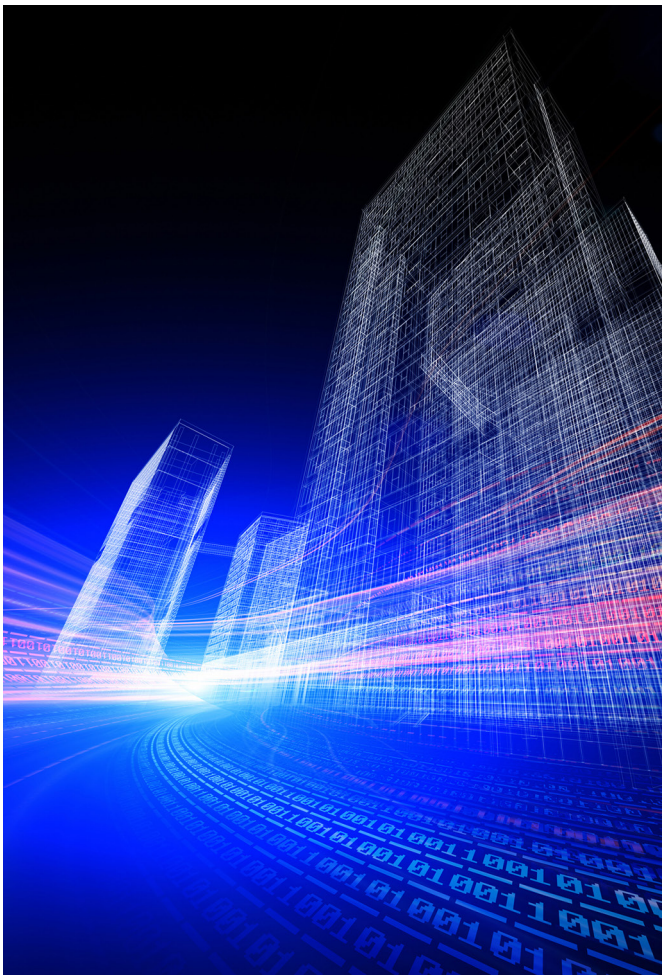
2017 dissertation: Impact of Zero Energy Buildings on the Power System.

By Karen Byskov Lindberg.

This thesis investigates the impacts of introducing energy efficient and electricity generating buildings, called ZEBs, into a power system with a high share of renewables. Detailed knowledge of electricity demand is essential for power system planning and operation. EUs 20-20-20 targets will increase the development of more energy efficient buildings as all new buildings shall be "nearly net zero energy buildings" (ZEBs) by 2020. The result from this ambition is that ZEBs, with lower energy demand and onsite power generation, will significantly change the way buildings are integrated in the power system. System operators must consequently prepare for changes in load profiles.

This PhD entails extensive research on the hourly load profiles of ZEBs, by investigating the differences between the existing building stock and new energy efficient buildings. Whether heat is supplied by a thermal source or electricity is essential for the total electric profile of a building. Hence, the heat load and electric specific load are evaluated separately. The different topology and utilization of the buildings called for evaluation of eleven different building categories, of which nine non-residential and two residential building types. To assess the impact on the power system of a large implementation of ZEBs, a methodology for aggregating the total load profile of the Norwegian building stock is developed. The methodology allows for evaluation of the effect of introducing any percentage of highly energy efficient buildings in the energy system. The following are some of the main results obtained in this PhD work:

- The annual heat demand of passive energy efficient buildings is about 50-60 % lower when compared to existing buildings, but the shape of the hourly heat load profile is similar for the two. Hence, the heat profile is determined by the operational pattern of the buildings, whereas the total heat consumption is dependent on the standard of the building.
- The electric specific demand of passive energy efficient buildings does not differ substantially from existing buildings, about -6 % for offices, and the shape of the hourly load profile is similar. Consequently, the electricity load of buildings seems to be less dependent on the technical standard of the building than the thermal load. ZEB optimization.
- Results show that PV is always a part of the ZEB's energy system design. Hence, on a building level, ZEBs have large exports of electricity to the local grid in summer, and import in winter.
- The net electric load profile of ZEBs are determined by the choice and size of energy technologies, i.e. the desgin of the building and how they are operated. ■



2017 dissertation: Politics in energy system transformation. Conditions for the development of an offshore wind industry in Norway.

By Håkon Endresen Normann.

This thesis is motivated by the urgent need to transform a fossil based energy system to a system based on renewable energy resources. This transformation will rely on the expansion of sustainable alternatives as well as the discontinuation of use of fossil fuels. This presents a dilemma for countries with substantial income from production of fossil fuels and ambitious climate policy targets. This dilemma opens up for conflicts of interests that shape the conditions for new renewable energy technologies. The politics of transitions has increasingly been recognised as an important research area within studies of innovation and sustainability transitions. The purpose of this thesis is to help understand the way in which the political context shapes the opportunities for developing and nurturing new renewable energy technologies. More specifically, the thesis studies how politics influence policies in a country deeply vested in a fossil-based energy system. The thesis uses the case of offshore wind as the empirical setting to explore the topic of politics in energy system transformation. Offshore wind has been pointed to as an opportunity to diversify activities in the offshore oil and gas industry in Norway, and substantial public and private resources have been dedicated to explore this opportunity. Offshore wind is thus a suitable case for studying both the development of an alternative to fossil fuels and the possibilities to reorient fossil based industries. Two main insights can be drawn from the thesis. The first relates to how niche technologies can exploit windows of opportunity. Public support for new technologies depends in part on the presence of articulated problems important to decision makers, and the capability of niche actors to attach new technology as a solution to these problems. This capability is in turn influenced by (i) the structure of policy networks, (ii) the alignment of interests between state actors, politicians and political parties, and business interests, and (iii) arbitrary or exogenous events, short-sightedness of politics, and uncertainty concerning technology. This final point underlines the difficulty in steering a transition. The second insight relates to the dual role of incumbent industries in transitions. Participation of large, established firms can contribute towards niche development. Large investments in offshore wind by Statoil, the largest Norwegian oil producer, have been important for the legitimacy of offshore wind in Norway and have led to a number of sub-contracts for Norwegian suppliers. At the same time, incumbent industries can represent a barrier for system change. New opportunities in the offshore petroleum industry can reduce the incentives for incumbent firms to invest in new renewable energy technologies. Moreover, climate and energy policy principles in Norway have co-evolved with the interests of incumbent industries, and are less favourable for new and immature industries. Thus, policies that target new renewable energy technologies should be seen in conjunction with policies aimed towards established industries. ■

Håkon Endresen Normann, UiO.

Education

PhD candidates with financial support from the centre budget

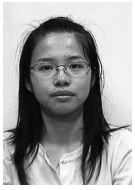

Martin Anfinsen
NTNU


Veronica Araoz
NHH (2012)


Lisa Maria Assman
NHH


Vegar Lein Ausrød
NTNU (2016)


Øyvind Bjørgum
NTNU (2016)


Xiaomei Cheng
NHH (2015)


Linda Ellingsen
NTNU (2017)


Kyritsis Evengelos
NHH


Thomas Gibon
NTNU


Geoffrey Gilpin
Vestforsk/UMB (2016)


Mads Dahl Gjefsen
UiO (2015)


Ole Inge Gjerald
Vestforsk/ NTNU


Jens Hanson
UiO (2013)


Daniel Haugstvedt
NTNU


Puck Hegeman
NTNU


Robert L. Jomisko
NTNU (2015)


Susanne Jørgensen
NTNU


Karen Byskov Lindberg
NTNU (2016)


Sylvia Lysgård
NTNU


Tuukka Mäkitie
UIO


Hector Marañon-Ledesma
UIO


Johannes Mauritzen
NHH (2012)


Patrick Narbel
NHH (2014)


Håkon Normann
UiO (2017)


Hilde Nykamp
UiO (2015)


Ha Thi Bich Pham
UiO (2016)


Hilde Reinertsen
UiO (2016)


Bente Johnsen Rygg
HiSF/NTNU (2015)


Vivek Sinha
NTNU


Christian Skar
NTNU (2016)


Zhonghua Su
NTNU

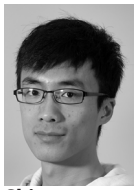

Eirik Swensen
NTNU (2015)


William Throndsen
NTNU (2016)


Trine Unander
NTNU


Hans Jakob Walnum
Vestforsk/AAU (2015)


Tyson Weaver
HiSF/NTNU (2016)


Shiyu Yan
NHH

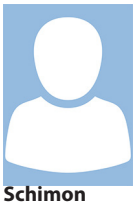

Ni Yuanming
NHH

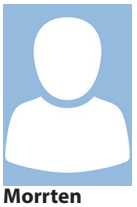

Elisabeth Svennevik
Uio

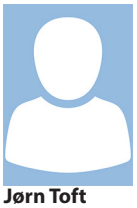

Marie Byskov Lindberg
UiO


Iren Tvedten
UiO


Christine Mee Lie
UiO


Schimon Grossman
NHH


Morrten Nielsen
NTNU


Jørn Toft Bysveen
NTNU

Post docs with financial support from the centre budget

Ekaterina Bjørnåli
NTNU (2016)

