

# NTNU SUSTAINABILITY SCIENCE CONFERENCE

## TRANSITIONS TO SUSTAINABLE SYSTEMS

**TRONDHEIM 18–20 OCTOBER 2017**

**CLARION HOTEL AND CONGRESS TRONDHEIM, NORWAY**

HOSTED BY NTNU SUSTAINABILITY



THE STRATEGIC RESEARCH AREA  
NTNU SUSTAINABILITY



 **NTNU**

Norwegian University of  
Science and Technology



Annik Magerholm Fet  
Conference Chair  
Vice Rector, NTNU Ålesund

Professor, Department of  
Industrial Economics and  
Technology Management

## Welcome to the first NTNU Sustainability Science Conference 2017!

The field of sustainability science advances our scientific understanding of the dynamics of human-environmental systems. It is a synthesis, integration and awareness of different scientific disciplines. With this conference, we therefore aim to expand interdisciplinary research, and to provide an arena to discuss the latest knowledge in sustainability science. We have chosen the theme, Transitions to sustainable systems, for our first conference, to highlight the importance of finding ways to practically implement sustainability strategies that recognize system interactions between economic, social and environmental dimensions.

In collaboration with the Royal Norwegian Society of Sciences and Letters (DKNVS), the Gunnerus Award in Sustainability Science will also be awarded at the conference to a scholar who has made outstanding contribution to the field of sustainability science.

On behalf of NTNU Sustainability, I thank you all for joining us, and look forward to many engaging discussions this week!

Sincerely,  
Annik

# Objectives of the NTNU Sustainability Science Conference – Transitions to Sustainable Systems

In order to reach the goals set by the 2030 Agenda for Sustainable Development, the three dimensions of sustainable development – economic, environmental and social – must be considered holistically.

NTNU SSC 2017 is designed to provide a forum for the presentation of sustainability research that spans human and ecological systems and disciplines. This is research that reflects the awareness and incorporation of interactions, feedbacks and overlaps between sustainability dimensions.

The NTNU Sustainability Science Conference aims to advance the field of sustainability science and contribute to the goals of the 2030 Agenda for Sustainable Development by:

1. Providing a forum for the international presentation of new research in the field of sustainability science;
2. Fostering an exchange of knowledge and good research practice between experts within all sustainability dimensions; and
3. Encouraging critical and cross-disciplinary discussion on current projects and initiatives.



The Strategic Research Area  
**NTNU SUSTAINABILITY**  
is one of four strategic research  
areas at NTNU:



ENERGY



HEALTH



OCEANS



SUSTAINABILITY

## About NTNU Sustainability

NTNU Sustainability is one of four strategic research areas at NTNU for the period 2014-2023. The program brings together the best minds from a range of disciplines to create the knowledge needed by society to understand and change unsustainable patterns of behavior and development. NTNU Sustainability aims to be an international leader. Annik Magerholm Fet led NTNU Sustainability from 2014-2016. From 2017, Professor Helge Brattebø is the director.

### New Research Strategy

From June 2017, NTNU Sustainability restructured its strategy. NTNU Sustainability consists of several core partners from research environments that excel within the field of environmental sustainability. In addition, other actors are affiliated partners on a project basis. Until the end of 2018, the program will focus on four main areas of research. To secure strategic interdisciplinary collaboration, each of these main areas should combine elements of research across three interlinked dimensions:

- Research on innovative, methods solutions and technologies
- Research on modelling, analysis and environmental impact assessment
- Research on behavior and governance for realizing improvement potential

### Research areas

- A – Sustainable use and conservation of biodiversity and ecosystem services
- B – Transition towards a circular economy and sustainable production and consumption systems
- C – Climate change mitigation and adaptation
- D – Transition towards smart sustainable cities and built environment

### Core partners

- Biology cluster
- Business transitions to sustainable development research group at NTNU Ålesund
- Center for Biodiversity and Ecosystem Services (CeBES)
- Center for Sustainable Energy Studies (CenSES)
- Environmental behavior and governance cluster in the Humanities
- Environmental behavior and governance cluster in Social Sciences and Economics
- Industrial Ecology Program (IndEcol)
- Norwegian Manufacturing Research Center (NMRC)
- Smart Sustainable Cities

More information on NTNU Sustainability is available at: <https://www.ntnu.edu/sustainability>

# The Gunnerus Award in Sustainability Science 2017 is presented to Professor Carl Folke

Professor Carl Folke has been awarded the 2017 Gunnerus Sustainability Award for his outstanding scientific work to promote sustainable development globally.

The Gunnerus Award honors outstanding scientific work for sustainable development globally and aims to promote research and strengthen the scientific basis of sustainability. The award will be presented during NTNU's sustainability conference on 19 October.

## The award winner

Professor Carl Folke is science director of the Stockholm Resilience Centre at Stockholm University, and director of the Beijer Institute of Ecological Economics at the Royal Swedish Academy of Sciences.

He is one of the founders of the Stockholm Resilience Centre and of the Resilience Alliance, and has played a key role in developing the International Society for Ecological Economics.

Folke has university degrees in economics, administration and biology, with a focus on ecology. He is an elected member of the Royal Academy of Sciences and the US National Academy of Sciences.

The award winner has been an environmental adviser to the Swedish government. He has collaborated with UN organizations in areas such as biodiversity, ecosystem services, water management and sustainable cities.

Folke has participated in the work on the Millennium Ecosystem Assessment. He has been a member of many scientific councils and committees, such as the National Center for Ecological Analysis and Synthesis in Santa Barbara, California, and the International Human Dimensions Program on Global Environmental Change.

## Significant contributions

Folke has contributed in significant ways to sustainability as a field of research and is internationally considered to be one of the most important researchers in designing this new area of research.

In particular, he has helped stimulate research to better understand complex socio-ecological systems. He has been a pioneer in the pursuit of fruitful dialogue and cooperation between the social sciences, economics and natural sciences to illustrate the important sustainability challenges facing society.



## Professor Carl Folke

The Royal Norwegian Society of Sciences and Letters (DKNVS) and the Norwegian University of Science and Technology (NTNU) established the international Gunnerus Sustainability Science Award, which confers a prize of NOK 1 million (approximately USD 130,000), plus a gold medal and diploma.



NTNU

Folke's initiative has opened new perspectives in understanding the dynamic interaction between human beings and nature, the features and services of ecosystems, as well as how socioeconomic conditions help to manage and maintain ecosystems' ability to cope with changes – their so-called resilience.

The award winner has created interdisciplinary environments for cooperation and contributed to the development of new research areas and approaches that have been adopted in science, education, politics and management, and more recently in the business community.

### **Leading the way**

Folke's research stresses the importance of living systems at different levels of community development. It shows how we can strive for resilience in the ways we direct and administrate systems where society and nature interact. His work illustrates – in superb fashion – how social progress, prosperity and well-being depend on developments in the biosphere.

Professor Folke has given many scientific lectures as an invited expert at conferences around the world, in addition to his public lectures, seminars for politicians and media interviews.

In 1995, Folke was awarded the Pew Scholar Award in Conservation and the Environment. In 2004, he received the Sustainability Science Award of the Ecological Society of America.

### **Professor Carl Folke is a most worthy winner of the Gunnerus Sustainability Award 2017.**

*Professor Carl Folke will be awarded the 2017 Gunnerus Sustainability Science Award for his outstanding scientific work to promote sustainable development globally on Thursday, October 19th.*

He will give a plenary lecture, *Transitions to biosphere resilience*, on Friday, October 20th at 10:40.

## About the Conference Chair

Dr. Annik Magerholm Fet is Vice-Rector at NTNU in Ålesund. She is a professor of environmental management, systems engineering and life cycle analysis, and held the position of Director NTNU's Strategic Research Area on Sustainable Societal Development (NTNU Sustainability) from 2014-2016. She is the head of several national and international research projects in global production, the environment and corporate social responsibility.

She has been involved in the development of the Norwegian system for Environmental Product Declarations, climate and water footprinting for products, and has worked on environmental analysis in relation to environmental responsibility in the maritime cluster. She is a member of the board of Polaris Media Nordvest and on the board for User-driven Innovation Projects in the Norwegian Research Council (User-led Innovation Arena - BIA) - the largest program in the NFR. She is also a Norwegian delegate to the UN Resource Panel, and the Norwegian expert in Sustainable Development Solutions Network - Northern Europe (SDSN-NE). She leads the Network for Green Growth - a research-based business-oriented initiative to strengthen Norwegian industry and contribute to business models for sustainable solutions.



Dr. Annik Magerholm

## About the Conference Coordinator

Haley Knudson is a Researcher at the Department of Industrial Economics and Technology Management at NTNU. Her research interests lay at the intersection between social needs and companies' responsibilities to support sustainable innovation and development. She has supported the development of international research projects funded by the Norwegian Research Council and European Union. Currently, she is coordinator for the Erasmus+ Capacity Building Project, CapSEM - Capacity building in Sustainability and Environmental Management, with universities in India, Nepal, Uganda, Norway, Portugal and the Netherlands. In addition to research and management, Haley is responsible for the Masters course, Green Value Creation and Ethical Perspectives. She has also served as the Research Coordinator for NTNU Sustainability under Professor Annik Magerholm Fet (2015-2016).



Haley Knudson

# TRANSITIONS TO SUSTAINABLE SYSTEMS

Conference program

Master of Ceremonies: Eva Bratholm

## WEDNESDAY, 18 OCTOBER

11:30-12:45

Registration and Lunch

Conference opening - COSMOS1&2 (Plenary hall)  
Opening statements  
Dr. Bjarne Foss – NTNU Pro-Rector for Research  
Rita Ottervik – Mayor of Trondheim  
Dr. Annik Magerholm Fet – Conference Chair

Musical performance  
Julie & Andreas

13:00-14:45

Opening Plenary  
Sustainability science and interdisciplinary perspectives

*Interdisciplinary challenges and solutions emerging from the IPCC process*  
Professor Camille Parmesan – Professor in Biological and Marine Sciences,  
Plymouth University and Professor in Geological Sciences, University of Texas at Austin

*Knowledge in transition requires transition in knowledge*  
Dr. Hans Bruyninckx – Executive Director, European Environment Agency

14:45-15:00

Coffee break



15:00-17:00	<p>Abstract session 1</p> <p>Track A Institutions, governance and ethics – Resource management and sustainability Room: COSMOS1&amp;2 (Plenary hall)</p> <p>Track B Smart &amp; sustainable city services – Mobility Room: LIVING4</p> <p>Track C Biodiversity and ecosystem services – Distribution of diversity and ecosystem services Room: COSMOS3A</p> <p>Track D Business models for sustainability – Transitioning business models Room: SPACE3</p>
17:00-18:00	Poster presentations with Tapas
18:00-18:30	Bus or walk to Nidaros Cathedral
18:30-19:30	Concert at Nidaros Cathedral, a gift from Trondheim Municipality
19:30 (approx.)	<p>Bus or walk back to Clarion</p> <p>Optional Sky Bar for participants</p>

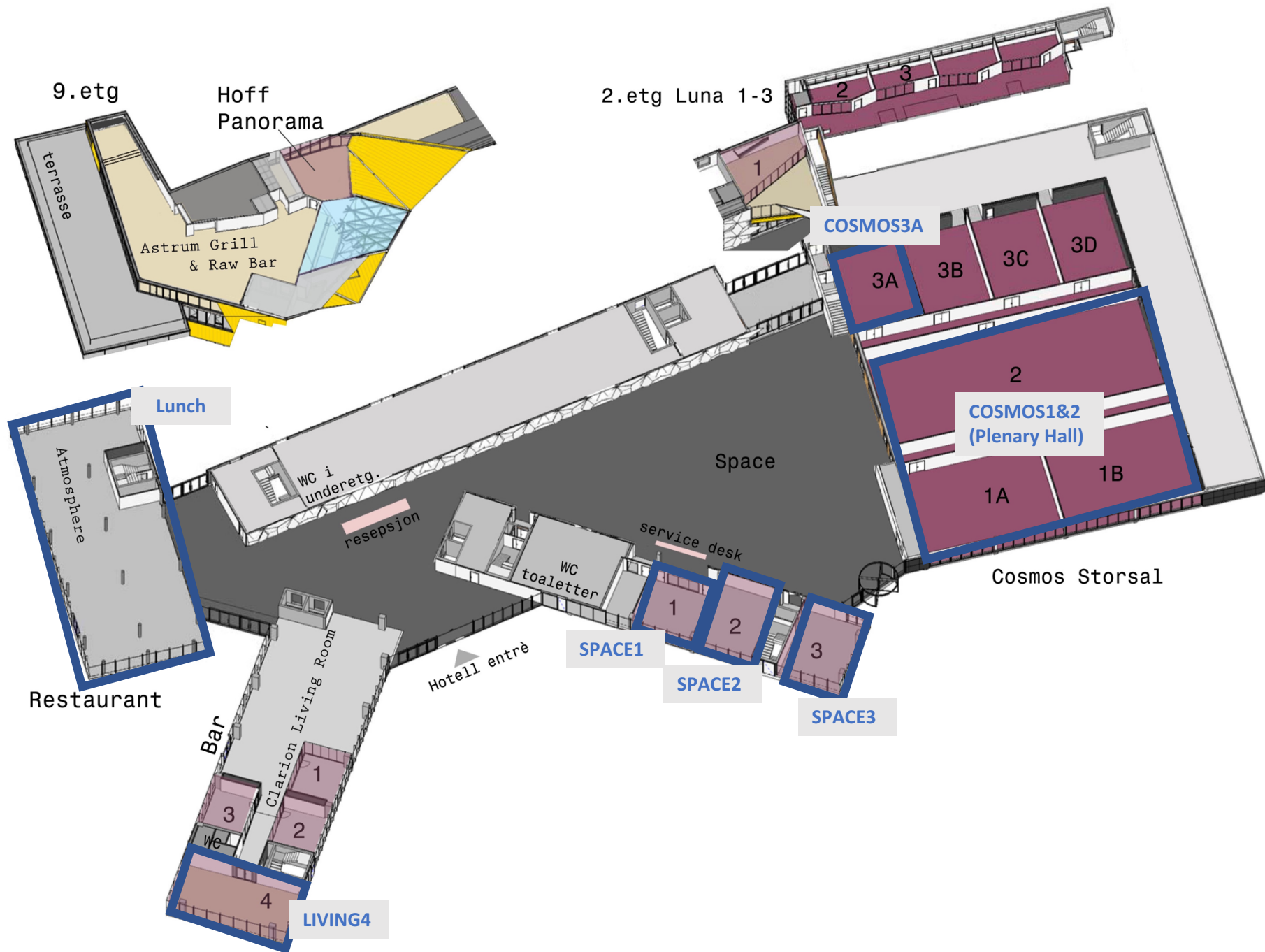
## THURSDAY, 19 OCTOBER

08:30-09:30	<p>Plenary 2 - COSMOS1&amp;2 Global challenges and the 2030 Agenda for Sustainable Development</p> <p><i>The transition to zero-carbon: the key challenge of sustainability</i> Dr. Andrea Tilche – Head of Unit “Climate Action and Earth Observation,” Directorate-General for Research and Innovation, European Commission</p> <p><i>Turning risks to opportunities, innovation towards the world’s 2030 agenda</i> Mr. Bjørn Haugland – Executive Vice President and Chief Sustainability Officer, DNV GL</p>
09:30-09:45	Coffee break
09:45-11:45	<p>Abstract session 2 Track A Institutions, governance and ethics – (2A) CSR, RRI &amp; education Room: SPACE3 (2B) Energy transition Room: SPACE2 Track B Smart &amp; sustainable city services – Participation and governance Room: COSMOS1&amp;2 (Plenary hall) Track C Biodiversity and ecosystem services – Methods and conservation Room: LIVING4 Track D Business models for sustainability – Sectoral studies and circular approaches Room: COSMOS3A</p>
11:45-13:00	Lunch