Chiara Bordin
NTNU

Jens Hanson
UiO

Gitte Koksvik
NTNU

Marius Korsnes
NTNU

Liste Lucìa
NTNU (2017)

Johannes Mauritzen
NHH (2015)

Adela Pages
NTNU (2014)

Stefan Pauliuk
NTNU (2015)

Parmita Saha
HiSF (2014)

Christian Skar
NTNU (2017)

William Throndsen
NTNU

Gerardo Perez Valdés
NTNU (2014)

Ola Edvin Vie
NTNU (2013)

Tyson Weaver
HiSF/NTNU

Håkon Normann
UiO

Funding plan

Partner	2011		2012		2013		2014		2015		2016		2017		2018		2019		All years		
	financial	inkind	financial	inkind	financial	inkind	financial	inkind	financial	inkind	financial	inkind	financial	inkind	financial	inkind	financial	inkind	financial	inkind	total
NTNU IØT	0	4 015	0	6 236	0	6 391	0	5 315	0	4 348	0	3 759	0	3 927	0	4 968	0	1 708	0	40 667	**40 667**
NTNU HF	0	3 670	0	3 951	0	4 246	0	4 601	0	3 018	0	3 819	0	3 865	0	5 562	0	1 061	0	33 794	**33 794**
NTNU Indecol	0	0	0	616	0	616	0	674	0	609	0	121	0	57	0	0	0	0	0	2 692	**2 692**
NTNU Elkraft	0	0	0	0	0	22	0	32	0	87	0	42	0	0	0	0	0	0	0	183	**183**
NTNU Samfunnsforskning	0	0	0	0	0	18	0	12	0	0	0	0	0	0	0	0	0	0	0	30	**30**
UiO	0	990	0	3 414	0	2 776	0	2 542	0	2 190	0	1 989	0	1 133	0	1 991	0	475	0	17 500	**17 500**
HiSF	0	613	0	1 166	0	866	0	952	0	6 536	0	3 593	0	7 142	0	3 083	0	1 448	0	25 399	**25 399**
VF	0	392	0	477	0	797	0	684	0	0	0	0	0	0	0	0	0	0	0	2 350	**2 350**
NHH	0	1 650	0	1 912	0	1 750	0	1 800	0	1 850	0	1 900	0	1 950	0	2 000	0	0	0	14 812	**14 812**
Sintef EF	0	2 179	0	2 362	0	2 039	0	2 166	0	2 049	0	1 612	0	1 606	0	1 637	0	0	0	15 650	**15 650**
Sintef TS	0	964	0	1 265	0	1 277	0	1 219	0	1 384	0	1 060	0	231	0	230	0	0	0	7 630	**7 630**
IFE	0	700	0	700	0	700	0	700	0	700	0	701	0	701	0	700	0	0	0	5 602	**5 602**
SNF	0	500	0	500	0	500	0	500	0	500	0	500	0	500	0	500	0	0	0	4 000	**4 000**
Total research partners	0	15 673	0	22 599	0	21 998	0	21 198	0	23 271	0	19 097	0	21 111	0	20 671	0	4 692	0	170 309	**170 309**
Total user partners	3 900	947	4 025	1 127	2 317	1 006	3 202	1 276	4 832	765	5 020	744	4 250	936	2 450	1 100	0	0	29 995	7 902	**37 897**
Research Council	4 235	0	9 866	0	12 273	0	9 730	0	11 409	0	9 024	0	5 720	0	17 089	0	653	0	80 000	0	**80 000**
0	**8 135**	**16 619**	**13 891**	**23 726**	**14 590**	**23 004**	**12 931**	**22 474**	**16 241**	**24 036**	**14 044**	**19 841**	**9 970**	**22 047**	**19 539**	**21 771**	**653**	**4 692**	**109 995**	**178 211**	**288 206**

Cost pr. research area

	2011		2012		2013		2014		2015		2016		2017		2018		2019		All years		
	financial	inkind	financial	inkind	financial	inkind	financial	inkind	financial	inkind	financial	inkind	financial	inkind	financial	inkind	financial	inkind	financial	inkind	total
BUDGET RA1	506	3 977	1 149	4 953	597	4 740	558	5 151	811	3 113	1 479	4 358	1 275	3 362	5 091	4 120	653	906	12 120	34 679	46 799
BUDGET RA2	2 699	5 036	3 465	5 286	3 137	5 205	2 333	4 009	2 131	2 458	2 352	1 100	1 034	1 791	3 449	1 793	0	0	20 600	26 678	47 278
BUDGET RA3	1 612	2 586	2 282	2 851	2 093	2 651	2 731	2 778	2 983	2 721	2 309	2 879	1 873	2 684	1 562	2 775	0	0	17 445	21 925	39 370
BUDGET RA4	1 634	2 207	3 590	6 466	3 345	6 800	3 952	6 086	4 630	10 558	2 316	5 666	1 882	9 738	1 513	7 690	0	3 117	22 861	58 327	81 188
BUDGET RA5	364	1 050	1 052	1 888	2 093	1 622	2 050	2 091	2 443	2 650	2 127	3 432	1 710	2 371	1 147	2 808	0	0	12 987	17 912	30 899
BUDGET Management	785	1 764	1 542	2 256	1 046	1 928	1 312	1 861	1 095	2 513	1 071	2 406	609	2 101	3 064	2 585	0	669	10 523	18 085	28 608
BUDGET Center	535	0	811	26	1 772	58	652	498	2 147	23	2 241	0	1 588	0	3 713	0	0	0	13 459	605	14 064
TOTAL	**8 135**	**16 619**	**13 891**	**23 726**	**14 083**	**23 004**	**13 588**	**22 474**	**16 241**	**24 036**	**13 894**	**19 841**	**9 970**	**22 047**	**19 539**	**21 771**	**653**	**4 692**	**109 995**	**178 211**	**288 206**

Budget and reported costs

Partner	2011	2012	2013	2014	2015	2016	2017	2018	2019	All years
NTNU IØT	4 142	7 049	8 197	6 491	5 540	5 061	4 998	6 851	1 708	**50 036**
NTNU HF	4 661	6 420	6 842	6 726	5 573	7 305	5 869	14 149	1 061	**58 608**
NTNU Indecol	0	616	1 496	2 161	2 076	1 011	672	62	0	**8 095**
NTNU Elkraft	96	247	239	321	350	95	0	93	0	**1 440**
NTNU Samfunnsforskning	0	0	76	12	40	0	82	0	0	**210**
UiO	1 074	4 140	4 127	3 655	3 086	2 323	1 962	2 911	1 128	**24 406**
HiSF	1 794	2 896	1 852	2 194	8 650	4 941	7 837	3 940	1 448	**35 551**
VF	1 042	1 127	797	1 195	510	510	510	455	0	**6 145**
NHH	2 349	3 089	2 688	2 738	3 429	2 837	2 836	2 248	0	**22 214**
Sintef EF	3 178	4 856	3 510	3 207	2 909	3 070	2 648	3 180	0	**26 558**
Sintef TS	1 804	2 433	2 381	2 234	3 294	2 075	807	1 656	0	**16 684**
IFE	2 100	2 047	2 032	2 110	2 269	2 030	1 549	2 495	0	**16 632**
SNF	1 407	1 398	1 289	1 551	1 289	1 449	1 200	1 441	0	**11 024**
Total research partners	**23 648**	**36 317**	**35 525**	**34 595**	**39 015**	**32 708**	30 970	**39 481**	**5 345**	**277 603**
Total user partners	**947**	**1 127**	**1 006**	**1 276**	**765**	**744**	936	**1 100**	**0**	**7 902**
Abroad	**160**	**173**	**556**	**192**	**497**	**284**	111	**729**	**0**	**2 701**
Total	**24 755**	**37 617**	**37 087**	**36 062**	**40 277**	**33 735**	**32 017**	**41 310**	**5 345**	**288 206**

For the tables showing budget and results, the numbers for 2011-2017 are the actual reported costs.
The numbers for NTNU HF includes the costs for the centre management and joint activities.