13:15-15:15	<p>Abstract session 3</p> <p>Track A Institutions, governance and ethics – Ethics, governance Room: COSMOS1&amp;2 (Plenary hall)</p> <p>Track B Smart &amp; sustainable city services – Urban Europe Research Alliance (UERA) Workshop: UERA COST Action proposal on urban transition Room: SPACE2</p> <p>Track C Biodiversity and ecosystem services – Mini-workshop: National ecosystem assessments Room: LIVING4</p> <p>Track D Business models for sustainability – Organizational aspects and motivation Room: COSMOS3A</p>
15:15–15:30	Coffee break
15:30-16:30	<p>Plenary 3 – COSMOS1&amp;2 Means for transition and implementation</p> <p><i>How digitizing urban and building information influence our quality of life</i> Dr. Marianne Linde – Sustainable City Director, City of Tilburg, the Netherlands</p> <p><i>Multi-dimensional struggles in sustainability transitions</i> Professor Frank Geels – Professor of System Innovation and Sustainability, University of Manchester</p>
16:30-18:15	Break before Gunnerus Ceremony
18:15	<p>Gunnerus Sustainability Science Award 2017 Award Ceremony and Dinner</p> <p>18:15 Aperitif</p> <p>18:45 Ceremony start with performances by the Trondheim Soloists and Sapere Aude Guitar Duo</p> <p>19:45 Dinner</p> <p>Please dress in business formal attire, no jeans</p>

## FRIDAY, 20 OCTOBER

08:00-09:00	Breakfast seminar: Open Innovation for Sustainable Systemic Transitions – Hosted by Climate-KIC Room: COSMOS1&2
09:00-10:30	Abstract session 4 Track A Institutions, governance and ethics – Policy, economics, innovation Room: COSMOS1&2 (Plenary hall) Track B Smart & sustainable city services – Sensor-based solutions Room: SPACE3 Track C Biodiversity and ecosystem services – Vegetation studies Room: COSMOS3A Track D Business models for sustainability – Seminar: Green investment tools for sustainable development Hosted by Sustainable Development Solutions Network Northern Europe (SDSN NE) and NTNU Sustainability Room: LIVING4
10:30-10:40	Coffee Break
10:40-11:10	Speech from the winner of the Gunnerus Sustainability Science Award 2017 – COSMOS1&2 <i>Transitions to biosphere resilience</i> Professor Carl Folke – Beijer Institute and Stockholm Resilience Center
11:10-12:10	Plenary 4 Future challenges and working together in the global system  <i>So who must now do what? What must policy makers do? What is the job of business? And how can you and I contribute to the needed transition?</i> Ms. Connie Hedegaard – Former European Commissioner for Climate Action (2010-2014)  <i>Intergenerational justice and sustainability</i> Professor Axel Gosseries – Professor of Social and Political Philosophy, Université catholique de Louvain
12:10-12:20	Coffee break
12:20-13:00	Panel Discussion – Recognizing knowledge and business gaps in reaching the SDGs (COSMOS1&2)
13:00-13:15	Conference closing with Abstract and poster awards Professor Annik Magerholm Fet – Conference Chair Professor Helge Brattebø – Director of NTNU Sustainability
13:15-14:15	Lunch





**Camille Parmesan**

## Keynote speakers

### **Camille Parmesan**

Professor in Biological and Marine Sciences, Plymouth University and Professor in Geological Sciences, University of Texas at Austin

#### **Opening Plenary: Sustainability science and interdisciplinary perspectives**

Wednesday 18 October: 13:00 –14:45

Interdisciplinary challenges and solutions emerging from the IPCC process

Professor Camille Parmesan's research focuses on the impacts of climate change on wild plants and animals. Parmesan's early research spanned multiple aspects of the behavior, ecology and evolution of insect/plant interactions in natural systems. For the past 20 years, the focus of her work has shifted towards the biological impacts of anthropogenic climate change in natural systems. Her research spans from field-based work on butterflies to synthetic analyses of global impacts on a broad range of species across terrestrial and marine biomes. She has also co-authored numerous assessments of the impacts of climate change on agricultural insect pests and on human health, particularly through changes in the wild animal vectors and reservoirs of diseases.

Parmesan has received numerous scientific awards, including being ranked the second most highly cited author in the field of Climate Change from 1999-2009 by Thomson Reuters Web of Science, being named the "2013 Distinguished Scientist" by the Texas Academy of Sciences, and elected a Fellow of the Ecological Society of America. Her 2003 paper in *Nature* was ranked the most highly cited paper on Climate Change (*Carbon Brief*, 2015).

She works actively with governmental agencies and NGOs to help develop conservation assessment and planning tools aimed at preserving biodiversity in the face of climate change. She was awarded the Conservation Achievement Award in Science by the National Wildlife Federation, named "Outstanding Woman Working on Climate Change," by IUCN, and named as a "Who's Who of Women and the Environment" by the United Nations Environment Program (UNEP). She has worked with the Intergovernmental Panel on Climate Change for some 20 years, and is an official Contributor to IPCC receiving the Nobel Peace Prize in 2007. Dr. Parmesan is an Adjunct Professor in Geological Sciences at the University of Texas at Austin (USA) and a Professor in the School of Biological Sciences at Plymouth University (UK), where she holds the National Aquarium Chair in the Public Understanding of Oceans and Human Health.

## Hans Bruyninckx

Executive Director, European Environment Agency

### Opening Plenary: Sustainability science and interdisciplinary perspectives

Wednesday 18 October: 13:00-14:45

*Knowledge in transition requires transition in knowledge*

Hans Bruyninckx is the Executive Director of the European Environment Agency since 1 June 2013. In 1996 Dr. Bruyninckx completed a PhD in international environmental politics at Colorado State University. Until his appointment at the EEA, he was professor of environmental politics and director of the HIVA Research Institute in Belgium, a policy-oriented research institute associated with the Katholieke Universiteit Leuven.

Over the last 20 years, he has conducted research in areas including environmental politics, climate change and sustainable development. He has taught global environmental politics and global environmental governance in relation to the European Union (EU), publishing extensively on EU environmental policies and its role as an actor in global environmental governance. Throughout his career, Dr. Bruyninckx has worked with governmental agencies, civil society and businesses, often in an advisory role.

## Andrea Tilche

Head of Unit "Climate Action and Earth Observation," Directorate-General for Research and Innovation, European Commission

### Plenary 2 Global challenges and the 2030 Agenda for Sustainable Development

Thursday: 19 October: 08:30-09:30

*The transition to zero-carbon: the key challenge of sustainability*

Andrea Tilche obtained his Doctor Degree in Agricultural Sciences at the University of Milano in 1978. His scientific career was mainly carried out in Italy where he set-up and directed the wastewater treatment laboratories of ENEA in Bologna. In 1998, he moved to the Joint Research Centre of the European Commission as Head of the Water Research Unit, and later moved to Brussels to lead the Water Key Action in the 5th Framework Programme.

After other appointments in the Directorate-General for Research and Innovation, since 2010 he is Head of the Unit "Climate Action and Earth Observation". He represents the EU at the Intergovernmental Panel on Climate Change and in other international fora.



Hans Bruyninckx



Andrea Tilche



**Bjørn Haugland**

## **Bjørn Haugland**

Executive Vice President and Chief Sustainability Officer, DNV GL

### **Plenary 2 Global challenges and the 2030 Agenda for Sustainable Development**

Thursday: 19 October: 08:30–09:30

*Turning risks to opportunities, innovation towards the world's 2030 agenda*

Bjørn Kjærand Haugland is Executive Vice President and the Chief Sustainability Officer in DNV GL Group. In his capacity as CSO for DNV GL group he oversees the groups sustainability performance and drives company-wide sustainability initiatives. Haugland has extensive experience assisting multinational companies in areas such as sustainability, climate change and corporate sustainability. Haugland is board member in StormGeo, WWF, Germanischer Lloyd SE and in SUSTAINIA. He is responsible for the Global Opportunity Report, a joint initiative together with UN Global Compact and Sustainia. Haugland started his career in DNV in 1991 and has held various management positions in Norway and abroad. He worked in Korea in the period 1995 to 1997. From 2004 to 2008 he was the Country Chair and responsible for DNV's operation in Greater China.

Haugland has a M.Sc. in Naval Architecture – Marine Structures and Hydrodynamics – from The Norwegian Institute of Technology in Trondheim and he attended the “Strategic International Leadership” programme at International Institute for Management Development (IMD). He is recognized in the global debate on sustainability and technology and he has his own blog on the Huffington Post and he is regularly writing articles for Recharge, Teknisk Ukeblad and Sysla Maritime and on DNV GL's own blog sites.

## **Marianne Linde**

Sustainable City Director, City of Tilburg, Netherlands

### **Plenary 3 Means for transition and implementation**

Thursday: 19 October: 15:30–16:30

*How digitizing urban and building information influence our quality of life*

Since October 2017, Marianne Linde has been the Sustainable City Director for the City of Tilburg. With a population of ca 214,000, it is the sixth largest city in the Netherlands. Climate change, energy transition, quality and maintenance of urban spaces, implementation of circular economy and a smart mobility system are actual topics in this City. Before this position, she was Director of Research at a private company (Geodan BV), former Director Urban Development at TNO and former member of the board at the Netherlands Environmental Assessment Agency. She has published many reports on sustainable urban development and spatial impact of environmental policies. Her main interest is in the recursive relation between quality of the place, sustainable urban policies, public private partnership and innovative technologies. Marianne Linde holds a Master of Science in Social Geography from the University of Utrecht and she received her Ph.D. in Geography from the same university.



**Marianne Linde**



## Frank Geels

Professor of System Innovation and Sustainability, University of Manchester

### Plenary 3 Means for transition and implementation

Thursday: 19 October: 15:30–16:30

*Multi-dimensional struggles in sustainability transitions*

Frank Geels is Professor of System Innovation and Sustainability at the University of Manchester. Geels is chairman of the international Sustainability Transitions Research Network ([www.transitionsnetwork.org](http://www.transitionsnetwork.org)), and one of the world-leading scholars on socio-technical transitions. He has been selected in the Thomson Reuters list of 'Highly Cited Researchers', was identified as one *The World's Most Influential Scientific Minds 2014*, and has been elected as member of the *Academia Europaea* (social science section). He has advised the OECD, European Environment Agency and IPCC about system innovation and sustainability transitions. He will speak in Plenary 3 – Means of transition and implementation.



Frank Geels

## Connie Hedegaard

Former European Commissioner for Climate Action

### Plenary 4 Future challenges and working together in the global system

Friday: 20 October: 11:10–12:10

SO WHO MUST NOW DO WHAT?

What must policy makers do? What is the job of business? And how can you and I contribute to the needed transition?

*What must policy makers do? What is the job of business? And how can you and I contribute to the needed transition?*

Connie Hedegaard was the European Commissioner for Climate Action (2010 – 2014) and the Minister for the UN Climate Change Conference in Copenhagen (2009). She was the Danish Minister of Climate and Energy (2007-2009) and Environment (2004-2007). Recently, she was a member of the Norwegian Government's Expert Committee for Green Competitiveness (2015–2016).



Connie Hedegaard



**Axel Gosseries (BE)**

## **Axel Gosseries (BE)**

Professor of Social and Political Philosophy, Université catholique de Louvain

### **Plenary 4 Future challenges and working together in the global system**

Friday: 20 October: 11:10 –12:10

#### *Intergenerational justice and sustainability*

Axel is a FNRS Research Professor (Maitre de recherches) and a Professeur extraordinaire at Louvain. He is also a Franz Weyr Fellow of the Czech Academy of Science (CELAPA, 2015–19) and a Distinguished Visiting Professor at the Institute for Future Studies (Stockholm, 2016-2019). He holds degrees in Law (St. Louis and Louvain), Environmental Law (LL.M., 1996, School of Oriental and African Studies) and Philosophy (PhD., 2000, Louvain, Dopp Prize 2001). Axel works in the field of political philosophy and economic and social ethics, and focuses especially on issues of intergenerational justice (justice between birth cohorts, age discrimination, historical injustice...), and on the political philosophy of the firm.

He has published one book on intergenerational justice (2004, Aubier) and edited four volumes including Institutions for Future Generations (2016, OUP, with I. Gonzalez Ricoy) and Intergenerational justice (2009, OUP, with L. Meyer). His papers have appeared in a variety of journals in Philosophy (J. of Political Philosophy; Politics, Philosophy and Economics; Canadian J. of Philosophy; Economics & Philosophy) Economics (J. of Environmental Econ. & Management, International Economic Review) and Law (RGAR, JTT, Loyola of Los Angeles L. R.; NYU Environmental Law J.).

He currently heads the Hoover Chair (2016–2021) and the Bernheim Project “Social Responsibility in Economic Life” (2007–2018). He is also the Vice-Chair of the School of Philosophy (since 2015). Responsibilities in the past include: Co-Chair of the Sustainable Development Task Force (2010–2013), Advisory board member of the University Magazine (2007–2011), Deputy Dean of the Faculty of Philosophy (2008–2009).

#### **Master of Ceremonies – Eva Bratholm**

Eva Bratholm has been a political reporter and program reporter for NRK, the Norwegian government-owned public broadcasting company, for 15 years, four of which were spent in Washington as a correspondent. She led several large TV programs among them “Bokbadet” through NRK2. Bratholm has also been the culture editor of Dagbladet and has been the newspaper’s correspondent in New York.



**Eva Bratholm**

# Urban Europe Research Alliance Workshop – Urban transition: Windows of opportunity for an improved science-policy interface

**Special session during Track B, Abstract session 3**  
**19 October 2017, 13:15 - 15:15**  
**Clarion Hotel & Congress Trondheim, Norway**  
**Room: SPACE 2**

*Hosted by NTNU Sustainability and Urban Europe Research Alliance*

Urban Europe Research Alliance (UERA) is one of the key initiatives of JPI Urban Europe. It connects nearly a hundred knowledge institutes and research organisations across Europe with a specific focus on urban challenges. Smart and sustainable cities are at the heart of this research.

The NTNU Sustainability Science Conference focuses on the transition to sustainable systems. To reach the Sustainable Development Goals and the Paris Agreement, the three dimensions of sustainable development – economic, environmental and social – must be considered holistically. The conference is a platform to share evidence-based research for sustainable decision-making.

Currently, many cities are experimenting in pilot projects and living labs with methods and technologies bringing about urban sustainability. For example, electrification of urban transport, deep energy-efficient renovation of neighbourhoods, and closing local resource cycles. However, it is a big challenge for urban stakeholders to come from this urban acupuncture to real urban transition. What are the barriers preventing this transition? How

can science help to achieve a breakthrough, for example by helping to identify the most promising options and assess their broad impact on environment and sustainability? How can the interface between science and policy be improved in order to foster upscaling and replication, and to deliver the desired transition of urban areas?

As part of NTNU's Sustainability Science Conference, a special session is organised by Urban Europe Research Alliance on the topic of urban transition and the windows of opportunity for an improved science-policy interface. Isidoros Ziogou and Theodoros Zachariadis will present their abstract, "Analysis of the implementation of green roof technology in the residential building sector of Cyprus."

The session will also brainstorm on different aspects of the urban transition and translate these into first ideas for a COST Action, bringing together European researchers with a key interest in urban transition towards smart and sustainable cities. Fostering of such networks can help to build a better evidence base for policy makers but also prepare the ground for new research proposals and operationalisation of JPI Urban Europe's Strategic Research and Innovation Agenda.



# Mini-workshop on National Ecosystem Assessments – Biodiversity and ecosystem services assessments for facilitation of political awareness, management and sustainable development

Special session during Track C, Abstract session 3  
19 October 2017, 13:15 - 15:15  
Clarion Hotel & Congress Trondheim, Norway  
Room: LIVING 4

*Hosted by NTNU Sustainability*

Assessment of biodiversity and ecosystem services is a key component for strengthening the science-policy interface for sustainable use and conservation of resources. However, good assessments of biodiversity and ecosystem services are often lacking, hampering management and political awareness as well as scientific advances in the field of biodiversity and ecosystem services research. In this workshop, we want to involve researchers, managers and other stakeholders for discussing the framework for National Ecosystem Assessments (NEA) and draw on the experiences from the NEA from France, Portugal and Spain.

### Some main questions:

1. How to organize an assessment, what is the main focus (specific nature types, sectors, challenges) and constraints? How to get access to relevant data, and who should be involved (research community, stakeholders)?
2. What type of impact/implications does the assessment have/are you hoping for: Policy, management, research agenda?
3. Which type of follow up actions could be relevant?

### Program:

- 13.15 Introduction by organizers, Gunnar Austrheim and Bente Jessen Graae
- 13.20 Perspectives from the Spanish NEA - Fernando Santos Martin, Social-Ecological Systems Lab., Dpt. Ecology, Universidad Autónoma de Madrid, Spain
- 13.50 Perspectives from the French NEA - Yann Kervinio, Division for Natural Resources and Risks Economics Transversal Directorate for Sustainable Development French Ministry for Environment
- 14.10 Perspectives from the Portuguese NEA – Vânia Proença, Instituto Superior Técnico Universidade de Lisboa
- 14.30 Comment from the Norwegian Ministry of Climate and Environment
- 14.40 – 15.15 Common discussion with the four panel members



# Breakfast Seminar – Open Innovation for Sustainable Systemic Transitions

20 October 2017, 08:00-09:00

Clarion Hotel & Congress Trondheim, Norway

Room: COSMOS 1&2

*Hosted by NTNU Sustainability and Climate-KIC*

In order to solve the massive, global problems climate challenges facing us all, we need people who cross boundaries, who think in systems and structures, who understand that we are not going to solve anything with single solutions.

Kirsten Dunlop, CEO of Climate-KIC

Climate change and sustainability topics are now front and centre of every responsible government, company and organisation's strategy.

It is obvious that in order to live up to the goals of the Paris agreement, change needs to happen on a large scale, and it needs to happen fast. Across traditional boundaries such as economic, social and environmental dimensions, innovative thinking and acting is crucial. But how do we achieve that?

Can Open Innovation be the key to unlocking the required systemic transitions?

In today's increasingly interconnected world, where information is more equally available than ever before, innovation itself is shifting from having largely taken place inside hidden R&D units and board room discussions, to more open processes where people of diverse backgrounds, disciplines, and skill sets can contribute and collaborate. Open Innovation is one such process – increasingly adopted by leading companies and organisations within numerous industries.

Join experts from some of the Scandinavian innovation agencies, innovative companies and Climate-KIC for a breakfast seminar and an insightful discussion on how to make use of Open Innovation processes in the transition towards a more sustainable future.



# Seminar on Business Models for Sustainability – Green Investment Tools for Sustainable Development

Special session during Track D, Abstract session 4  
20 October 2017, 09:00 - 10:30  
Clarion Hotel & Congress Trondheim, Norway  
Room: LIVING 4

*Hosted by NTNU Sustainability, Sustainable Development Solutions Network Northern Europe and Sustainable Development Solutions Network Turkey*

To implement the UN Agenda 2030, the Paris Agreement and the Addis Ababa Action Agenda on Development Financing, new financial instruments are needed to cover the wide area of sustainable development. Green finance is becoming a leading tool to connect forward-looking industrial actors and businesses with investors. The background for this development is that business models that promote sustainability are better suited for future markets. In addition, new green investment tools expand relevant innovation opportunities. Currently, the use of green investment tools, such as green bonds and the decarbonization of financial portfolios, are growing. Nevertheless, compared with the global financial market these instruments are still very small.

This talk-show format session will discuss how green investment tools can be scaled up and become more holistic in the Agenda 2030 perspective by

simultaneously addressing environment, social and governance issues. Speakers will present experiences with green investment tools, and discuss issues of how to make green investment tools more holistic from the UN Agenda 2030 perspective.

## **Moderator**

Fritz Balkau, International Advisor at Sustainable Solutions, Paris

## **Speakers**

Anders Olstad, Jan Erik Saugestad, CEO at Storebrand Asset Management  
Björn Bergstrand, Head of Sustainability at Kommuninvest  
Idil Bilgiç, Principal Economist at the European Bank for Reconstruction and Development (EBRD)  
Kristina Alnes, Senior Advisor at CICERO



THE STRATEGIC RESEARCH AREA  
**NTNU SUSTAINABILITY**



# PhD and Postdoc Workshop: It's all about connecting

Friday October 20th, 2017

20 October 2017, 14:00 - 18:00 (Mingling to follow)

Clarion Hotel & Congress Trondheim, Norway

Room: LIVING 4

The Forum for Young Scholars in Sustainability (FYSS), wants to expand our knowledge about conferences and research societies as tools for connecting and for strengthening our research skills.

Through an inspiring session, we will explore the different opportunities for PhDs and early-stage researchers. At the end, each participant will be able to present their research to a small group and get feedback on her/his content and presentation skills.

## More information

<http://www.ntnu.edu/web/sustainability/fyss>

<http://www.ntnu.edu/climate-kic>

<http://isdrs.org/>

## Agenda

14:00 – 14:20	Introduction to the session and the participants
14:20 – 15:00	Lessons learned from a young researcher Dr. Julian Kirchherr
15:00 – 15:15	Coffee break
15:15 – 15:45	The role of communities and networks Lars Gjølme, Climate KIC NTNU
15:45 – 16:45	Opportunities for young sustainability researchers Dr. Walter Vermeulen, President of the International Sustainable Development Research Society (ISDRS) Q/A and discussion
16:45 – 17:00	Coffee break
17:00 – 17:45	The importance of sharing your research Informal exercise
17:45 – 18:00	Closing remarks
18:00	Mingling for participants



# PARALLEL SESSION 1 SCHEDULE



All presenters should bring their presentation on a USB stick to the presentation room 10 minutes before the scheduled session start.

## Track A Institutions, governance & ethics

### Abstract session 1 – Resource management and sustainability

**Room: COSMOS1&2 | Moderator: Sophia Efstathiou, Postdoctoral Fellow,  
Dept. of Philosophy and Religious Studies, NTNU**

15:00-15:05	Session Introduction
15:05-15:20	August Wierling and Valeria Jana Schwanitz An analytic narrative for sustainable development derived from multidimensional, cross-country data analysis
15:20-15:35	Jennifer Bailey, Sigrid Sandve Eggereide and Kristian Ellingard Climate Change, Aquaculture and Conflicts of Interests in Northern Norway: Research Results and Comparative Methodologies
15:35-15:50	Erika Palmer and Dana Ilmari Polojärvi On the Frontlines of Climate Change: Native Arctic Communities and the Systemic Forces of Sustainability Intersections
15:50-16:05	Frode Flemsæter and Svein Frisvoll Mare Nullius? The moral seascapes of marine bioprospecting. A discourse analysis
16:05-16:20	Lillian Hansen Empowerment and change in socio-technical transitions: The case of sustainable salmon feed development in Norway
16:20-16:35	Hilde Bjørkhaug and Heidi Vinge Discourses on farmland management and protection. Saving land for future generations or optimize present societal needs?
16:35-16:50	Jostein Brobakk, Gerald Schwarz, Hilde Bjørkhaug and Alexander K Thanem Understanding policy barriers for a bioeconomic transition: Institutional settings and stakeholder positions
16:50-17:00	Joint questions and discussion



## **An analytic narrative for sustainable development derived from multidimensional, cross-country data analysis**

August Wierling, Western Norway University of Applied Sciences  
augustw@dhvl.no

Valeria Jana Schwanitz, Western Norway University of Applied Sciences  
valerias@dhvl.no

*Track A – Institutions, governance and ethics*

### **Introduction & methods**

The need for developing narratives of sustainable development, i. e. a positive outlook on structural changes necessary to undertake in the coming years and decades, has recently been stressed (c.f. Ostrom (2014), Costanza et al. (2014), ICS & ISSC (2015)). Our 'narrative of change' follows from a multidimensional data analysis for about 100 countries for the years 2000, 2005 and 2010 deploying the K-means procedure (Hartigan-Wong-Algorithm). We utilize the six key dimensions suggested in Holden et al. (2016), but we partly deviate from their proposed choices of indicators and related thresholds by choosing:

1. Eradicating extreme poverty: In each country, no person is below the international poverty line of international \$1.90 per day (2011).
2. Enhancing human capabilities: Each country achieves a human development index above 0.8.
3. Ensuring rich participation: For each country, the participatory index of the Varieties of Democracy Project is larger than 0.52.
4. Ensuring fair distribution: The Gini coefficient in each country is below the alert-line of 0.4.
5. Mitigating climate change: National per-capita emissions do not exceed 3.6 tCO<sub>2</sub>eq per person and year.
6. Safeguarding biosphere integrity: Each country has developed, adopted and begun implementing National Biodiversity Strategy and Actions plans by 2015 (Aichi target no. 17).

### **Results & discussion & conclusion**

We found that the optimal cluster size for our dataset for the year 2010 is seven, which is why we group countries into seven different clusters. The characteristic features that distinguish the clusters from each other are a result of the performances in respect to above thresholds. Namely they are: A 'Space for overall considerable improvements, but yet a relatively small carbon footprint' (e. g. India, Guatemala and Slovenia), B 'Moderate human development with a participatory deficit' (e. g. Russia, Vietnam, Tunisia), C 'High to very high societal development at high environmental costs' (e. g. Germany, Korea, Uruguay), D 'Towards a better societal development; current front runner' (e. g. Costa Rica, South Africa and Israel), E 'Very high societal development at very high environmental costs (e.g. Australia, Canada, USA), F 'Rural countries struggling with societal development' (e. g. Bangladesh, Ethiopia, Tanzania), and G 'Rural countries struggling with extreme poverty' (e. g. Lesotho, Zambia and Madagascar). By additionally utilizing background data such as access to electricity, national ecological footprints and shares in world population, we find four pivotal points for sustainable development. These are 1) reducing population growth, 2) proclaiming unprecedented global solidarity, 3) decoupling of societal prosperity from unsustainable energy and material consumption, and 4) securing the resilience of the natural system. We relate our results to the new generation of long-term climate scenarios, the Shared- Socio-Economic Pathways (SSP) – in particular comparing to SSP1 'Sustainability – Taking the Green Road' and SSP2 'Fossil-fueled Development – Taking the high way' (O'Neill et al. 2017). With our approach we depart from the currently dominant narrative of economic development by identifying groups of countries that tell similar stories of modern societal evolution, equally accounting for all six key dimensions.