alternative energies
and world reserves are

Appendix 1: Personnel

Name	Institution	Main research area
Heidenreich, Sara	NTNU	RA 1
Skjølsvold, Tomas Moe	NTNU	RA 1
Ryghaug, Marianne	NTNU	RA 1 og 4
Lagesen, Vivian A	NTNU	RA 1 og 4
Sørensen, Knut	NTNU	RA 1 og 4
Robert Næss	NTNU	RA 1 og 4
Wicken, Olav	UiO	RA 1 og 4
Walnum, Hans Jakob	Vestlandsforsking	RA 1 og 4
Baltruszewicz, Marta	Vestlandsforsking	RA 1 og 4
Aall, Carlo	Vestlandsforsking	RA 1 og 4
Holden, Erling	HiSF	RA 1 og 4
Yttri, Gunnar	HiSF	RA 1 og 4
Rygg, Bente Johnsen	HiSF	RA 1 og 4
Espegren, Kari	IFE	RA 2
Westgaard, Sjur	NTNU	RA 2
Fleten, Stein-Erik	NTNU	RA 2
Lind, Arne	IFE	RA 2
Rosenberg, Eva	IFE	RA 2
Seljom, Pernille (16,7 % IFE)	IFE	RA 2
Midthun, Kjetil	SINTEF TS	RA 2 og 3
Tomasgard, Asgeir	NTNU	RA 2 og 3
Skar, Christian	NTNU	RA 2 og 5
Eskeland, Gunnar	NHH	RA 3
Bjørndal, Mette	NHH	RA 3
Bjørndal, Endre	NHH	RA 3
Sandal, Leif	NHH	RA 3
Andersson, Jonas	NHH/SNF	RA 3
Rud, Linda	NHH/SNF	RA 3
Gaasland, Ivar	SNF	RA 3
Godal, Odd	SNF	RA 3
Heum, Per	SNF	RA 3
Stokka, Arne	SINTEF TS	RA 3
Egging, Ruud	NTNU	RA 2 og 5
Østerlie, Thomas	NTNU Samfunnsforskning	RA 4
Moen, Øystein	NTNU	RA 4
Widding, Øystein	NTNU	RA 4
Sørheim, Roger	NTNU	RA 4
Weaver, Tyson	NTNU	RA 4
Steen, Markus	SINTEF TS	RA 4
Bjørgum, Øyvind	NTNU	RA 4
Vie, Ola Edvin	NTNU	RA 4
Schwanitz, Valeria Jana	HISF	RA 4 og 5
Nilsen, Sverre Konrad	SINTEF TS	RA 5
Graabak, Ingeborg	SINTEF Energi	RA 5
Belsnes, Michael	SINTEF Energi	RA 5
Fodstad, Marte	SINTEF Energi	RA 5
Voller, Steve	SINTEF Energi	RA 5
Wolfgang, Ove	SINTEF Energi	RA 5
Schäffer, Linn Emelie	SINTEF Energi	RA 5
Ahcin, Peter	SINTEF Energi	RA 5
Arvesen, Anders	NTNU	RA 5
Hertwich, Edgar	NTNU	RA 5
Strømman, Anders Hammer	NTNU	RA 5

PhD candidates with financial support from CenSES

Name	Nationality	Period	M/F	Topic
Anfinsen, Martin	Norwegian	21.11.16-20.11.20	M	Gender and Energy
Araoz, Veronica (Defended 30.05.12)	Mexican	01.08.08-30.05.12	F	Pricing in Non-Convex electricity markets
Assmann, Lisa Maria	German	15.08.12-14.08.16	F	Speed optimization theory and practices In maritime shipping
Ausrød, Vegar Lein (14.12.16)	Norwegian	01.11.10-30.06.16	M	Commercialization of renewable energy
Bjørgum, Øyvind (Defended 09.05.16)	Norwegian	01.10.10-09.06.16	M	New firms developing novel technology in a complex emerging industry. The road towards commercialization of renewable marine energy technologies
Cheng, Xiaomei (Defended 18.12.15)	Chinese	15.09.11-18.12.15	F	Essays on Efficiency and Productivity in Electricity Networks
Ellingsen, Linda (Defended 6.6.17)	Norwegian	15.09.13-14.01.17	F	Life cycle assessment of traction batteries for transport applications
Evengelos, Kyritsis		15.08.14-14.08.18		Empirical analysis of energy markets
Gibon, Thomas	French	01.12.11 - 30.11.15	M	Scenario-based life cycle inventory methods to inform climate mitigation
Gjefsen, Mads Dahl (Defended 11.05.15)	Norwegian	15.03.10-11.05.15	M	Discords in Science and Technology Advocacy: Lessons from CCS for Geoengineering
Gjerald, Ole Inge	Norwegian	01.09.08-31.12.15	M	Renewable strategies? Implementing and commercializing new energy technologies
Hanson, Jens (Defended 04.10.13)	Norwegian	01.01.08-04.10.13	M	Dynamics of Innovation Systems for Renewable Energy Technology: The Role of Post-Introduction Improvements
Haugstvedt, Daniel	Norwegian	01.06.10-17.01.14	M	Hydropower Scheduling Analysis Using Statistics and Stochastic Programming
Hegeman, Puck	Dutch	01.06.16-31.05.19	F	
Hellemo, Lars (Defended 06.06.16)	Norwegian		M	Managing Uncertainty in Design and Operation of Natural Gas Infrastructure
Jomisko, Robert L. (Defended 04.09.15)	Norwegian	01.09.10-15.11.15	M	Under investigation. About processes of learning and management of knowledge in climate, energy, and environmental policy
Jørgensen, Susanne	Norwegian	01.10.15-13.08.19	F	Numbers and Narratives in Energy
Lindberg, Karen Byskov (50% CenSES, 50% ZEB) (Defended 03.02.17)	Norwegian	01.09.11- 01.05.16	F	The impact of zero emission buildings (ZEB) on the energy system through smart grid and demand side management (DSM)
Lysgård, Sylvia	Norwegian	23.01.12 - 25.05.17	F	Hva dreier det seg om? Næringsliv, politikk og praksiser i to norske (miljø)saker
Mäkitie, Tuukka		11.05.15-10.05.18		Innovation activities of offshore oil and gas industry in the emergence of niche technologies
Marañon-Ledesma,Hector		01.09.15-31.08.18	M	Demand Response in the future sustainable European Power System
Mauritzen, Johannes (Defended 14.05.12)	Norwegian	01.08.08-14.05.12	M	Windonomics: empirical essays on the economics of wind power in the Nordic electricity market
Narbel, Patrick (Defended 14.06.14)	Swiss/Finnish	15.08.10-14.08.14	M	Framework promoting the development of renewable energy in developing countries
Normann, Håkon (Defended 09.03.17)	Norwegian	19.03.12-30.09.16	M	New renewable industry formation: The constraining and enabling role of the oil and gas industry on an emerging offshore wind industry in Norway
Nykamp, Hilde (Defended 16.11.15)	Norwegian	01.02.12 - 16.16.16	F	Green Innovation in the Norwegian Construction Industry
Pham, Ha Thi Bich (Defended 04.02.16)	Vietnamese	01.12.08-04.02.16	F	Building and transforming dominant technology - The Portland cement industry
Reinertsen, Hilde (Defended 27.04.16)	Norwegian	01.05.10-27.04.16	F	Optics of evaluation: Making Norwegian foreign aid an evaluable object, 1980-1992
Rygg, Bente Johnsen (Defended 17.04.15)	Norwegian	01.02.11-17.04.15	F	Renewable Energy as a Community Concern: How Local Communities Face the Challenge of Increasing Use and Production of Renewable Energy
Sinha, Vivek	Indian	01.08.11-01.12.16	M	Unleashing the potential of renewable energy for decentralized production: an investigation into organization strategies and system requirements
Skar, Christian (Defended 29.07.16)	Norwegian	16.08.10-01.05.15	M	Modelling of the European power market for low emission scenarios
Su, Zhonghua	Chinese	01.03.13 - 01.12.16	F	Equilibrium models for energy systems
Swensen, Eirik (Defended 13.05.15)	Norwegian	01.09.10-13.05.15	M	Love and intricacies" – Stumbling stones for development of carbon capture and storage
Throndsen, William (Defended 25.05.16)	Norwegian	01.04.11-25.05.16	M	Response and Responsibility. Smart meters, end use, and the possibility of a green material public
Unander, Trine	Norwegian	08.01.13 - 29.08.18	F	Environmental organisations as boundary organisations
Walnum, Hans Jakob (Defended 23.09.15)	Norwegian	01.09.11- 23.09.15	M	Fixing or transferring environmental problems in the transport sector
Weaver, Tyson (Defended 28.04.16)	American	01.09.11-28.04.16	M	Norwegian hydropower international development
Yan, Shiyu	Chinese	01.09.13-31.08.17	M	Using CO2 differentiated vehicle tax to improve new vehicle fuel economy: evidence from Norway

PhD candidates with financial support from CenSES, cont.

Svennevik, Elisabeth	Norwegian		F	
Lindberg, Marie Byskov	Norwegian		F	
Yuanming, Ni		15.08.14-14.08.18	F	

PhD candidates working on CenSES projects with financial support from other sources

Arvesen, Anders (Defended 30.01.13)	Indecol	Norwegian	01.08.08- 31.07.12	M	Understanding the environmental implications of energy transitions: A case study for wind power
Babri, Sahar (Defended 20.08.15)	NHH	Iranian	08.12- 20.08.15	F	Essays on Transportation
Bouman, Evert (Defended in 2015)	DION	Dutch	01.06.12 - 31.05.15	M	Prospective Environmental Impacts of Selected Low-Carbon Electricity Technologies
Cai, Hong	NHH			F	Energy, Natural Resources and the Environment
Dahlen, Kai Erik	PURELEC/ RENERGI	Norwegian	01.10.10-30.09.14	M	Risk management and assessment for energy markets: Extreme value statistics
Forminykh, Elena	NHH	Russia	01.10.10-30.09.14	F	
Gilpin, Geoffrey (Defended 10.11.16)	Vestforsk/UMB	Canadian	01.09.08-31.07.16	M	Life cycle analysis of 1st through 4th generation biofuels
Godbolt, Åsne Lund (Defended 13.06.14)	RENERGI	Norwegian	01.08.08-13.06.14	F	Building markets, shaping policy? The role of economics in energy policy and energy use
Gribkovskaia, Victoria (Defended 08.06.15)	NHH	Belarusian	2007 - 08.06.15	F	Essays on Pricing in Electricity Markets
Hagfors, Lars Ivar	NFR, RISKY-RES	Norwegian	01.10.13-30.09.17	M	Building markets, shaping policy? The role of economics in energy policy and energy use
Haugom, Erik (Defended 24.10.12)	NFR - Renergi	Norwegian	01.01.09-24.10.12	M	Modelling and forecasting electricity prices and volatilities
Heidenreich, Sara (Defended 24.10.14)	RENERGI	German	15.09.10-24.10.14	F	Blowing in the wind: The socialization of offshore wind technology
Helgesen, Per Ivar	RENERGI	Norwegian	01.06.12-31.05.16	M	Regional effects of energy policy
Hopaneng, Lina Ingeborgrud	NTNU/KULT	Norwegian	01.08.14 - 31.07.17	F	BREV (Bringing Environmental Knowledge into Action)
Jakobsen, Siri (Defended 29.04.16)	NFR, Forskningsløft nord	Norwegian	01.08.10-31.07.14	F	Sustainable innovation in the process industry, innovation, cooperation and technology transfer
Johansen, Ulf	NTNU/IØT	Norwegian	21.03.12 - 15.11.14	M	Winners and losers in regional economic development
Karlstrøm, Henrik (Defended 20.03.12)	RENERGI	Norwegian	18.08.08- 20.03.12	M	Empowering markets? The construction and maintenance of a deregulated market for electricity in Norway.
Klimek, Alexandra (Defended 09.12.14)	NFR.RENERGI	German	01.09.09-09.12.14	F	Engineering and Politics: Embedding Carbon Capture, Transport and Storage (CCS) in Norway
Kong, Jiehong (Defended 25.08.12)	NHH	Chinese	14.08.08 - 25.08.12	F	Integration and coordination of supply chain: Case studies in forestry and petroleum industries
Korsnes, Marius (Defended 01.12.15)	NTNU, China project	Norwegian	21.05.12-20.05.15	M	Chinese Renewable Struggles. Innovation, the Arts of the State and Offshore Wind Technolog
Lauvås. Thomas	RFF-Nord/ Helgeland Sparebank	Norwegian	19.09.13- 18.09.17	M	Technology entrepreneurship and university- industry technology transfer
Ottesen, Stig Ødegaard (Defended 09.03.17)	NCE Halden	Norwegian	01.01.11-30.06.16	M	Techno-economic models in Smart Grids: Demand side flexibility optimization for bidding and scheduling problems
Seljom, Pernille	RENERGI	Norwegian	01.01.11-31.12.14	F	The future Norwegian energy system in a European context
Skjeret, Frode	NECCI	Norwegian	01.11.12-01.03.15	M	Regulation of electricity markets
Skjølsvold, Tomas Moe (Defended 24.08.12)	RENERGI	Norwegian	01.08.08-24.08.12	M	Innovation and commercialization in bioenergy
Stavø, Jorunn-Elisabeth	HiSF (RELEASE)	Norwegian		F	
Steen, Markus (Defended 09.09.16)	RSO/SVT	Norwegian	01.06.10-30.05.15	M	Green industrial restructuring and the emergence of novel production networks in new renewable energy
Steinmo, Marianne (Defended 27.03.15)	HBS	Norwegian	01.08.10-27.03.15	F	How Firms use University-Industry Collaboration to innovate: The role and development of Social Capital and Proximity Dimensions
Suboticki, Ivana	NTNU			F	Sustainable Transition through Transformed Transportation

PhD candidates working on CenSES projects with financial support from other sources (continued)

Name	Funding	Nationality	Period	M/F	Topic
Sulavik, Jan	HiSF (RELEASE)	Norwegian		M	
Søraa, Roger	NFR, Klimaforsk	Norwegian	01.09.14-30.08.17	M	Craftspeople as climate advisors
Toftaker, Marit	RENERGI	Norwegian	01.01.10 - 01.12.15	F	EV User Preferences and User Strategies
Yttri, Gunnar (Defended 09.09.16)	HiSF (RELEASE)			M	
Tunc, Durmaz (Defended 01.09.15)	NHH	Turkish	01.08.09 - 01.09.15	M	Essays in energy, environment and technology
Xiaozi, Liu (Defended 09.11.12)	NHH	Chinese	14.08.10 - 09.11.12	F	Essays on economic optimization: bringing fisheries economics and fisheries biology
Øverås, Ingrid	NTNU/KULT	Norwegian	01.2005 - 31.12.12	F	Localization and Design of wind parks in Norway - Controversies in Environmental Planning

Postdoc researchers with financial support from CenSES in 2017

Name	Nationality	Period	M/F	Topic
Bordin, Chiara		01.01.17 – 05.02.17	F	
Hanson, Jens	Norwegian	01.10.13-17.05.17	M	Innovation processes in renewable energy technologies and industries
Koksvik, Gitte	Norwegian	01.12.16-30.11.19	F	Horizon2020
Korsnes, Marius	Norwegian	01.05.16 -01.05.19	M	Prosumers and new forms of energy use in low-energy buildings and neighborhoods.
Skar, Christian	Norwegian	01.09.16 – 31.08.18	M	Stochastic programming, power markets, SET-NAV
Throndsen, William	Norwegian	01.06.16 – 31. 05.19	M	Smartgrid
Normann, Håkon Endresen	Norwegian	01.05.2017-31.04.2020	M	
Skar, Christian	Norwegian	01.09.2016-31.08.2018	M	
Weaver, Tyson	Amrican	01.08.16-31.07.18	M	Renewable energy technologies in the power sector

Postdoc researchers with financial support from other sources in 2017

Arvesen, Anders	Norwegian	01.02.13-31.12.17	M	Scenario-based life cycle assessment of energy technologies and energy systems
Haugom, Erik	Norwegian	01.10.13-30.09.17	M	

Master degrees awarded in 2017

- Alamban, Alok: Business Models and Market Pricing Mechanisms within Virtual Microgrids for smart energy networks. NHH, 2017.
- Arnesen, Kristin Elise Skøyen, Borgen, Snorre Thorsønn: A Multi-Horizon Stochastic Programming Approach to Optimal Component Sizing for the Strategic Microgrid Design Problem. IØT, NTNU, 2017.
- Bakke, Kim Andre: Passivhus - Hva med sluttbrukeren? NTNU/KULT 2017.
- Borge, Kari Sofie Hall: Heuristic solution approach to simultaneous optimization of heat and work integration - A two-level optimization model using genetic algorithms to establish the energy target for maximum heat and work recovery. IØT, NTNU, 2017.
- Brøndbo, Helene Kvilhaug; Storebø, Axel: Capacity Expansion in Power Markets - a Real Options Approach. IØT, NTNU, 2017.
- Ekern, Lina Lassesen; Naustdal, Ingrid; Roald, Malene: Forecasting the EPEX spot price distribution using fundamental variables. IØT, NTNU, 2017.
- Engmark, Edda; Sandven, Hanne: Stochastic multistage bidding optimisation for a Nordic hydropower producer in the post-spot markets. IØT, NTNU, 2017.
- Espedal, Linn Kristin and Tomas Halleråker: Operasjonell analyse av Nygårdstangen godsterminal. NHH, 2017.
- Finjord, Fredrik; Tangen, Marius: Real Options Valuation of Wind Energy Investments in Norway and Sweden: A Case Study. IØT, NTNU, 2017.
- Gjelstad, Simen: Lønnsomhetsforbedring i Tide Verksted AS. NHH, 2017.
- Harbo, Sondre: Tackling Variability of Renewable Energy with Stochastic Optimization of Energy System Storage - Solving a Stochastic, Multistage AC Optimal Power Flow problem with the Stochstic Quasi-Gradient Method. IØT, NTNU, 2017.
- Hope, Jeanette. Oversvømmelse. En kunnskapsteoretisk studie av klimatilpasning i Trondheim kommune. NTNU/KULT 2017.
- Hovd, Nina Sakshaug; Sitek, Thea Marie: A qualitative study of Norwegian firms diversifying into the emerging offshore wind industry. IØT, NTNU, 2017.
- Lien, Morten Adrian; Brelin, Sebastian: Empirical Analysis of Hydropower Scheduling. IØT, NTNU, 2017.
- Kongelf, Håkon; Overrein, Kristoffer: Coordinated Multimarket Bing for a Hydropower Producer using Stochastic Programming. IØT, NTNU, 2017.
- Lyngstad, Line: Mellom halm og teknologi. En kvalitativ studie av brukere av grønne boliger. NTNU/KULT 2017.
- McGeorge, Kristian and Erik Haugen: Insentiver for investering i distribusjons- og regionalnett under ulike modellalternativer. NHH, 2017.
- Møller, Arne-Steffen: Efficiency Benchmarking for German Municipal Energy Suppliers. NHH, 2017.
- Olsen, Karianne; Tho, Martin Fauske; Ornum, Linn: Entry into Emerging Industries - How should Norwegian companies enter the emerging offshore wind industry? IØT, NTNU, 2017.
- Orlov, Alisa: Blockchain in the Electricity Market: Identification and Analysis of Business Models. NHH, 2017.
- Ruud, Einar Johan: Beslutningsstøtte med kontinuerlig virkningsgradsmåling i vannkraftverk. IØT, NTNU, 2017.
- Samuelsen, Joakim: Analyzing the potential effects of off-grid electrification through different funding and financing models - A case study of the LAMTIB initiative in Singapore. IØT, NTNU, 2017.
- Siljan, Oda Marie; Hansen, Kristine: Optimizing the Vessel Fleet Used to Install an Offshore Wind Farm. IØT, NTNU, 2017.
- Welhaven, Sebastian; Bakke, Linn Cathrin Tysse: A standardized process assessing off-grid PV-system investments in developing countries. Multi-horizon stochastic programming for valuing projects with high uncertainty. IØT, NTNU, 2017.
- Wood, Jonathan and Stefan Funk: Can demand response help reduce future distribution grid investments? An economic study of peak shaving in the Norwegian distribution grid: SEMIAH pilot in Engene, Sørlandet (Southern Norway). NHH, 2017.