### **References**

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**Climate Change, Aquaculture and Conflicts of Interests in Northern Norway: Research Results and Comparative Methodologies**  
**Comparative methodologies and Research Results**

Jennifer L. Bailey, Department of Sociology and Political Science, Norwegian University of Science and Technology  
jennifer.bailey@svt.ntnu.no

Sigrid Sandve Eggereide, Department of Sociology and Political Science, Norwegian University of Science and Technology  
eggereid@alumni.ntnu.no

Kristian Ellingsgaard, Department of Sociology and Political Science, Norwegian University of Science and Technology  
kristian.ellingsgard@ntnu.no

*Track A – Institutions, governance and ethics*

Both climate change and government policy are likely to increase the presence of Atlantic salmon aquaculture in Northern Norway. This paper is the first step in the collection, evaluation and comparison of available knowledge about how actors who rely directly on marine ecosystem services will be affected. It will identify core actors and identify and classify their core concerns as identified by the different research methods and using an extended concept of sustainability (including economic, governance, cultural and ecological elements) developed in association with the interdisciplinary NFR-Funded “SUSTAIN-FISH” project. It will draw heavily upon research

results from the interdisciplinary EU 7th FP project “Ocean Certain”. The paper’s secondary objective is to compare the findings yielded by different methodologies (principally workshops, media mining and discourse analysis), to see to what degree the findings correspond or deviate and to probe the value added of each methodology. The intent here is to capture a more comprehensive assessment of who the key actors are and how aquaculture affects them.

**On the Frontlines of Climate Change: Native Arctic Communities and the Systemic Forces of Sustainability Intersections**

Erika Palmer, Stipendiat/Research Fellow, University of Bergen  
erika.palmer@uib.no

Dana Ilmari Polojärvi, Professor of Humanities and Communications, Maine Maritime Academy  
d.polojarvi@mma.edu

*Track A – Institutions, governance and ethics*

**Introduction**

The impact of climate change on sea ice and permafrost has led to flooding and coastal erosion in Native Arctic communities. Examples of this are easily found in the Yukon-Kuskokwim Delta region of Southwest Alaska. Native Alaskans are adapting to the effects of climate change by moving homes further from shorelines, but less adaptable are the cultural resources above and below ground that are being swept away as coastlines recede and rivers widen. Cultural resources include archaeological artefacts and structural features of the Yupik peoples. Anthropological studies as early as the mid-20th century began to document the loss of cultural resources in this region. Kwethluk, a native village of just over 700 people in Southwest Alaska exemplifies the threat of climate change to the social and cultural sustainability of Native Alaskans. In preparation for the installation of a water and sewage system in Kwethluk, a cultural resources survey report from 2002 noted the extent of the erosion in recent decades of the Kwethluk river bank as severe. Historically, native villages were situated as close to the river as possible. This means that as the river bank erodes, the cultural resources are lost. Recent fieldwork in the form of archaeological monitoring for the water

and sewer system project in Kwethluk showed that the erosion and the loss of cultural resources is accelerating. Underpinning this is that Native Alaskan communities have been socially marginalized since colonization, which has led to a host of persistent social problems, such as poverty and alcohol abuse.

### **Methods**

Using Kwethluk as a case study, this study presents a system dynamics model that investigates several feedback mechanisms in this social system.

### **Results**

Using system dynamics modeling, this study evaluates the systemic interaction of environmental, social and cultural sustainability in Native Arctic communities highlighting institutional governance. As these sustainability domains and institutional actors interact, unintended consequences emerge from the system structure. Using a societal collapse framework, the model indicates that well-intended state policies act as drivers to socially and culturally marginalize Native Alaskan communities.

### **Discussion**

Social problems in Native Alaskan communities is linked to the loss of cultural identity driven by social marginalization, and which is now exacerbated by climate change. The threat of climate change to the cultural heritage of Native Alaskans is situated at the intersection of environmental, social and cultural sustainability. Waiting for a sustainable transition is not an option in a community like Kwethluk, and local, national and international actors must coordinate to keep Native Arctic communities environmentally, socially and culturally sustainable.

### **Conclusion**

The outcome of this study is to galvanize institutional actors to direct policy to specific system structures in order to effect real change in system behavior, specifically the feedback relationships between the local tribe and state organizations.

### **Mare Nullius? The moral seascapes of marine bioprospecting. A discourse analysis**

Frode Flemsæter, Centre for Rural Research  
frode.flemsater@rural.no

Svein Frisvoll, Centre for Rural Research  
svein.frisvoll@rural.no

#### *Track A – Institutions, governance and ethics*

The ocean is currently about to be re-discovered and explored beyond the oil and fisheries, attracting stakeholders previously not that concerned with these marine areas. A key issue in this process is questions regarding rights to access, collect and utilize resources, and the sharing of costs and benefits, which are potentially high in both ends. This is a very complex situation trying to manage private rights in shared landscapes – or rather sea-scapes. In this paper we will analyse the discourse and various normative assessments pertaining to the access, collection, utilisation, costs and benefits from marine bioprospecting. The analysis is carried out in light of the transition to a sustainable bioeconomy.

Marine bioprospecting implies searching for genes or biomolecules from bacteria, algae or animals in the ocean or at the ocean floor. There are great expectations from authorities and researchers that marine bioprospecting can have major positive effects on the development of medicine as well as for food and fodder. The expectations to yet unknown possibilities are also huge.

Marine bioprospecting in Norway is regulated by the Nature Diversity Act and the Marine Resources Act, both stating that the resources in the ocean belongs to the public. However, none of the acts provides a detailed framework for how access rights, utilization, and cost/benefit sharing should be organized in practice. Therefore, at present Norway does not have a functioning regulatory system for marine bioprospecting.

Currently, a state driven process aims to better regulate and control bioprospecting. However, this process has been a lengthy one, and it has proved challenging to establish these new regulations. In an on-going research project, we analyse the role of rights in the transition to a

bioeconomy, and one of the aspect we look into is the ongoing process, in particular the moral and spatio-legal aspects, of establishing a rights system for marine bioprospecting.

Although it seems to be recognized by many researchers and authorities that a lack of such regulatory system hampers the broad value creation from marine bioprospecting, the rights situation for bioprospecting is described as a juridical vacuum. The process of establishing the regulations are highly demanding regarding many aspects on different scales, many of them illustrated in 44 hearing statements from different stakeholders.

### **Empowerment and change in socio-technical transitions: The case of sustainable salmon feed development in Norway**

Lillian Hansen, PhD Student, Centre for Rural Research  
lillian.hansen@rural.no

Magnar Forbord, Senior Researcher, Centre for Rural Research  
magnar.forbord@rural.no

#### *Track A – Institutions, governance and ethics*

Introduction: The role of actors, power and leadership is becoming increasingly recognized in socio-technical transitions and the study of long-term structural change (see e.g. Geels 2016; Brown et al. 2013; Avelino and Rotmans 2009). In this paper we add a contribution to the recent literature by analysing a certain case, the development of more sustainable feed in the salmon farming industry. Investigating certain initiatives/ technologies in the salmon feed development, we ask: How and in what way have certain combinations of actors, motivations, relations and resources contributed to a more sustainable transition?

Theoretical framework: Socio-technical transitions and enactment of power: Using the Power-in-Transition model of Avelino and Rotmans (2009) we analyse how actors influence transition processes. This model conceptualizes how actors at the niche- and regime-level (Geels et al. (e.g. 2016) drive transitions through exercising power and leadership. In the

model, power is understood as the ability of actors to mobilize resources. Resources are here understood broadly: natural resources, artefactual, mental, monetary etc. Various conditions, like skills, can empower actors at different levels. At the niche-level actors can exercise innovative power -the capacity to create or discover new resources. At the regime-level actors can exercise constitutive power to establish a distribution of resources. At the intersection between niche and regime-level, actors can connect to form extended networks that can give transformative power -the ability to create new distributions of resources. In addition, actors can enact destructive power through e.g. hindering certain resources from being mobilized. Avelino and Rotmans describe leadership as an especially important driver in transitions. In the transition management framework leaders are understood as “frontrunners”—agents with unique personal competencies such as visionaries (Rotmans and Loorbach 2009).

Method: We chose a case study of the development of sustainable salmon feed in Norway, focusing on five specific events in this development: 1) from wet feed to dry feed, 2) the salmon going vegetarian, 3) replacing crops in fish feed, 4) the development of the sustainability standard ASC. The transition is not completed, but we can argue that there have been big shifts towards more sustainability in the salmon feed industry between the 1950's and year 2016. For describing the case, we started out with a media analysis (Retriever), followed by studies of web pages, reports and scientific article on each event. We are now in the planning of interviews with key informants to complete the case.

Results: Preliminary findings show that a more sustainable development of the salmon feed was enabled through involving social (counter ) movements and 'radical' groups of actors that challenged dominant trends at the landscape level like, environmental organisations; they involved an active mobilization of resources(power); there was interaction between niches and regimes, as companies developing innovative solutions for feed compositions, in cooperation with more established research regimes as e.g. agriculture; not least, certain leaders of large industries served as important “frontrunners” by fronting ambitious visions for their companies. We argue that the role of technology, institutions and structures in sustainable transitions cannot be considered separate from the actors upholding or transforming them.

**Discourses on farmland management and protection. Saving land for future generations or optimize present societal needs?**

Hilde Bjørkhaug, Centre for Rural Research  
hilde.bjorkhaug@bygdeforskning.no

Heidi Vingen, Centre for Rural Research  
heidi.vinge@bygdeforskning.no

*Track A – Institutions, governance and ethics*

This paper explores how land is negotiated in Norway and discusses how valuation of “in the interest in society”, the demarcating node of whether agricultural land is protected or not in Norway evolves around the need for infrastructure, housing for a growing urban population, land-owners’ economic interests or agriculture and food interests. In the Norwegian food security and food sovereignty discourses available land for growing grain has become a determining measure. It is seen as a major challenge to sustain or increase this area (and the productivity of the production on it). Data from in-depth analysis with stakeholders, media texts and public documents and reports are analysed to reveal valuation of farmland and farmland protection in Norway. The paper investigates recent developments in debates on the status of protecting agricultural land and discusses challenges that occur when major societal interest meets in concrete conflicts around issues such as where the next road should go. Analysis in the paper shows that a decision to secure availability of agricultural land is value based, weighted against public interests and open for negotiations. As for the situation of farmland, it struggles to reach value as societal need for the future in competition with other goods for the present.

**Understanding policy barriers for a bioeconomic transition: Institutional settings and stakeholder positions**

Jostein Brobakk, Centre for Rural Research  
jostein.brobakk@bygdeforskning.no

Gerald Schwarz, Thünen Institute  
gerald.schwarz@thuenen.de

Hilde Bjørkhaug, Centre for Rural Research  
hilde.bjorkhaug@bygdeforskning.no

Alexander K Thanem, Centre for Rural Research  
alexander.thanem@bygdeforskning.no

*Track A – Institutions, governance and ethics*

The development of the bioeconomy calls for a shift in our approach towards policy studies. A bioeconomic transition is a complex endeavor calling for coherent parallel activities from societal actors and institutions across different sectors to reach consensus on the most sustainable pathways for bioeconomic transitions. Such processes require careful management, multi-scalar governance and a balanced policy development. Building on a comprehensive foresight process the policy analysis in the Biosmart project (financed by the Norwegian Research Council) aims at providing a better understanding of the impacts of current policies and their institutional settings on bioeconomic transitions in Norway and identify opportunities for greater coordination of policies. The poster presents results of the mapping of the institutional context involved in implementing and supporting policies and identifies policy and institutional barriers for bioeconomic transitions. Findings of literature studies, stakeholder consultations and survey analysis indicate that access to private investment capital and fossil energy scarcity are minor drivers of bioeconomic transitions. Instead, state initiatives and governmental policies emerge as key drivers with the highest priority across different stakeholder types. While policy measures are seen as key drivers, dominating governing principles enhance siloing effects - although often unintended. Separate bioeconomy strategies emerge from sectoral siloes reflecting different interests and objectives and hindering coherent activities and balanced policy development. The poster provides an overview of institutional and policy barriers and explores potential consequences for a transition to a smart bioeconomy in Norway.



**WEDNESDAY, 18 OCTOBER | SESSION 1 | 15:00–17:00**

**Track B Smart & sustainable city services**

**Abstract session 1 – *Mobility***

**Room: LIVING4**

**Moderator: Judith Borsboom-van Beurden, Senior Researcher,  
Dept. of Architecture and Planning, NTNU**

15:00-15:05	Session introduction
15:05-15:20	Pia Laborgne, Monika Heyder, Joanna Skok, Ralf Trunko and Brendan McGill "Smart" participation? A use case in electric bike infrastructure planning
15:20-15:35	Ray Pritchard and Dominik Bucher Targeted sensing technology for bicycle research
15:35-15:50	Tom Erik Julsrud, Cyriac George and Eivin Farstad Car sharing and pathways to sustainable mobility: insights from a qualitative study of early users
15:50-16:05	Maximilian Franz Böhm, Eirin Ryeng and Torbjørn Haugen Wi-Fi and Bluetooth based sensors for pedestrian detection in urban areas
16:05-16:20	Lin Ye, Lizhen Huang, Johan Wåhlin, Kang Gui, Junfeng Ge and Bian Yang Road ice intelligence with multi-function sensors for better winter mobility
16:20-16:35	Shanshan Jiang, Marit Natvig and Erlend Stav Semantic Enabled Federated Catalogue Services for Open Data
16:35-17:00	Joint questions and discussion

### **“Smart” participation? A use case in electric bike infrastructure planning**

Pia Laborgne, European Institute for Energy Research  
laborgne@eifer.org

Monika Heyder, European Institute for Energy Research  
heyder@eifer.org

Joanna Skok, European Institute for Energy Research  
skok@eifer.org

Ralf Trunko, Cyberforum e.V.  
Trunko@Cyberforum.de

Brendan McGill, University of Freiburg  
brendanmc6@gmail.com

#### *Track B – Smart and sustainable city services*

The URBAN INNO project (EU-funded Interreg project 2016-2019, coordinated by the City of Rijeka) addresses the challenge of a better linkage of actors (citizens, policy and administration, science, local economy) within urban innovation ecosystems. A major goal is to develop and implement participatory methods and tools in order to actively involve end-users in innovation processes. The focal point is on central European cities and urban regions. The project aims at enabling the transfer and exchange of urban innovation models and practices throughout Europe. In so-called local pilots, different participatory instruments are tested and evaluated on-site.