Appendix 2: Related Projects including CenSES Research Partners

Modelling and forecasting risk in the electricity market, carbon market and related energy markets (ELCARBONRISK).
RCN/RENERGI. 2010 - 2014
Project leader: Sjur Westgaard, NTNU.
Total budget: NOK 13 770 000

Investment in renewable electricity under climate policy uncertainty (PURELEC).
RCN/RENERGI. 2010 - 2014
Project leader: Stein-Erik Fleten, NTNU.
Total budget: NOK 8 450 000

Public acceptance of post carbon strategies
RCN/RENERGI. 2009 - 2014
Project leader: Knut Holtan Sørensen, NTNU.
Total budget: NOK 8 891 000

Building markets, shaping policy? The role of economics in energy policy and energy use.
RCN /RENERGI. 2007 - 2013
Project leader: Knut Holtan Sørensen, NTNU.
Total budget: NOK 3 368 00

ECar, A strategy for electrification of road transport in Norway.
RCN /RENERGI. 2009 - 2013
Project leader: Tarjei Solvang, SINTEF Energy Research.
Total budget: NOK 10 600 000

Environmental Sustainability Benchmarking of Low-Carbon Energy Technologies.
RCN/RENERGI. 2011 - 2013
Project leader: Edgar Hertwich, NTNU.
Total budget: NOK 2 954 000

Optimal power network design and operation.
RCN /RENERGI. 2011 - 2015
Project leader: Morten Hovd, NTNU.
In budget for CenSES: NOK 2 700 000

Dissemination of Scientific Knowledge as a Policy Instrument in Climate Policy. RCN/NORKLIMA. 2011 - 2014
Project leader: Göran Sundqvist, UiO.
Total budget: NOK 6 200 000

Intermittent Renewables, Balancing Power and Electricity Market Design (INTREPED).
RCN/RENERGI. 2012 - 2015
Project leader: Gunnar Eskeland, SNF.
Total budget: NOK 6 000 000.

Regional effects of energy policy (RegPol).
RCN /RENERGI. 2012 - 2015
Project leader: Arne Stokka, SINTEF Technology and Society.
Total budget: NOK 11 950 000

Renewable energy as transition strategy.
RCN/RENERGI. 2011 - 2014
Project leader: Keith Smith, UiO

The future Norwegian energy system in a European context
RCN/RENERGI. 2011 - 2014
Project leader: Kari Aamodt Espegren, IFE.
Total budget: NOK 7 270 000

Energy Technology System Analysis Programme
RCN/RENERGI. 2012 - 2015
Project leader: Kari Aamodt Espegren, IFE.
Total budget: NOK 1 720 000

Integrating households in the smart grid (IHSMAG).
ERA-NET. 2012 - 2014
Project leader NTNU: Marianne Ryghaug, NTNU.
Total budget: EUR 1 148 810

NORSTRAT - Nordic electricity road map 2050: Strategic choices towards carbon neutrality
Nordic Energy Research. 2011 - 2015
Project leader: Ingeborg Graabak, SINTEF Energy Research

NORD-STAR - Centre of Excellence for Strategic Adaptation Research.
Nordforsk. 2011 - 2015
Centre director: Michael Goodside, Aarhus University.
Total budget: NOK 35 000 000

Greenhouse gas emission goal for cars; feasibility and policy instruments.
SD, 2012 - 2013.
Project leader: Gunnar Eskeland, NHH
Total budget: NOK 500 000

Teknologibasert entreprenørskap og innovasjon som driver for industriell utvikling i Nord-Norge.
NFR og Helgeland Sparebank. 2013-2016.
Project leader: Roger Sørheim, NTNU/Handelshøgskolen i Bodø.
Total budget: NOK 5 500 000

Crafting Climate Advisors - Developing Arenas for the Education of Craftsmen in the Face of Climate Transitions
KLIMAFORSK. 2013
Project leader: Jøran Solli, NTNU
Total budget: NOK 187 000

Influence of bioethanol fuels treatment for operational performance, ecological properties and GHG emissions of spark ignition engine
EEA. 2013-2015
Project leader: Otto Andersen, Vestlandsforsking

useITsmartly - Environmental peer-to-peer education for youths with focus on smart use of Information and Communication Technologies.
IEE. 2013 – 2016.
Project leaders: Knut H. Sørensen and Robert Næss, NTNU.
Total budget: NOK 2 300 000.

Hvordan vil en dreining av fornybarstøtten i EU i retning av mer markedsstyrte instrumenter påvirke grønne investorer? (RISKY-RES)
NFR, ENOVA, NVE, Statnett og Energi Norge. 2013-2016.
Project leader: Stein-Erik Fleten, NTNU.
Total budget: NOK 7 000 000.

Bringing environmental knowledge into action: Environmental knowledge management in Norwegian local governments.
Miljø2015 program. 2014 - 2017
Project leader: Vivian Anette Lagesen, NTNU.
Total budget: NOK 5 000 000

Europeanisation of energy-technological innovation systems: drivers, consequences and strategic challenges for Norway.
ENERGIX. 2014 - 2017
Project leader: Per-Ove Eikeland, Fridtjof Nansens Institutt.

Day-ahead bidding with multiple short-term markets".
Sintef Energy Research. 2015-2018
Project leader: Marte Fodstad
Total budget: NOK 18 000 000

Hybrid and other configurations for environmentally friendly transport
MARINTEK. (2014 – 2015)
Project leader: Elizabeth Lindstad
Total budget: NOK 2 550 000

Norwegian Energy Road Map 2050.
SINTEF Energy Research.
Project leader: Marte Fodstad
Project startup: 2016
Total budget: NOK 14 900 000

Navigating the Roadmap for Clean, Secure and Efficient Energy Innovation – SET-Nav (Horizon 2020)
TU Wien, NTNU and SINTEF Technology & Society with partners
Project leader: Gustav Resch,
Local project leaders: Ruud Egging (NTNU), Kjetil Midthun (SINTEF)
Project startup: 1. April 2016 - 31. March 2019
Total budget: EUR 3 999 411,25

Internationalization of Norwegian Offshore Wind Capabilities (InNOWiC)
EnergiX. 2016 - 2020.
Project leader: Asbjørn Karlsen
Total budget: NOK 10 800 000

Project title: Markets - actors - technologies: A comparative analysis of smart grid solutions
Funding source: ERA-net Smartgrid plus
Year: 2015-2017
Project leader: Toke H. Christensen, Aalborg universitet
Total budget: NTNU: 5,3 mill NOK, whole consortium 14, 1 mill Nok

Framtidsbilder: Det norske lavutslippssamfunnet
Vestlandsforsking
Employer: ENOVA
Project leader: Carlo Aall, Vestlandsforsking

SHAPE-ENERGY.
Coordinated by: Anglia Ruskin University.
Partner: NTNU (KULT).
Project leader from NTNU: Sara Heidenreich, KULT

INVADE.
Coordinated by: Smart Innovasjon Østfold.
Project partner: NTNU (KULT)

ECHOES
Financed by H2020
Project partner: NTNU

MATCH
Financed by Smartgrids ERA-net
Project partner: NTNU

Assessment of the Value of Flexibility Services from the Norwegian Energy System
2016
IFE, SINTEF, NTNU
Project leader: Kari Espegren

Greening the Fleet – Sustainability Transitions in the Maritime Shipping Sector (GREENFLEET)
Project leader: Tone Merethe Aasen (tone.m.aasen@sintef.no)
Programme: EnergiX, Norges Forskningsråd 2017-2020
Budget: 11,8 mill NOK

Conditions for growth in renewable energy industries
2016
UiO TIK , SINTEF TS

Where Does the Green Economy Grow? The Geography of Nordic Sustainability Transitions (GONST)
Project leader: Teis Hansen, Lund University. Leader WP5 (Policy Learning): Håkon Finne (hakon.finne@sintef.no)
Programme: Nordic Green Growth Research and Innovation Programme, Nordic Innovation, NordForsk and Nordic Energy Research, 2017-2020. Budget: 20 mill NOK .

NEW PROJECTS

Conditions for growth in renewable energy industries (RenewGrowth). EnergiX project. Project leader: Jens Hanson, TIK, UiO. Budget: 10,3 M NOK. Partners: Utrecht University & SINTEF TS.

Trans-atlantic cooperation on energy market models (TACEEM). INTPART. Project leader: Asgeir Tomasgard, Department of Industrial Economics and Technology Management, NTNU. Budget: 6.350.000. Partners: Norwegian University of Science and Technology (NTNU), Norwegian school of economics (NHH), University of Maryland (UMD), Technische Universität Berlin (TUB), Universidade Federal de Santa Catarina (UFSC), Universidade Federal do Rio de Janeiro (UFRJ), State University of Campinas (UNICAMP), Instituto Nacional de Matemática Pura e Aplicada (IMPA), Johns Hopkins University (JHU).

Transition towards zero emission ports (TRAZEPO). EnergiX project. Project leader: Nokut, SNTEF TS. Budget: 10,5 mill. Partners: Narvik Havn, Kristiansand Havn, Oslo Havn, KS Bedrift Havn, Kystverket, Norske havner.

Where does the green economy grow? (GONST). The geography of Nordic sustainability transitions. Funded by Nordfors, Nordic Energy Research and Nordic Innovation over the Nordic Green Growth Research and Innovation programme. Budget: 20 M NOK. Project leader: Markus Steen. Project management: Lund University, Department of Geography.

Assessment of the value of flexibility of the Norwegian Energy Resources (ASSETS). Budget: ca 10 M NOK. Project leader: Pernille Seljom, IFE. Partners: NTNU-IØT, SINTEF TS.

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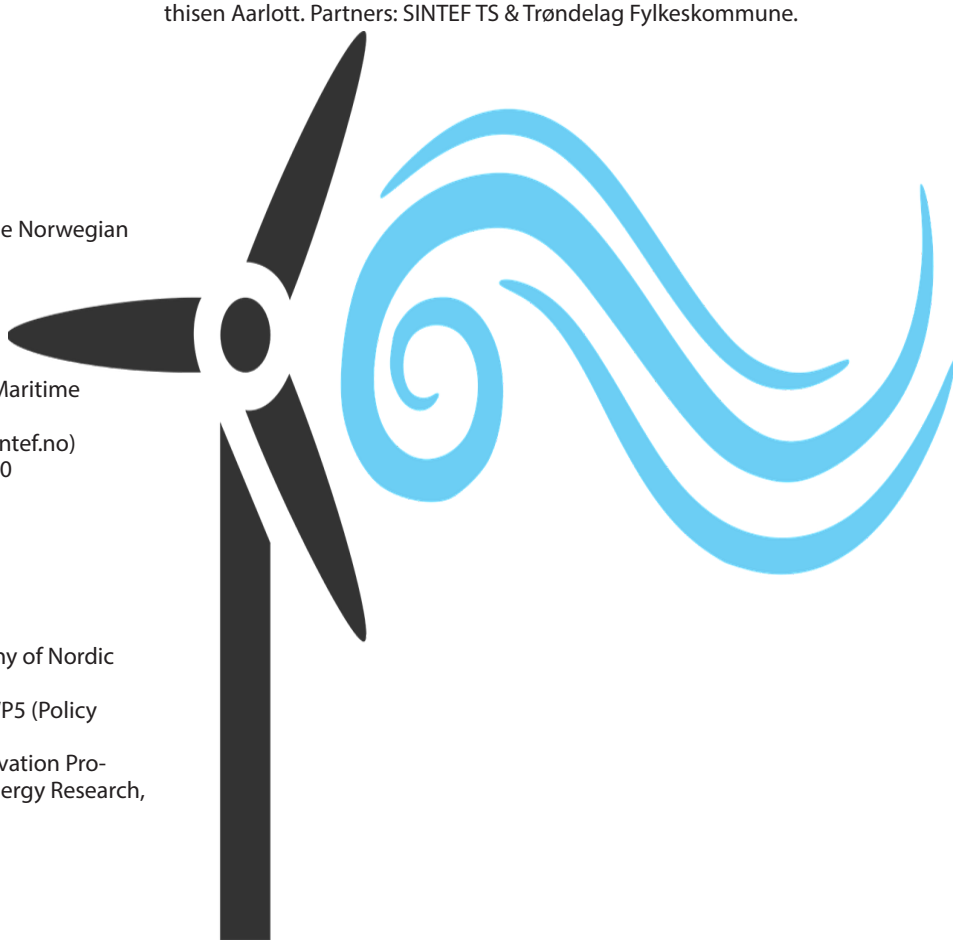

Appendix 3: Publications

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47. Solbu, G., Levold, N. & Skjølsvold, T. M. "Nyanser av mistillit". morgenbladet.no. 19. september 2017.
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61. Walnum, Hans Jakob. Alle problemene blir ikke løst med overgang til elbiler. Fagblad. 6. November 2017.
62. Walnum, Hans Jakob. Death of the gas guzzler. New Scientists. 17. November 2017.
63. Woods, Ruth, Journalist, Bazilchuk, Nancy Reney. Living in a Zero Emission House. Gemini, 1.juni 2017.

Guest researcher, key notes and invited lecturer

1. Egging, R. Presentation, 30 November 2017, IFP, Paris.
2. Egging, R. Presentation, 21. December 2017, Santiago La Coruna.
3. Eskeland, Gunnar. Green Urban Development. Faculty Seminar, Resources for the Future, Washington, DC, Jun 8. 2017.
4. Eskeland, Gunnar. Keynote Speaker, Baltic Energy Forum, Nov 24, Energy Transition, Vilnius.
5. Eskeland, Gunnar. Keynote Speaker, Nordic Business Breakfast, Vilnius.
6. Eskeland, Gunnar. Risk and Climate Change: the role of precaution. Fibe conference, Bergen, 3. January 2017.
7. Korsnes, Marius. Nullutslepp i smarte byar. Perspektiv frå samfunnsforsking. Seminar: Mandagsmøte med urbanistene, Tenketanken urbanistene, Trondheim. 9. oktober 2017.
8. Korsnes, Marius. Prosumers: Who are they, and what can they do? Ecology Seminars, Inland Norway University of Applied Sciences, Evenstad. 7. juni 2017.
9. Korsnes, Marius. Samfunnsvitskap: Relevans for klima og miljøtematikk - eksempel frå Trondheim. Bakkefestivalen 2017. Bakkegata. 6.mai 2017.
10. Korsnes, Marius. 3 weeks at Jiaotong University, China.
11. Korsnes, Marius. 6 weeks at DEMAND centre, Lancaster.
12. Korsnes, Marius. Visiting researcher at Lancaster University, DEMAND Centre, 2017.
13. Ryghaug, Marianne. Samfunnsvitenskapelige perspektiver på bærekraftig omstilling av energisystemet. Energix programstyremøte. Gjesteforelesning. NTNU/Energix. 2. november 2017
14. Schwanitz, V. "The World in 2050 – How to project what can't be projected?" 31.05.2017, Graduate School of Engineering, Technical University of Cottbus
15. Schwanitz, V. "The World in 2050 – How to project what can't be projected?" December 14th, 2017 at Tokyo City University/Japan.
16. Schwanitz, V. "The World in 2050 – How to project what can't be projected?" November 1st, 2017, at Okinawa Institute of Science & Technology.
17. Schwanitz, V. Okinawa Institute of Science and Technology, grand for visiting researcher (from 15.10.-23.12.2017).
18. Schwanitz, V. visiting scholar at the Osaka University (HANDAI). 4.1.-11.1.2017.
19. Søraa, Roger Andre. Craft as Practices of Knowledge Making, chair. 4S Conference. 30. august- 2.september 2017.
20. Sørensen, Knut H. Research stay at UCLA.
21. Sørensen, Knut Holtan. Making sense of low emission society: Energy dialogues, climate justice and energy citizenship. University of Wisconsin - Madison. 28. September 2017.
22. Tomasgard, Asgeir. Towards a near zero emission power system in Europe. 3rd International Conference of Skoltech Center for Energy Systems: "Science for Energy Systems Regulation". Moscow, October 10-12, 2017.
23. Tomasgard, Asgeir: Using stochastic programming to analyse demand response in European electricity markets, Joint Czech-German-Slovak Conference on Mathematical Methods in Economy and Industry, Jindřichův Hradec September 6, 2017.
24. Tomasgard, Asgeir: Towards Zero Emission power systems, Implications of Paris Workshop, Trondheim, March, 2017.
25. Tomasgard, Asgeir: Naturgassens rolle i Europas framtidige kraftsystem, VISTA-dagen, Det norske vitenskaps-akademi, November 2016.