The paper will present the pilot of Karlsruhe, focusing on integrative and integrated electric bike infrastructure planning, embedded in local energy, mobility and climate strategies. The initial point of the inter- and transdisciplinary approach of the pilot is the improvement of the collaboration between science, municipal actors, citizens and other local stakeholders. The pilot serves as use case for testing public participation GIS (geographic information systems) for participative urban infrastructure planning as part of smart city approaches and e-governance. Besides user-friendliness and attractiveness of the tools and approaches and usability of the results, a

central question is how to design such forms of participation in an inclusive way, avoiding effects of exclusion? And also, in a more general view, how can data, maps and models be made more accessible and understandable for citizens on the one hand, and how, on the other hand, can they better integrate stakeholder knowledge, perceptions, ideas and needs?

This pilot captures the practical intersection of smart and sustainable city services and their planning, by simultaneously examining participation in the ‘smart city’ (exploring ICT tools for participation), as well as planning for the ‘smart city’ (exploring participation towards distributed electro-mobility).

The paper will present the approach and results of the pilot.

### **Targeted sensing technology for bicycle infrastructure intervention research**

Ray Pritchard, PhD Candidate, Department of Architecture and Planning, Faculty of Architecture and Design, NTNU—Norwegian University of Science and Technology  
raymond.pritchard@ntnu.no

Dominik Bucher, PhD Candidate, Institute of Cartography and Geoinformation, Department of Civil, Environmental and Geomatic Engineering, ETH Zürich  
dobucher@dethz.ch

#### *Track B – Smart and sustainable city services*

#### **Introduction**

In order to improve understanding of how bicycle networks are used and valued, many bicycle suitability metrics have been created, taking account of such factors as infrastructure quality, perceived safety, directness and attractiveness. However the empirical data behind these metrics is often very limited either in data collection time or detail. This study makes use of a Global Positioning System (GPS) based mobile application to identify route choice and transport mode in order to observe the before and after effects of a bicycle infrastructure project in Oslo, Norway.

## Methods

The GoEco! Project is a collaboration between ETH Zurich and SUPSI which has created a mobile application GoEco! Tracker (suitable for Android and Apple) to collect route and mode choice data in connection with a sustainable transportation gamification initiative. This study makes use of the same application to observe the route and mode choices of people who live in proximity to a bicycle lane infrastructure project. GPS data is recorded via the commercial application Moves, which is subsequently refined (in terms of mode identification) and collated for research use by GoEco! Tracker.

Approximately 160 participants were recruited to the study who live or travel in close proximity to Oslo Municipality's City Route 1 bicycle lane project – between Torshov and Grünerløkka (Byrute 1). Their travel behaviour was recorded over a period of 1-3 weeks in May and June 2017. The intervention will be built in August, and post-intervention travel behaviour for the same participants will be recorded in September/October. A small control group was additionally recruited in a neighbouring suburb.

In addition to the GPS based registration method, traffic counting has also been deployed using radar devices to cross-check how the impact of infrastructure in one street does or does not effect the distribution of transportation across parallel alternative streets.

## Expected Results/Discussion

As a before-after study, it is expected that this research will reveal the impacts of a bicycle lane upgrade against the following hypothesis: growth in levels of cycling along the intervention street are due to changes in route choice among existing cyclists.

The active transport research field seldom makes use of longitudinal before and after studies, and to the author's knowledge, there have not been other studies that have attempted to classify the before and after impacts of an infrastructure intervention using GPS methods. There are multiple challenges associated with creating a successful study in this way. These include sample recruitment, intensive geographic analysis within server and in raw data extracted from server. These challenges explain why this study is able to fill a research gap, despite the fact that neither the method nor analytical approach are unique, but only the combination in the field of cycling research.

Additional radar counting methods are used to validate the findings from the GPS data.

## Car sharing and pathways to sustainable mobility: insights from a qualitative study of early users

Tom E. Julsrud, PhD, Institute of transport Economics  
tej@toi.no

Cyriac George, MA, University of Oslo  
mrcyriac@gmail.com

Eivind Farstad, PhD, Institute of transport Economics  
efa@toi.no

### *Track B – Smart and sustainable city services*

There are expectations that shared mobility systems, such as bike sharing and car sharing, may help to spur a transition towards smarter and more sustainable urban regions with mobility system less dependent on privately owned cars. Since car sharing has been shown to reduce the number of cars on the road and vehicle kilometer traveled it has the potential to reduce road congestion, road land-use, emissions and energy consumption. Shared mobility may, in the long run, challenge the current mobility regime, which is dominated by privately owned automobiles, and play a significant role in a broader socio-technical transition.

A shift to shared mobility depends, however, not only on changes in technologies, infrastructures and institutions, but also on the development of new mobility practices at the level of individual users and households. It is of importance to understand the processes related to the way car sharing is being implemented and used, why it could fail as a mobility alternative, and how it is possible to make car sharing a relevant alternative to private cars.

This paper uses a social practice approach, as well as a mobility biography approach to develop a deeper understanding of how car sharing is used among a sample of early adopters of ICT-supported car sharing. Young families with children are, in this respect, particularly interesting, since they



are at a life stage when acquisition of a car and relocation to the suburbs is common, and when long-term car-dependency may commence. Our focus is, on the one hand, how car sharing has been integrated in their everyday mobility practices and; on the other hand, how a transition towards long-term car sharing can be stabilized through policy measures and governance.

Empirically the study is based on in-depth interviews with 10 households in Oslo that have substituted or forgone privately owned cars for shared ones, or experimented with car sharing during the last year. The paper contributes to a theoretical discussion on how practice theory can contribute to studies of socio-technical transitions in the mobility systems. It will also provide knowledge on potential implications of car sharing on households' mobility patterns, and relevant measures to support uptake of car sharing in urban regions.

#### **Wi-Fi and Bluetooth based sensors for pedestrian detection in urban areas**

Maximilian Franz Boehm, NTNU  
maximilian.boehm@ntnu.no

Eirin Ryeng, NTNU  
eirin.ryeng@ntnu.no

Torbjørn Haugen, NTNU  
torbjorn.haugen@ntnu.no

#### *Track B – Smart and sustainable city services*

An improvement of pedestrian infrastructure, as well as a higher amount of people walking in inner city areas are desirable. Pedestrian volumes are one of the key performances to argue for an enhancement of walkability. Information about the amount of pedestrians, walking in urban areas are nowadays often based on annual countings or traffic model estimations. For the increasing needs of sustainable inner city infrastructure planning, a wider range of available data can encourage policy makers for an enhancement of walkable infrastructure.

The growing number of mobile devices, equipped with Bluetooth and Wi-Fi interfaces, creates new possibilities in pedestrian data collection in indoor and outdoor situations. An automatic, cost effective pedestrian counting device, operating with Wi-Fi and Bluetooth data to acquire pedestrian information, is highly welcomed.

Preliminary tests indicated that Bluetooth and Wi-Fi signals could indeed be utilized for the detection of pedestrians in urban areas. The during these test used sensors are measurement instruments, which detect unique Wi-Fi and Bluetooth Media-Access-Control (MAC) addresses, sent from mobile phones, headsets or other hardware devices. Nevertheless showed these tests also several disadvantages, regarding the used system. One of the main challenges were the strong and non-removable antennas of the equipment, which are causing strong overlapping issues while using them in complex and space limited urban surroundings.

During this project a new sensor with the focus of a usage in narrow urban areas is about to be developed. The aim is to build an easy to handle and low cost device, based on a microcomputer. The sensors are tested during controlled indoor tests, to validate the measurement equipment. In a second phase, several field tests are conducted to evaluate the performance of the sensors in different urban geometries, like bridges, pedestrian zones and arterial main roads. Filter techniques, such as speed ranges or characteristically movement behaviors of the different road users support the distinguishing between pedestrians, cyclists or cars. The measurement system is examined and discussed in case of its reliability, the further usage and its restrictions.

### **Road ice intelligence with multi-function sensors for better winter mobility**

Lin Ye, Huazhong University of Science and technology  
lye@mail.hust.edu.cn

Lizhen Huang, Norwegian University of Science and Technology  
lizhen.huang@ntnu.no

Johan Wåhlin, Statens Vegvesen  
johan.wahlin@vegvesen.no

Kang Gui, Huazhong University of Science and technology  
gk\_work@hust.edu.cn

Junfeng Ge, Huazhong University of Science and technology  
gejf@mail.hust.edu.cn

Bian Yang, Norwegian University of Science and Technology  
bian.yang@ntnu.no

#### *Track B – Smart and sustainable city services*

Climate change may increase road slipperiness due to the climate change in Nordic countries. In recent years, there are several accidents caused by the sudden icing on road reported in Norway. These accidents can cause significant environmental, economic and health challenges. To increase the safety of winter road service, ITS (intelligent transport systems), MDSS (maintenance decision support system) and road weather information system are used to improve the safety of winter road transport. However, those current systems are not valid enough for the extreme winter events, such as heavy snowfall, sudden icing (i.e. black ice<sup>1</sup>), extreme cold, etc.

The winter road service is a complex system including multi discipline and stakeholders. To improve the safety and sustainability of winter road service for the changing future, we envision a data driven Ice Intelligence System. The ice intelligence system aims to: 1) forecasting the ice formation, detect and monitor the ice existence and evolution on the road, and then identifying the risk level of winter road; 2) optimising the winter road service with holistic

sustainability perspective. One of the main challenges for ice intelligence is to have the accurate information on road surface status (i.e. invisible ice). Few of current researches or existing system can deal with this challenge. For example, in Norway, Statens Vegvesen uses optical sensors, both mobile and stationary, for road surface status information collecting. These are generally effective at detecting ice on a road, but due to their mechanism of operation (absorbed light from nearest surface), they are expected to struggle if the ice is wet or invisible. Instead of reporting a very slippery condition, they would report a wet road with good friction. This type of misinformation could surprise road users, and cause accidents. To fix such mistakes, this study aims to develop the new generation of road surface status information system with multifunctional sensor. The developed system will identify the ice and snow under different situation (i.e. ice, ice with salt, gravel, rind) in better data quality and users' friendliness.

1 Black ice, sometimes called clear ice, refers to a thin coating of glaze ice on a surface, especially on roads. The ice itself is not black, but visually transparent, allowing the often black road below to be seen through it. Road users don't expect it and have difficulties to see it.

### **Semantic Enabled Federated Catalogue Services for Open Data**

Shanshan Jiang, PhD / research scientist, SINTEF Digital  
Shanshan.Jiang@sintef.no

Marit Natvig, Research manager, SINTEF Digital  
Marit.Natvig@sintef.no

Erlend Stav, PhD / senior research scientist, SINTEF Digital  
Erlend.Stav@sintef.no

#### *Track B - Smart and sustainable city services*

Open data fuels the development of new and innovative ICT solutions towards the vision of smart and sustainable cities. More and more public data become available, both historical data and real time data e.g., from sensors. Datasets have been open through various channels. Some are published in portals and catalogues, e.g., in Norway through the national portals data.norge.no and geonorge.no, while others in their own websites.

However, there is currently some challenges to the use of this data. There is a lack of overview of available open data. Often the published data descriptions are unprecise or incomplete and it is time-consuming to browse over a large number of datasets with unprecise or incomplete descriptions to identify relevant datasets. In addition, there is no common data models and Application Programming Interfaces (APIs). This hinders automatic search for software programs to discover and utilize open data dynamically.

To improve this situation and facilitate the development of innovative applications, federated catalogue services are needed to search datasets from different catalogues and find the datasets most suitable to the user needs. Semantic search based on ontologies is a promising approach to increase search quality and efficiency and enable automatic search. Such semantic and automatic search among different catalogues is not available national-wise and internationally.

CKAN is an open source data portal platform widely used in implementing catalogue systems for open government and smart cities data. CKAN does not provide ontology-based semantic search. Therefore, we have implemented a prototype for semantic-enabled federated catalogue services based on CKAN. The lean startup method is followed, with an iterative approach of components development where feedback is collected automatically by mechanisms integrated in the prototype.

The prototype consists of three components:

- A harvester plugin to import dataset descriptions from different catalogues.
- A semantic plugin for management of ontologies, annotation of datasets with ontology concepts, and semantic search based on ontologies. APIs are available for semantic search to enable automatic search.
- A front-end user interface to demonstrate the semantic search including the semantic search results, visualization of ontology graph and annotations.

To verify the idea, transport domain is selected as the application area and three transport-related use cases have been developed to identify the supporting services and relevant data required. As ontologies are vital in this approach, we are defining and elaborating an ontology based on the

information models of transport standards and widely used systems e.g., NVDB, INSPIRE, DATEX.

Hackathons are planned in the autumn to allow users and developers from start-ups, SMEs and city authorities to test and experiment with the prototype, and to gather feedbacks on using the prototype and issues related to the opening and use of data, e.g., which data needs to be open, the quality or errors in the data. In this way, we hope to contribute to lowering the barriers for publishing and using open data, and facilitating innovative services for smart cities.

**WEDNESDAY, 18 OCTOBER | SESSION 1 | 15:00–17:00**



**Track C Biodiversity & ecosystem services**

**Abstract session 1– *Distribution of diversity and ecosystem services***

**Room: COSMOS3A**

**Moderator: Ivar Herfindal, Researcher, Dept. of Biology, NTNU**

15:00-15:05	Session introduction
15:05-15:30	Kris Verheyen, Alicia Valdés, Jonathan Lenoir, Pieter De Frenne, Guillaume Decocq and the SmallForest-consortium Small but strong: ancient forest patches deliver high levels of ecosystem services in agricultural landscapes
15:30-15:45	Bram Van Moorter, Ilkka Kivimäki, Robin Devooght, Manuela Panzacchi and Marco Saerens Measuring simultaneously habitat loss and fragmentation due to infrastructures: a novel habitat functionality metric
15:45-16:00	Yajie Liu, Jennifer Bailey and Jan Grimsrud Davidson Ecosystem services of sea trout populations and the values of recreational fishing in Norway
16:00-16:15	Gary Watmough, Cheryl Palm, Clare Sullivan and Jens Christian-Svenning Understanding socio-ecological systems: Coupling population and satellite remotely sensed environmental data to increase human-natural systems understanding
16:15-16:30	Asit Kumar Roy and Debajit Datta Evaluating agroecosystem sustainability of interdunal wetlands of littoral West Bengal, India
16:30-16:45	Debajit Datta Stakeholder based collaborative planning towards sustainable wetland management in Ichamati floodplains of West Bengal, India

### **Small but strong: ancient forest patches deliver high levels of ecosystem services in agricultural landscapes**

Kris Verheyen, Forest & Nature Lab, Ghent University  
Kris.verheyen@ugent.be

Alicia Valdés, Ecologie et Dynamique des Systèmes Anthropisés, Jules Verne University of Picardie

Jonathan Lenoir, Ecologie et Dynamique des Systèmes Anthropisés, Jules Verne University of Picardie

Pieter De Frenne, Forest & Nature Lab, Ghent University

Guillaume Decocq, Ecologie et Dynamique des Systèmes Anthropisés (EDYSAN, FRE 3498 CNRS), Jules Verne University of Picardie

The SmallForest-consortium

#### *Track C – Biodiversity and ecosystem services*

Positive relationships between biodiversity and multiple ecosystem services have been reported for large forests. Yet, accelerating forest loss and fragmentation in agricultural landscapes across the world have strongly enhanced the frequency of small forest patches that cover at most a few hectares. Surprisingly, we know very little about the ecosystem service delivery of such small woodlands in comparison to larger forests. Although the theory of island biogeography predicts that small and isolated forests harbor less biodiversity and they may thus deliver a smaller amount of ecosystem services compared to large forests, the evidence so far is inadequate. We quantified the biodiversity of six taxonomic groups (including plants, arthropods and fungi), five ecosystem services (related to food and wood provisioning, pest and climate regulation) and one disservice (human disease risk) across 224 small forest patches in agricultural landscapes along a 2500-km latitudinal gradient spanning the entire temperate forest biome in Europe. We show that small and ancient forest patches maximize delivery of multiple ecosystem services at high performance levels (high amount of service provided per spatial unit). Strikingly, smaller forest patches deliver

multiple services at higher performance levels than larger patches of a similar age, even if the larger patches harbored a higher biodiversity. Our findings emphasize the conservation value of small woodlands in agricultural landscapes and underpin the need for targeted policy instruments to conserve the biodiversity and enhance the performance levels of multiple ecosystem services in agricultural landscapes, seeing that small woodlands are currently not included in major national and international policies affecting biodiversity and ecosystem services in agricultural landscapes (e.g. the EU Common Agricultural Policy and the Natura 2000 network).

### **Measuring simultaneously habitat loss and fragmentation due to infrastructures: a novel Habitat Functionality metric**

Bram Van Moorter, NINA  
bram.van.moorter@nina.no

Ilkka Kivimäki, Aalto University  
ilkka.kivimaki@aalto.fi

Robin Devooght, Université libre de Bruxelles  
rdevoogh@ulb.ac.be

Manuela Panzacchi, NINA  
manuela.panzacchi@nina.no

Marco Saerens, Université catholique de Louvain  
marco.saerens@uclouvain.be

#### *Track C – Biodiversity and ecosystem services*

The ecological impact of transportation infrastructures is often considerably higher than their mere footprint in terms of direct habitat loss. Roads and railways can represent barriers to movements preventing access to potentially suitable habitat. When assessing the total effect of a given transportation infrastructure, it is crucial to quantify both direct habitat loss, and indirect habitat loss due to fragmentation. We developed a novel Habitat Functionality Metric, HFM, to quantify simultaneously the total effect

of habitat loss and fragmentation. The metric is calculated using animal movement data (GPS), based on a graph theoretical approach.

First, using a large set of GPS-tracking data for wild reindeer in Norway, we estimated reindeer Habitat Quality (using Habitat Selection Probability Functions, Lele et al. 2009), and Movement connectivity (using the Step Selection Probability Functions, Fortin et al. 2009; and the Randomized Shortest Path framework, Kivimäki et al. 2014). After, the HFM was computed by calculating the connectivity of all pixels in the landscape weighted by their habitat quality. This weighted sum allowed us to integrate effects from anthropogenic infrastructures on habitat quality (e.g. habitat loss) and connectivity (e.g. habitat fragmentation) within one metric. Hence, landscapes with highest HFM scores indicate large amounts of connected, high-quality habitat, while landscapes with lowest HFM score indicate highly fragmented and/or poor-quality habitat. HFM can be used in a scenario-approach to quantify the total impact of existing or planned infrastructures and, therefore, it allows identifying land-planning or mitigation options causing the lowest cumulative impact on animal space use. The HFM will be used to guide Environmental Impact Assessment and support the identification of the most sustainable mitigation measures for wild reindeer in Norway.

Our approach does not include demographic data, and therefore relies on the assumption that habitat quality is adequately captured by the preference exhibited by the individual animals. Despite this limitation, that needs to be addressed in future studies, we believe that our approach represents a major step forward towards a more comprehensive assessment of the ecological impacts of transport infrastructures, as it combines and synthesizes both effects in terms of habitat loss and fragmentation.

### **Ecosystem services of sea trout populations and the values of recreational fishing in Norway**

Yajie Liu, Department of Economics, Norwegian University of Science and Technology  
yajie.liu@ntnu.no

Jennifer L. Bailey, Department of Sociology and Political Science, Norwegian University of Science and Technology  
jennifer.bailey@svt.ntnu.no

Jan Grimsrud Davidsen, Department of Natural History, NTNU University Museum  
jan.davidsen@ntnu.no

### *Track C – Biodiversity and ecosystem services*

This paper is to explore the ecosystem services provided by sea trout populations and to assess recreational values of sea trout fishing and the trade-offs of these values associated with changes in characteristics of trout stocks, fishing sites and management issues. Sea trout (*Salmo trutta* L) is an anadromous salmonid species and sensitive to negative environmental conditions in both freshwater and marine habitats in the coastal areas. Land-use alterations and other human activities are hypothesised to cause changes in individual migration strategies of sea trout and hence influence the movements between estuarine and fjord habitats. The sea trout is an important species in both freshwater and marine ecosystems by providing ecosystem goods and services. The most important ecosystem services are provisioning, social-cultural ecosystem services, that produce valuable food products harvested for personal use and that serve as the basis of recreational fisheries and cultural values. Fishing sea trout in the near shore coastal areas and in rivers is a very popular and accessible recreational activity supporting in turn both a locally significant tourism industry and local well-being. The sea trout has also been an integral part of the local cultural heritage, its folkways and lore, especially through the transfer to and development of local ecological knowledge and fishing experience among the young. However, these ecosystem services ultimately depend on the status and dynamics of sea trout populations. Recreational fishing for this species has in recent years been more restricted in some parts of Norway due to management actions in response to the declining stocks. We will conduct a discrete choice experiment among Norwegian anglers through workshops and questionnaire surveys. Based on the information and data collected, we will investigate anglers' preferences for different attributes related to sea trout stock, fishing and management, and then further assess recreational values derived from sea trout fishing and their trade-offs among

these attributes. By strengthening social-ecological connections to sea trout, stakeholders and policy makers become more aware of interdependency between fish populations, ecosystem services and human societies, and develop appropriate management actions and policies to adopt such migratory strategies.

### **Understanding Socio-ecological systems: Coupling population and satellite remotely sensed environmental data to increase human-natural systems understanding**

Gary, R. Watmough , Postdoctoral Research Fellow Section for Ecoinformatics and Biodiversity, Aarhus University  
g.r.watmough@gmail.com

Mark Musumba, Postdoctoral Research Fellow, University of Florida  
musumba2020@gmail.com

Clare Sullivan, Earth Institute, Columbia University  
clares@gmail.com

Cheryl, A. Palm, Research Professor, University of Florida  
cpalm@ufl.edu

Jens-Christian Svenning, Professor, Section for Ecoinformatics and Biodiversity, Aarhus University  
svenning@bios.au.dk

#### *Track C – Biodiversity and Ecosystem Services*

Introduction: The links between population and environment in developing countries means that biodiversity conservation and human development cannot be achieved in isolation. Therefore, socio-ecological interactions, which vary spatially and temporally, need to be further understood. This requires increased amounts of data, which cannot feasibly be collected using household surveys alone as costs of running large scale panel surveys are prohibitively expensive. Remotely sensed satellite data offers opportunities to increase data availability but requires that we link environmental data with spatially discrete socioeconomic data in a way that accurately depicts human-environment interactions. Proxy measurements of environmental

characteristics identified from remotely sensed satellite data have recently been found to have relatively high accuracies when predicting human poverty. The ways in which metrics are derived from satellite imagery and linked with socioeconomic data are crucial for accurate estimation of poverty. Yet, to date, approaches linking satellite metrics with socioeconomic data are poorly characterized. Here, we present an approach that explicitly considers how people use the landscape in a rural setting of a developing country. We use this approach to examine the links between local environmental conditions and poverty for a case study in Kenya.

Methods: We present a multi-scale approach to estimate capital endowments from satellite data which considers how rural communities achieve their livelihoods using various environmental and non-environmental resources. Four levels of human-environment interactions are identified; homestead, agricultural fields, common pool resource access and regional market access. At each level proxies for capital endowments are extracted from remotely sensed satellite data. We use the approach to investigate the population-environment relationships in the Sauri, Millennium Village site in Kenya. Classification tree models are used to identify the nonlinear relationships between livelihoods and landscape characteristics.

Results: The multi-scale approach to linking socioeconomic and remotely sensed data minimizes redundant environmental data, reduces multiple counting of pixels and mimics human-environment interactions using a GIS. Results indicate that the relationships between household poverty and livelihoods are complex. We find that high resolution satellite data explains about 50%-60% of the variation of household. Measures of the proportion of building coverage within a homestead (social capital); greenness intensity of agricultural areas (physical capital) and amount of bare ground within agricultural areas (physical/natural capital) were correlated with poverty.

Discussion and Conclusion: Remotely sensed satellite data can be a useful tool to monitor socio-ecological systems at a fine spatial and temporal resolution. A multi-scale approach to linking households with remote sensing data could enhance the modelling of human-environment interactions. The increase in data that this would bring will help to enhance our understanding of socio-ecological systems and human-environment interactions and in

future can help to improve the monitoring of the sustainable development goals for human livelihoods and biodiversity conservation

### **Evaluating Agroecosystem Sustainability of Interdunal Wetlands of Littoral West Bengal, India**

Asit Kumar Roy, Department of Geography, Jadavpur University  
asit.roy790@gmail.com

Debajit Datta, Department of Geography, Jadavpur University  
debajit.geo@gmail.com

#### *Track C – Biodiversity and ecosystem services*

The coastal wetlands of India are enriched with the potential of diverse agroecosystem services and produces. In particular, the interdunal wetlands of littoral West Bengal serve various agroecosystem functions such as paddy cum fish culture, brackish water aquaculture, carbon sequestration, biodiversity conservation, coastal flood control, ground water recharge and many more. These wetlands are intensively harvested by local small and marginal farmers as well as traditional fishermen primarily on a subsistence basis. At present, many of these wetlands are plagued with the problems of land use conversion; hyper salinization as well as reluctance of young generation of farmers to pursue subsistence agriculture and other traditional livelihood activities. However, no comprehensive estimation of the various agroecosystem services of these interdunal wetlands have been performed till date although it was found to be highly imperative and pre-requisite of sustainable wetland management.

In this research paper, few interdunal wetlands were selected from the Digha-Talsari coastal stretch of Purba Medinipur district of West Bengal to evaluate the sustainability status of these wetland agroecosystems by estimating their total economic values. Since there is no provision of ecological taxes or indirect payments in India regarding wetland restoration, only people directly dependent on the wetlands for their livelihoods had been considered as the stakeholders in this study. Altogether, 50 households situated in and around the wetlands were engaged for the purpose of a contingent valuation survey to assess the cumulative values of their agroecosystem

services. Respondents were asked dichotomous choice questions involving their present situation and a hypothetical scenario in order to estimate their willingness to pay to restore and preserve the wetlands using agroecosystem practices. Moreover, the direct market pricing method was also applied to infer the values of marketable goods and products. Subsequently, logistic regression models were used to analyze the collected dataset.

Among the surveyed questionnaires, total 48 were found to be valid and 28 willingness to pay options were shortlisted. It was found that the respondents were generally ready to pay for wetland restoration and utilize those wetlands for sustainable agroecosystem practices. Their willingness to pay was dependent on various socio-economic factors like income, level of education, household population and off-farm members of rural households.

Overall, the study emphasized the necessity of suitable management regimes towards utilization of wetland resources that can retain the ecological functions of the wetland intact as well as provide a sustainable livelihood to the rural masses. Few such necessary management guidelines had been forwarded to attain this in the imminent years.

### **Stakeholder based collaborative planning towards sustainable wetland management in Ichamati floodplains of West Bengal, India**

Debajit Datta, Department of Geography, Jadavpur University  
debajit.geo@gmail.com

#### *Track C – Biodiversity and ecosystem services*

The floodplain wetlands of River Ichamati are vital natural resources of southern parts of the Indian state of West Bengal providing a wide gamut of environmental functions and socio-economic services to the local communities for centuries. However, these wetlands are plagued with notable environmental degradations in the form of excessive harvesting, biodiversity losses, conflicts on land uses and ownerships, seasonal water scarcity, siltation, coastal flooding and saline water intrusion, road construction and other developmental activities etc. These are chiefly due to the absence of any holistic management initiative and inadequate understanding of the alternative utilization options by the local and regional administrations as



well as primary stakeholder populations dependent on the wetlands. In such a scenario, implementation of any sustainable management regime would remain unattainable if livelihood rights and indigenous knowledge of local communities are not adequately acknowledged while framing the wetland utilization and conservation guidelines.