Dissemination and presentations for partners

1. Andersen, Allan Dahl. Alternative markets and "green flings": experiences of entering into new markets outside of petroleum. Seminar: Transformations in the Norwegian petroleum industry: handling turbulence and forging ahead? Oslo, 14. September 2017.
2. Anfinsen, Martin. Presentasjon av Senter for energi, klima og miljø, CenSES, SHAPE ENERGY og egen elbilforskning. Seminar: Women in the Nordic Energy Sector. 2017-11-22.
3. Berstad, David. Verdikjedeplanlegging for hydrogen. CenSES-samling for brukerpartnere og forskere. Værnes, 24. august 2017.
4. Bjørndal, Endre; Bjørndal, Mette Helene; Pritchard, Geoff; Zakeri, Golbon; Corey-Wright, Ryan. Stochastic Dispatch Models for Electricity Markets. PhD Winter School 2017 - Stochastic Programming with Applications in Energy, Logistics, and Finance; 2017-01-15 - 2017-01-21.
5. Bjørndal, Mette Helene. Markedsdesign og nodepriser. Markedsdialogmøte. Enova, Bergen 28. november 2017.
6. Egging, Ruud. SET-Nav meeting 1. October 2017, Berlin.
7. Egging, Ruud. SET-Nav workshop and meeting 2017.03.28 Zurich.
8. Ellingsen, Linda. Fossilfri mobilitet i byene: Klimafotavtrykk fra Fossil vs Elbil. CenSES-samling for brukerpartnere og forskere. Værnes, 24. august 2017.
9. Eskeland, Gunnar. Biofuels in Transport, NHO Logistics, Voss, 2017.
10. Espegren, Kari. Innledning og presentasjon av brukercase. Kick-off meeting GONST project in Lund, with partners from Lund University, Tampere University, Aalborg University, DTU, NIFU and SINTEF, May 2017.
11. Espegren, Kari. Kick-off meeting GREENFLEET project in Oslo, organised by SINTEF TS and UiO TIK, with Lund University and Chalmers University.
12. Espegren, Kari. Kick-off workshop with partners from Utrecht University and SINTEF TS for EnergiX project: Conditions for growth in renewable energy industries (RenewGrowth).
13. Fjellså, Ingvild Firman. Fleksibilitet hos forbrukere. 2017-10-31 (presentasjon for brukerpartnere og forskere i Cineldi).
14. Holden, Erling. «Bærekraftig transport». Statens Vegvesen region Midt. Molde, 29. mai 2017.
15. Holden, Erling. «Bærekraftig transport». Statens Vegvesen region Midt. Stjørdal, 30. mai 2017.
16. Holden, Erling. «Fornybar energi i Sogn og Fjordane». Sparebankstiftinga Sogn og Fjordane. Sandane, 15 februar 2017.
17. Holden, Erling. «Fornybar energi og bærekraftig transport». Senioruniversitetet U3A Bergen, Bergen, 27. september 2017.
18. Holden, Erling. «Fra null til 20 min på 20 år», Zeroakademiet. Sogndal, 26. April 2017
19. Holden, Erling. «Fornybar energi i Sogn og Fjordane». Sogn og Fjordane fylkeskommune. Leikanger, 20. september 2017.
20. Ingeborgrud, Lina. Brukererfaringer med elbil i Norge - et sosioteknisk perspektiv. Seminar om kunstig lyd (AVAS) og elbil; 2017-11-07 (presentasjon for interesseorganisasjoner, bransje og politiske aktører).
21. Korsnes, Marius. Workshop on teamwork and collaboration. Seminar: CenSES Early Career Research School. CenSES, Paris. 26-28.februar 2017.
22. Korsnes, Marius. Berekraftig overgang: Samfunnsvitskaplege perspektiv på berekraftige overgangar med eksempel frå Kina (Presentasjon for Miljøvernforbundet).
23. Korsnes, Marius. Nullutslepp i smarte byar. Perspektiv frå samfunnsforsking. (Presentasjon for Urbanistene).
24. Lindberg, Karen B. Prosumers and flexibility. Kick-Off: CenSES Brukercase: Prosumenters rolle i det framtidige energisystemet. Trondheim, 5 October 2017.
25. Lindberg, Karen B. The Future of DSO. Kick-Off: CenSES Brukercase: Prosumenters rolle i det framtidige energisystemet. Trondheim, 5 October 2017.
26. Lindberg, Karen B. Hvordan påvirker nullutslippsbygg effektbruken i Norge? Hvordan bygge nullutslippssamfunnet? Klimadebatt i Oslo, 3. mai 2017.
27. Lindberg, Karen B. Impact of ZEBs on the Power System. (ZEB - Zero Energy Buildings with on-site PV). HYDROCEN workshop: Future market structures and prices. Lilleaker, 12-13 June 2017.
28. Lindberg, Karen B. Nullutslippsbygg – Hva påvirker valg av oppvarmingsløsning? Varmpepumpekon feransen 2017. Fornebu, 29 - 30 March 2017.
29. Linnerud, Kristin. Fra støtte av moden vann- og vindkraft til støtte av innovasjon. Sogn og Fjordane fylkeskommune. Leikanger, 20. september 2017.
30. Linnerud, Kristin. Green Bonds - klima forskning og finansiering av grønn energi. Brødrene Dahl. Gardemoen, 22. mars 2017.
31. Linnerud, Kristin. Hva betyr reformen for norsk fornybar-næring? CICERO/ZERO semi nar. EUs vinterpakke: Nye regler for grønt energiskifte. Oslo, 16. februar 2017.
32. Linnerud, Kristin. Støtteordninger for fornybar energi. Zeroakademiet. Sogndal, 28. april 2017.
33. Linnerud, Kristin. El-sertifikatordningen. Sparebankstiftinga Sogn og Fjordane. Sandane, 15 februar 2017.
34. Linnerud, Kristin. Innovasjon under usikkerhet i energibransjen. Brødrene Dahl Vasskraft. Loen, 18. august 2017.
35. Linnerud, Kristin. Tre råd til norske energipolitikere. 'Åpent hus' halvdagsseminar på CICERO. Oslo, 4. april 2017.