In the present paper, the authors sought to examine the current status of different utilization and conservation initiatives of one such floodplain wetland of River Ichamati through participatory appraisals using multi-criteria decision analysis. For this purpose, a framework of criteria and indicators for assessing the status of sustainability of the selected wetland was developed and structured in a hierarchical manner based on simplified multi-criteria methods. This framework had been applied to recognize the optimal utilization pattern for this wetland from stakeholders' perspectives through mathematical scoring. The aim was to not only ensure higher levels of community engagement in decision making and management but also effectively lead to the formulation of improved utilization and conservation strategies through conflict resolution and priority identification.

The results obtained from the criteria and indicators based assessment revealed the dominance of agricultural activities as the prime livelihood options followed by fishing and livestock rearing in and around the wetland. Moreover, unsustainable status of the wetland regarding conservation of aquatic biodiversity and water resources was also observed. In the post-monsoon period, the wetland was found to be suffering from eutrophication related issues caused by excessive usage of chemical fertilizers and pesticides in the adjoining agricultural fields. Accordingly, both diversity and quantity of fishes were reported to be experiencing a declining trend here. In particular, the indigenous varieties of small freshwater fishes were obliterating from the wetland rapidly since the other introduced and hybrid varieties of fishes were used to be regularly released by the local fishermen every year owing to their easy availability in the market.

In these circumstances, few alternative utilization strategies encompassing both traditional as well as innovative livelihood options to restore and manage the wetland sustainably were developed through collaborative planning engaging the stakeholder members of the local community. In general, enhancement of the participation status of ordinary community members

belonging to different stakeholder groups in decision-making and resource sharing had been identified as a prime determinant of ecological as well as socio-economic sustainability of these floodplain wetlands.

**WEDNESDAY, 18 OCTOBER | SESSION 1 | 15:00–17:00**



**Track D Business models for sustainability**

**Abstract session 1 – *Transitioning business models***

**Room: SPACE3**

**Moderator: Helge Brattebø, Professor, Industrial Ecology Program, NTNU**

15:00-15:05	Session Introduction
15:05-15:25	Fritz Balkau and Annik Magerholm Fet Challenges in the transition to sustainable business models
15:25-15:45	Anne Toppinen, Miska Sauru, Minna Autio and Sami Berghäll Business models of Nordic wooden multistory construction on the road to bioeconomy
15:45-16:05	Arnoud van Waes, Rob Raven, Jacco Farla and Jeroen de Jong Business models for socio-technical transitions: the case of smart cycling innovations
16:05-16:25	Thomas B. Long Business models for sustainability and their role in helping to manage supply chain greenhouse gas emissions
16:25-16:45	Lucia Mortensen How Ports' governance of strategic networks can generate sustainable business models based on industrial symbiosis
16:45-17:00	Joint questions and discussion

## Challenges in the transition to sustainable business models

Fritz Balkau, Sustainable Solutions  
fbalkau@gmail.com

Annik Magerholm Fet, NTNU  
Annik.fet@ntnu.no

### *Track D – Business models for sustainability*

Sustainable business models have evolved in a relatively short time to an astonishing degree of complexity. Some models retain a simple focus, others merge multiple disparate factors such as resource efficiency, regulatory compliance and community outreach to address the challenges of the new agenda. Some seek new business opportunities in the growing sustainability dynamic.

The first sustainable business models focussed on ‘pollution-waste-materials flow’ issues. Many still do. But for some there were also challenges in dealing with social issues in remote communities, NIMBY in built-up areas, equity in resource development, etc. More advanced business models incorporated various forms of CSR into a ‘triple bottom line’ structure. Stakeholder participation became a key to moving forward, as with the mining sector slowly evolving its earlier focus on resource efficiency towards a ‘stewardship’ model that incorporates joint decision-making. Vertically integrated companies talk about ‘common shared value’ models to foster relationships along their value chains.

The early models aimed to remove roadblocks to business activity. More recent models attempt to capture business value from the agenda itself. Companies can re-centre themselves around more sustainable products and services, and lead the change to a different future. A big shift is in the service sector, with major electricity suppliers moving to decentralised and distributed energy rather than being primary suppliers. While similar challenges face all companies looking for more coherent business models, three aspects stand out.

First, the sustainability agenda is changing, both quantitatively (stricter norms), and qualitatively (new parameters). The sustainability agenda

includes multiple criteria, not just a single issue like energy. Climate change, biodiversity, unhealthy foods, are issues where change is faster than many investment cycles. Conflict between sustainability criteria remains an unresolved problem. The US EPA highlighted ‘cross-media pollution’ already in 1980; the life cycle constituency now speaks of avoiding ‘burden-shifting’. In an increasingly connected world, these factors have serious repercussions if a business model falls too far behind.

We know more about the origin of our products than ever before. A business model that does not reference all the parts of the supply-chain may not last long. Singapore recently penalised Tesla’s “clean” electric vehicle when the impact from electricity generation was factored in. Generally, there is increasing concern now about the ‘life behind the product’.

The biggest handicap of most sustainability models is their lack of deep integration in business and financial planning. Where sustainability is still a corporate ‘add-on’, the model often slides into green-washing. In this way, VW’s dubious corporate management decisions on vehicle testing completely ignored the risk to the company’s sustainability image.

Finally, we note that business models, like everything else, are subject to fashion. Who now remembers The Natural Step? Do companies still talk about eco-efficiency? What happened to the excitement over industrial ecology, or has this simply morphed into the more trendy term of circular economy? We would do well to reflect on the natural life cycle of our sustainable business model before it is replaced by something new.

## **Business models of Nordic wooden multistory construction on the road to bioeconomy**

Sami Berghäll, Assoc. Professor, University of Helsinki, Department of Forest Sciences sami.berghall@helsinki.fi

Miska Sauru, B.Sc., , University of Helsinki, Department of Forest Sciences miska.sauru@helsinki.fi

Minna Autio, Assoc. professor, University of Helsinki, Department of Forest Sciences minna.autio@helsinki.fi

Anne Toppinen, Professor, University of Helsinki, Department of Forest Sciences  
anne.toppinen@helsinki.fi

### *Track D – Business models for sustainability*

#### Introduction

Sustainability is a key topic in reaching the acceptability of bioeconomy and new sustainability driven innovations are called for in order to renew traditional sectors of economy into bioeconomy. The rise of wooden multistory construction (WMC) is currently the most evident new business opportunity in the emerging bioeconomy in the Nordic countries that has not faced sustainability related critical voices. Previous literature on business models in construction sector is quite extensive (see Mokhlesian and Holmen 2012). However, regarding the specific viewpoint of renewable wood based construction, there is a very scarce literature combining business model perspective to the wood building sector. There is also lack of business model related innovations (or business model research) in bioeconomy, emphasizing the need to better understand both how value is created and the roles various parties within and outside the firm play in it. In this paper, we combine the business model literature to the Service-Dominant-Logic as a platform to analyze the changing WMC business and the involved value networks towards 2030.

#### Methods

The study uses third round results from a Delphi process conducted in 2016-17 among 23 construction value chain professionals in Finland, and also by drawing from the expertise in the European pioneering WMC country of Sweden.

#### Results

The panelists emphasized the need to increase quality and availability of new business solution to WMC. Respondents voiced hope for getting new players to the market and to add more competition among large-scale construction

businesses and improve quality of construction. What is alarming is that our professional expert panel did not recognize consumers as a part of the WMC business network: they only see companies, NGOs (e.g. Wood Industry Association), and other interest groups (e.g. civil servants) key players in the process of developing wood construction businesses in the future. Yet, they are aware of consumer needs concerning wooden housing, such as builders of one-family houses (using wood as construction material) as well as increasing pro-environmental attitudes among consumers. While the SDL perspective was not gauged per se, some of the results support the arguments from the theoretical perspective. In order to solve customer problems and offering those valuable services, such as good quality indoor air expectations, business should strengthen positive image of wood construction industry. Transforming business models towards sustainability, respondents were emphasizing also price (cost effective), size of a flat, lightness of the wood and swiftness of wooden construction.

#### Discussion and conclusions

Today's construction industry, distinctively having a project-based firms working together in networks, could benefit of service-led relationship (SLR) business model in solving the problems of flawed construction both in company level and customer level. Our results demonstrate to some extent scope for changing business models towards wood material based multistory solutions towards 2030. Enhancing stronger sustainability driven culture for this traditional field of business, and creating business models that could capture sustainability based value, remains still as a challenge.

### **Upscaling potential of bike service business models in the Netherlands**

Arnoud van Waes , Utrecht University - Copernicus Institute of Sustainable Development a.h.m.vanwaes@uu.nl

Rob Raven, Utrecht University - Copernicus Institute of Sustainable Development

Jacco Farla, Utrecht University - Copernicus Institute of Sustainable Development

Jeroen de Jong, Utrecht University - School of Economics

### *Track D – Business models for sustainability*

#### Introduction

In this paper, we explore the relationship between business models and socio-technical transitions by evaluating bike services in the Netherlands. More specifically, we are interested in how business models can explain upscaling potential of bike services in the urban mobility system.

Cycling and cycling innovations such as bike services have been largely overlooked in transition studies, despite that an emerging coalition of city and regional authorities, entrepreneurs and academics increasingly consider cycling as a crucial part of responding to a range of societal challenges. Also the role of business models in change processes and transitions has received little attention (Boons & Lüdeke-Freund, 2013). Business models comprise the ways organizations create, deliver and capture value. They could overcome key barriers to market diffusion of sustainable technology (Wustenhagen & Boehnke, 2008) (Bolton & Hannon, 2016).

#### Methods

The main research question is as follows: What types of bike services and related business models contribute to an urban mobility transition in the Netherlands and what is their scaling potential in the urban mobility system?

A bike service business model typology is developed by qualitatively analyzing 8 bike service innovations and related business models, focusing on key elements: customer value proposition (target customer, job to be done & offering), profit formulae (revenue model & cost structure), key processes (processes, rules & norms) and key resources (people, technology, information, channels, partnerships & brand) (Johnson, Christensen, & Kagermann, 2008).

Their upscaling potential is assessed through the Prospective Transitions Framework by Frenken (2013). This qualitative framework is based on Nelson's model explaining that the fate of a technology depends on the co-evolution of technology, industry structure and supporting institutions.

#### Preliminary results and discussion

Our preliminary results demonstrate a typology of 5 different bike service business models:

- 2-way station-based (bikes have to be returned to the original fixed location)
- 1-way station-based (bikes can be returned to a different fixed location)
- 1-way free-floating (unlock and drop a bike anywhere using a smartphone)
- Bike as a service (long term subscription on the use of a bike)
- Peer-to-peer (share your bike with another user)

We find that the free-floating, bike as a service and peer-to-peer models have most scaling potential because they are less dependent on physical infrastructure. The rapid diffusion of these models seems due to technological developments (i.e. GPS, smart-locks, digital platforms), the lack of clear institutions and the involvement of new foreign venture-capital backed actors. Although these actors have the right ingredients to rapidly scale up their business model and compete with local bike sharing systems, they encounter institutional barriers as local governments intent to regulate free-floating bikes services. One explanation is they are not (yet) embedded in the local institutional environment, in contrast to their competitors. So the success of a business model depends on its fit or misfit with its institutional context. Therefore, the success of these bikes services requires broader institutional change.

### **Business models for sustainability and their role in helping to manage supply chain greenhouse gas emissions**

Thomas B. Long, Management Studies Group, Wageningen University  
Thomas.long@wur.nl

### *Track D – Business models for sustainability*

Supply chains represent risks and opportunities for the management of sustainability objectives. The supply chains of large supply chain leading organisations can contain a high proportion of the total greenhouse gas (GHG) emissions associated with products and services. This means that supply chains are often a key area for the management of climate change mitigation

objectives, and represent both regulatory and reputational risks to supply chain leading organisations.

At the same time, business models are receiving greater attention in terms of sustainability performance. It is increasingly recognised that to maximise business sustainability performance, business models must be redesigned to fully integrate sustainability. What this means in terms of the management of supply chain GHG emissions by large supply chain leading firms is unclear. This research explores (1) how the management of supply chain GHG emissions interacts with business model design, (2) the extent to which business model changes can facilitate more effective supply chain GHG emission management, and (3) what this means conceptually for the sustainable supply chain management and business models for sustainability disciplines.

Data from 31 interviews from actors concerned with supply chain GHG emission management are used to establish the character of sustainability initiatives from a range of public and private sector examples. This data is then analysed through a business models for sustainability framework. The results show that some supply chain GHG emissions management activities are of a 'bolt-on' nature with little to no business model for sustainability characteristics or implications. However, other approaches are found to involve the use of business model for sustainability principles and approaches.

This paper contributes both conceptually and in terms of practice. The conceptual contribution is achieved by bridging the themes of sustainable supply chain management and business models for sustainability. These domains of research share common goals and could provide interesting synergies and complementarities. For example, both focus on improving the triple bottom line of business performance but focus on different levels. Sustainable supply chain management is often more operationally and tactically focused, while business model research is of a more strategic nature. The results also highlight how business model for sustainability approaches can be employed to enhance the achievement of corporate sustainability/climate mitigation objectives. The results provide practical guidance to managers on how to adjust their business models for to better manage and reduce supply chain GHG emissions.

## **How Ports' governance of strategic networks can generate sustainable business models based on industrial symbiosis**

### **The case of Port of Aalborg**

Lucia Mortensen, Industrial PhD fellow  
lum@aalborghavn.dka; lucia@plan.aau.dkb

a Port of Aalborg, Resource and Business Development Department & Department of Infrastructure and Environmental Development  
b Aalborg University, Department of Planning and Development

#### *Track D – Business Models for sustainability*

Businesses' transition towards sustainable and green economy is well on its way [see e.g. Ellen Macarthur Foundation, 2017]. New and diverse inter-firm business models such as industrial symbiosis (IS) are sprouting all over the world at local and regional levels e.g. in developed countries (Aid et al., 2015; Corder et al., 2014; Costa et al., 2010; Daddi et al., 2016; Gibbs & Deutz, 2005; Korhonen, 2004; Papathanasoglou et al., 2017), in newly industrialized ones e.g. Korea (Behera et al., 2012; Oh et al., 2005; Deutz & Lyons, 2015), in emerging economies such as China (Qu et al., 2015; Yu et al., 2014; Liu et al., 2016), India (Ashton & Bain 2012), South Africa (Deutz & Lyons, 2015), in developing countries e.g. Bangladesh (Deutz & Lyons, 2015), Thailand (Panyathanakun et al., 2013), Malaysia (Sharib & Halog 2017), Liberia (Deutz & Lyons, 2015), etc.