36. Midthun, Kjetil. Innledning og presentasjon av brukercase. CenSES-samling for bruker partnere og forskere. Værnes, 24. august 2017.
37. Nguyen-Ones, Mai Thi. The Effects of a Day off from Retail Price Competition: Evidence on Consumer Behaviour and Firm Performance in Gasoline Retailing. Forskermøtet 2017, Oslo, 4. januar 2017.
38. Næss, Robert. Det grønne skiftet - hva må til? TEKNA - kursdager - samferdsel 2017; 2017-01-12 (presentasjon for Tekna og medlemmesbedrifter).
39. Næss, Robert. Det grønne skiftet - Innovas jon, Atferd og Utvikling. Nasjonal innovasjon scamp; 2017-02-14 (presentasjon for ENOVA, kommuner og lærere).
40. Ryghaug, Marianne Erfaringer med FME CenSES og tverrfaglig energiforsking, presentasjon for Vitenskapsdivisjonen, Norges Forskningsråd Sted: Trondheim 29.03.17.
41. Ryghaug, Marianne. Forskning om klima, energi og miljø. Presentasjon for stortingspoli tikere, Ap; 2017-03-24.
42. Ryghaug, Marianne. Samfunnsvitenskapelige perspektiver på bærekraftig omstilling av energisystemet. Energix programstyremøte; 2017-11-02.
43. Ryghaug, Marianne. Tverrfaglig energiforsking ved KULT. Presentasjon for Styreleder i ENERGIX; 2017-03-22, NTNU.
44. Ryghaug, Marianne. Tverrfaglige forskningssenter - Strategi og praksis. Workshop: Strategisamling CenSES. Selbu. 14. november 2017.
45. Ryggvik, Helge. Foreign market entry as a way of handling turbulence? Seminar: Transformations in the Norwegian petroleum industry: handling turbulence and forging ahead? Oslo, 14. September 2017.
46. Seljom, Pernille. Eksempel på analyse av lokal produksjon av hydrogen, Rotnes-caset. CenSES-samling for brukerpartnere og forskere. Værnes, 24. august 2017.
47. Skar, Christian, Midthun, Kjetil Trovik, Tomasgard, Asgeir. Flexible Norwegian energy as a green service to Europe. Seminar at Statoil Rotvoll. Trondheim, 1. februar 2017.
48. Skar, Christian. Analyzing energy transition pathways using multi-horizon stochastic programming. Workshop: Energy Modeling Workshop (5th PyomoFest). NTNU. Energy/CINELDI/Sandia National Labs. 5. oktober 2017.
49. Skar, Christian. Energitrender og utviklingstrekk. Seminar: Region Namdal Møte, Rørvik. 1. juni 2017.
50. Skar, Christian. Rollen til fleksibel etterspørsel i avkarbonisering av det europeiske kraftsystemet. Kick-off møte om CENSES brukercase om «Prosumenters rolle i det framtidige energisystemet». Workshop, CenSES, Trondheim. 5. oktober 2017.
51. Skjølsvold, Tomas Moe. Prosumenter i energisystemet. Aktører og perspektiver. Kickoff CenSES brukercase: Prosumers; 2017-10-05. Presentasjon for forskere og brukere i CenSES.
52. Strømman, Anders Hammer. The transport transition - Electrification and new transport concepts: Keynote, Conference: Energy Transition 2017, Trondheim, 7. March 2017.
53. Strømman, Anders Hammer. Hydrogen sin rolle i omstilling av transportsektoren. CenSES-samling for brukerpartnere og forskere. Værnes, 24. august 2017.
54. Strømman, Anders Hammer. Sirkulærøkonomi og kraftsektoren. Samspillet mellom industriell verdiskaping, kraftproduksjon og kraftutveksling med Europa. CenSES-samling for brukerpartnere og forskere. Værnes, 24. august 2017.
55. Svennevik, Elisabeth. Bildeling og bærekraftig mobilitet. CenSES-samling for brukerpartnere og forskere. Værnes, 24. august 2017.
56. Sæle, Hanne. Erfaringer fra forskning i SINTEF. CenSES-samling for brukerpartnere og forskere. Værnes, 24. august 2017.
57. Sørheim. Roger. Introduksjon: Erfaringer fra første runde med teknologi-FME: Hvordan skape innovasjon fra forskning. CenSES-samling for brukerpartnere og forskere. Værnes, 24. august 2017.
58. Throndsen, William. «De mest foroverlente private strømkundene i Norge» - Solceller og prosumenter på Hvaler. CenSES Brukerpartnersamling. 24. august 2017.
59. Throndsen, William. Smarte nett, smarte forbrukere? Rektors besøk på instituttet, KULT, NTNU. 20. oktober 2017.
60. Throndsen, William. The sunniest place in Norway - Solar PV on the fringes of the electricity grid. INVADE WP3 workshop businessmodels. Stavanger, 23.-24. mars 2017.
61. Throndsen, William. The sunniest place in Norway - Solar PV on the fringes of the electricity grid. MATCH Project Workshop. Trondheim. 20.-21.mars 2017.
62. Throndsen, William. Comparison of Danish and Austrian cases in the MATCH project. MATCH Project Workshop. Trondheim. 2. oktober 2017.
63. Throndsen, William. Norges mest fremoverlente strømbrukere - Solceller og prosumenter på Hvaler. CenSES-samling for brukerpartnere og forskere. Værnes, 24. august 2017.
64. Throndsen, William. AMS og nye tjenester - Hvilke endringer ser vi komme i husholdningenes og i sluttbrukerpraksis? 2017-11-07 NELFOs Årskonferanse (presentasjon til norsk elektroforening).
65. Throndsen, William. Presentation of INVADE WP9 - Task 9.2. User practises and behaviour analysis. European Utility Week; 2017-10-03 - 2017-10-05 (presentasjon på bransjetreffet utility week).
66. Throndsen, William. Styrer forbrukerne det grønne skiftet? Eller, hva skjer når Smartgrids møter hverdagen? (presentasjon for NVE 30.11.2017).

67. Thune.,Taran Mari. Modes of innovation in upstream petroleum – past successes, future hindrances? Seminar: Transformations in the Norwegian petroleum industry: handling turbulence and forging ahead? Oslo, 14. September 2017.
68. Tomasgard, Asgeir, Kjetil Midthun & Christian Skar: Towards a Zero emission European Power System. Implications of Paris Workshop, 5-6 March 2017.
69. Tomasgard, Asgeir. Aktive konsumenter og effekten på energisystemet. CenSES-samling for brukerpartnere og forskere. Værnes, 24. august 2017.
70. Torvik. Ragnar. Financial aspects of the energy transition: Panel discussion. Conference: Energy Transition 2017, Trondheim, 7. March 2017.
71. Walnum, Hans Jakob. Innledning og presentasjon av brukercase. CenSES-samling for brukerpartnere og forskere. Værnes, 24. august 2017.
72. Wolfgang, Ove. Innledning og presentasjon av brukercase. Samling for CenCES brukerpartnere, forskere og stipendiater. Trondheim: 24.august 2017.
73. Wolfgang, Ove. Innledning og presentasjon av brukercase. CenSES samling 24. august 2017.
74. Wolfgang, Ove. Innledning og presentasjon av brukercase. CenSES-samling for brukerpartnere og forskere. Værnes, 24. august 2017.
75. Wolfgang, Ove: Brukercase: Prosumenters rolle i det fremtidige energisystemet. CenCES energi og klimakonferanse 8. desember 2017.
76. Wolfgang, Ove: Brukercase: Prosumenters rolle i det fremtidige energisystemet. CenCES energi og klimakonferanse 8. desember 2017.
77. Wolfgang, Ove: Innledning og presentasjon av brukercase. CenSES samling, 24. august 2017.
78. Yan, Shiuy. Instruments to achieve a long-term goal of almost zero emissions of greenhouse gases in city passenger transport. CenSES-samling for brukerpartnere og forskere. Værnes, 24. august 2017.
79. Project meeting SHAPE in Brussels w/partners Anglia Ruskin, KIT, POLITO, ENTPE etc., September 2017.
80. Project meeting for the InNOWiC project in Newcastle (UK) with partners from Newcastle University and NTNU, June 2017.
81. Project meetings w/ MATCH-project: Sbi (DK), ITA (AUS), September 2017.
82. Project meetings: Smart grids - smart cities? In Brussels and Malmö w/ partners from NTNU, UiB, University of Sheffield, LATTS Paris, Linköping University, Amsterdam University, January 2017.
83. Project meetings: Smart grids - smart cities? In Brussels and Malmö w/ partners from NTNU, UiB, University of Sheffield, LATTS Paris, Linköping University, Amsterdam University, November 2017.

Conferences and workshops

1. Brukerpartner- og forskersamling 24. august. Radisson Blu hotel Trondheim Airport.
2. CenSES brukersamling: nye brukercase, Stjørdal, august 2017.
3. CenSES Early Career Research School. 26-28 February, Paris, France
4. CenSES Energi- og klimakonferanse 2017. 7. – 8. desember 2017. Scandic Solli, Oslo
5. CenSES Rundebordskonferanse 17. oktober 2017. Hotell Bristol, Oslo 6. CenSES Strategisamling 14. – 15. november. Selbusjøen Hotell og gjestegård, Selbu.
7. Crafting climate and sustainability, 14. – 15. June 2017.
8. Energy Transition 2017, Trondheim, 7. mars.
9. Energy Transition Workshop: 7. – 8. november, 2017.
10. Implications of Paris Workshop. Samarrangert med University of Maryland & CREE, Mars 2017.
11. International Youth Peace Conference on Climate Change and Peace 2017- 30.09.2017-08.10.2017 - http://www.internationalconferences.no/(HiV).
12. Kick-off møte: Prosumenters rolle i det framtidige energisystemet. 05.10.2017, Sintef Energi.
13. Kick-off meeting GREENFLEET project in Oslo, organised by SINTEF TS and UiO TIK, with Lund University and Chalmers University, May 2017.
14. Nature Masterclass workshop, 30. november – 1. desember 2017, Trondheim.
15. NTVA. Teknologiforum på framtidens transport, samarrangert med NTVA, CenSES, Mozees og CICEP. April 26, 2017.
16. Re-assembling urban life: STS and the making of sustainability. Organized at 4S conference, Boston, September 2017.
17. Seminar: Innovasjon og omstilling i den norske oljesektoren. 14.09.2017. UiO.
18. Seminar: Hvordan oppnå fossilfri mobilitet i norske byer? 13.11.2017. Oslo.
19. Schwanitz, Valeria Jana in Cooperation with Vestlandsforsking and De Heibergske Samlinger - Research Days 2017, Workshop "Climate Change Voices", 30.09.2017.
20. Stochastic programming with applications in energy, logistics and finance. 15-21 January 2017. PhD Winter school 2017. Passo del Tonale, Italy.
21. Theorising sustainability interventions: practice, consumption, technology and organization, at NESS conference - Tampere, June 2017.

Monographs

1. Holden, Erling; Linnerud, Kristin; Banister, David; Schwanitz, Valeria Jana; Wierling, August Hubert. The Imperatives of Sustainable Development: Needs, Justice, Limits. 250 p. Routledge, 2017 (ISBN 978-1138714267).

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"Knowledge and engagement for sustainable energy transition"

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