IS is the type of business model where two or more organizations live in mutualism, i.e. supporting and benefitting from each other's activity. A classic example from Aalborg region in Denmark is the cement company Aalborg Portland delivering chalk slurry to the Nordjylland power plant, which is used to the flue gas cleaning and returned as gypsum (NBEN, 2016). IS is applied to reduce material and energy loss, improve ecological footprints of industrial processes, foster eco-innovation and generate eco-efficiency gains within industrial systems. Through IS, businesses can increase their economic performance, improve business competitiveness and diminish their corporate risk. (Verguts et al., 2016; Boons et al, 2016; Lombardi & Laybourn, 2012; Chertow & Ehrenfeld, 2012; Domenech & Davis, 2011).

Business models based on IS have been initiated by business representatives, planned by public administration, encouraged and supported by an anchor organization or by hybrid middle-out approaches, involving both businesses and authorities in development processes (Costa and Ferrão, 2010; Chertow, 2007; hewes & Lyons, 2008).

The study has empirical basis within the case of Port of Aalborg's environmental and strategic initiative Miljø++, initiated in 2016 and Aalborg region's existing IS. It explores how new sustainable business models based on IS can be created by activating the ports' governance capacity of engaging cross-sector actors within strategic networks. Methodologically, the study uses literature review, case study, interviews, observations, and social network analysis to examine the role of networks' social embeddedness for establishment of IS.

Ports have the capacity and possibility of playing a considerable role in IS development, as an anchor, mediator and engine for such processes (Cerceanu et al., 2014; Mat et al., 2016). Ports have the access to a considerable number of (often heavily polluting) companies situated at their perimeter, having good relations to these, formalized, among others, by rental contracts and services offered. Ports have many times strong relations with municipal, regional and national authorities. Ports play an important role in the regional development, having a good reputation among other economic actors, such as e.g. consultants and lawyers (Merk, n.d.). All this, makes possible for ports to gather and engage relevant actors across sectors in strategic networks for creation of industrial symbiosis (Baas, 2011).

The Ports' role in governing strategic networking for sustainable transition of businesses in Aalborg region is found to be considerable. A model for how new sustainable business models based on IS can be created by activating the ports' governance capacity of engaging cross-sector actors within strategic networks is proposed. The study discusses as well transferability of such a model to other contexts and suggests further topics for research.

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THURSDAY, 19 OCTOBER | SESSION 2 | 09:45-11:45

# PARALLEL SESSION 2 SCHEDULE



## Track A Institutions, governance & ethics

### Abstract session 2A – *CSR, RRI, Education*

Room: SPACE 3

Moderator: May Thorseth, Professor, Dept. of Philosophy and Religious Studies, NTNU

09:45-09:50	Session introduction
09:50-10:05	<b>Kaisu Sammalisto, Rodrigo Lozano and Robin Vonhaartman</b> Working with sustainability: institutionalisation perceptions at the University of Gävle
10:05-10:20	<b>Bente Johnsen Rygg and Gunnar Yttri</b> Social acceptance of renewable energy – does ownership matter?
10:20-10:35	<b>Siri Carson</b> RRI and CSR – a conceptual analysis based on the example of Atlantic salmon farming
10:35-10:50	<b>Sam A. Kasimba</b> Linking Sustainable Development and Corporate Social Responsibility Initiatives: Experiences from Large-Scale Gold Mining and Local Communities in Obuasi, Ghana
10:50-11:05	<b>Thomas B. Long</b> Sustainable entrepreneurship and responsible innovation: The role of investors in managing socio-ethical issues
11:05-11:20	<b>Sophia Efstathiou, Marius Korsnes and Laura Sommer</b> Sustainability Communication: Some tools from improvisation practices
11:20-11:35	<b>Sebastian Kreuz and Eugenia Ploss</b> Why, and how will it look like? Evaluating answers of energy experts concerning the German Energiewende and its implication for communication
11:35-11:45	Joint questions and discussion

## **Working with sustainability: institutionalisation perceptions at the University of Gävle**

Kaisu Sammalisto  
kaisu.sammalisto@hig.se

Rodrigo Lozano  
rodrigo.lozano@hig.se

Robin von Haartman  
robin.vonhaartman@hig.se

### *Track A – Institutions, governance and ethics*

Higher education institutions have been working to better incorporate and institutionalise sustainability into their system and with their stakeholders. An increasing number of which can serve as a proxy of how sustainability is institutionalised at the university; however, there has been little research on this. This paper is aimed at addressing this by using the case study of the University of Gävle, Sweden, which has been working with sustainability issues for the last 25 years.

A survey was sent to 687 faculty and staff, of which 340 replied (a response rate 49.5%). The survey was a follow up from a previous one in 2010. The survey focussed on how faculty and staff (with main tasks in education, research, PhD studies, and technical/administrative or managerial duties) work with sustainability in their functions.

The responses highlighted an increased understanding and acceptance of the sustainability work of the university and give an input from personnel for continued operational sustainability activities at the university. The results of the latter survey show that the social dimension is more prominent when compared to the survey in 2010, where the environmental focus was dominating. This indicates that the perception of sustainability is more balanced throughout the university. The findings also show that faculty and staff: understand the principles of sustainability; discuss spontaneously sustainability and its implications to their work; and have, to a great extent, integrated it into their daily activities, such as management,

education, and research. Sustainability at the University of Gävle has gone beyond the stage of incorporation and is moving towards a better and deeper institutionalisation. It is important to engage with the university stakeholders, where faculty and staff play a key role in this process, to better institutionalise sustainability at universities.

The research was limited by the type and number of respondents from the university. These are also affected by the respondents' perceptions.

## **Social acceptance of renewable energy – does ownership matter?**

Bente Johnsen Rygg, Western Norway University of Applied Sciences (HVL)  
bente.johnsen.rygg@hvl.no

Gunnar Yttri, Western Norway University of Applied Sciences (HVL)  
gunnar.yttri@hvl.no

### *Track A – Institutions, governance and ethics*

Development of small hydropower projects in Norway is increasing, urged by the agreement on green certificates between Norway and Sweden. Many projects are developed and several will be in the years to come in order to reach the deadline of 31.12.2021 when the projects have to be operative in order to receive green certificates.

This paper is part of a research project concerning the local impacts and sustainability of renewable energy projects called RELEASE. More specifically, it is concerned with sustainable development along three dimensions: an economic dimension, an environmental dimension and last, a social dimension. This paper is part of a work package focusing on the social dimensions of renewable energy projects.

In this paper, we study how ownership of small hydropower projects affect the social acceptance of these projects. We study three main forms of ownership models:

- 1) Projects developed by traditional utilities owned by the municipality
- 2) Projects developed by professional small-scale private developers

### 3) Projects developed by landowners

The method we use is interviews with project developers in these three main categories, political and administrative leaders and case handlers in the municipalities, landowners and inhabitants living in the area where the small hydropower project is located. In addition, analysis of documents of municipal plans, case handling of the projects and newspaper articles are carried out.

Among our preliminary findings are that the municipalities favor as much local activity, employment and value as possible. In the case handling process, ownership of the projects is emphasized, and ownership by local landowners seems to be given value by municipal politicians. We also found that environmental and tourist organizations are more careful in their expressions of criticism towards projects developed by local landowners than projects developed by traditional energy companies.

Recently, foreign capital has found interest in Norwegian small hydropower projects in cooperation with local landowners. There is also projects that have been taken over entirely by foreign owners. This opens for a new and interesting perspective on development of small hydropower projects in Norway, as long as ownership now is fluctuating. The original idea of small hydropower to contribute to an increase in local value creation in Norwegian rural areas is challenged by an international context where several European countries works to increase their production of renewable energy.

#### **RRI and CSR – a conceptual analysis based on the example of Atlantic salmon farming**

Siri Granum Carson, NTNU  
Siri.granum.carson@ntnu.no

*Track A – Institutions, governance and ethics*

Responsible (Research and) Innovation (RI/RRI) is a relatively recent and still evolving “megatrend” pertaining to governance of research and

innovation, prominently used in relation to emerging technologies. This trend echoes the way the concept CSR (corporate social responsibility) has evolved over the last couple of decades, involving key terms such as participation, anticipation and globalization. In this paper, I present a conceptual analysis of the concepts CSR and RRI based on an example from the Norwegian context, namely the development and growth of the Atlantic salmon farming industry in Norway. This is an economically successful and technologically advanced industry, and the industry as well as policy makers at the national level are planning for an exponential growth in the years to come. However, the industry faces considerable challenges in terms of social legitimacy, and meet resistance from environmental organizations, local communities, fisheries, wild salmon fishers, and other interest groups. Tackling these challenges is a matter of balancing considerations of a number of interests at different levels: Eco systems, economic and social systems, at a local, national and global level, and cannot necessarily be solved through traditional, hierarchical forms of governance. It is an area where “soft law” and self-regulation are widely used as governing instruments. The example is used to highlight the interconnection between CSR and RRI in two ways: 1) Both are characterized by the phenomenon of “new governance”, understood as non-hierarchical, network-based forms of governing where a number of different stakeholders are involved, and 2) Both are best understood as practices aiming to secure the social legitimacy of business and R&I institutions respectively.

#### **Linking Sustainable Development and Corporate Social Responsibility Initiatives: Experiences from Large-Scale Gold Mining and Local Communities in Obuasi, Ghana**

Sam A. Kasimba, PhD Candidate, Department of Geography, NTNU  
sam.kasimba@ntnu.no

*Track A – Institutions, governance and ethics*

Prominent to today’s global challenges is the need to incorporate environmental adherence, economic activities and social responsibility,

often regarded as sustainable development (SD). For the mining sector, this means a maximization of profit and a minimization of negative environmental and social impacts, a strategy that requires an integration from the inception, to the closure of mines. This has seen a rise of corporate social responsibility (CSR) strategies initiated by mining companies to reconcile the link between business, environment and society. For instance, the AngloGold Ashanti Limited (AGA) in Ghana established the Obuasi Community Trust Fund (OCTF), following a sustainability agreement between the company and the government of Ghana in 2004. The agreement maintains that AGA annually contributes US\$ 1 per ounce of gold produced and another 1% of the net profits to OCTF to support local community development, such as roads, schools, hospitals and vocational training. However, these initiatives have not led to evidently advanced SD outcomes, and the link between SD and CSR remains unclear, and debatable. More so, there are no empirical evidence suggesting that such trust funds are indeed crucial in advancing SD. Within this context, taking a case study approach, the present article examines the extent to which the OCTF has the potential to achieve SD, and mitigate uneven development in the local communities, and the challenges faced in this endeavor.

In this article, I argue that even though there are visible projects initiated in different parts of Obuasi, these have not had substantial impacts on SD due to various challenges. First, Ghana's mining industry has gone through various reforms, and has seen the country adopting global policies such as the structural adjustment programmes (SAP). As advocated by the World Bank and IMF in the 1980s, SAP reforms have led to a proliferation of foreign mining corporations capturing licenses that allow them to take control of large concessions, leaving local communities with less land for farming. Secondly, the elusive nature of SD and CSR do not take into consideration the political, social, economic, environmental, and cultural context of Ghana. This is because the concepts, and the initiatives they ensue, tailored in developed countries, rely on an assumption that they are universally applicable. The third challenge arises from the transition of mining techniques, from early artisanal small-scale mining (ASM) to modern and high tech large-scale mining. This has had negative environmental outcomes, affected the social well-being of various individuals, and increased socio-economic challenges. For instance, large-

scale mining has led to land degradation, water pollution, displacement of people, and disrupted livelihood strategies. More so, the modernization of mining has elevated labour surplus, complicated ASM, increased incentives of engaging in illegal mining, and a persistent tension between local communities and AGA. This article recommends that enhancing SD should take into account the global and local political nature of mining, promote an inclusive decision-making in the distribution and sharing of benefits, and consider the local power dynamics that influence the integration of environmental, economic growth and social well-being.

### **Sustainable entrepreneurship and responsible innovation: The role of investors in managing socio-ethical issues**

Thomas B. Long, Management Studies Group, School of Social Sciences, Wageningen University  
Thomas.long@wur.nl

Vincent Blok, Management Studies Group, School of Social Sciences, Wageningen University

#### *Track A – Institutions, governance and ethics*

Sustainable entrepreneurs develop innovations that tackle grand challenges. Responsible innovation focuses on making innovation processes more ethically acceptable, sustainable, and societally desirable, and could provide sustainable entrepreneurs with a method for managing socio-ethical challenges. Responsible innovation potentially provides benefits to sustainable entrepreneurship, such as a systematic way for identifying and managing ethical and societal issues in the innovation process and reducing risk. However, its application to contexts that sustainable entrepreneurship occurs in may be problematic. For example, there may be difficulties in managing the goals, expectations and values of different stakeholders, questions over asymmetric information, as well as tensions between commercial interests and those of responsibility. Sustainable entrepreneurs are also likely to be constrained due to limited resources, and the need to generate profits and compete with traditional (non-ethical) businesses.

The management of tensions between economic and responsibility (sustainability) objectives does not just fall on the shoulders of sustainable entrepreneurs themselves. In many cases, sustainable entrepreneurs are likely to be the recipients of investment. Such investment could come from traditional sources, angel investors or institutional investors (such as incubators). How investors support or hinder the application and practice of responsible innovation in these contexts is unclear. From an investor perspective, responsibility could be seen as an unwanted side-effect and one that negatively impacts their return on investment (ROI). Investors will play a critical role in the transition to sustainability, so examining cases where they play a positive role in the generation of environmental and social value could provide valuable insights.

In this research, we seek to examine cases of both supportive and non-supportive investors. This will allow an understanding of the conditions and critical success factors needed for a supportive investment environment for responsible innovation within commercial contexts. The research takes place in the context of European clean tech start-ups within the agricultural, water and energy sectors. Data is collected via semi-structured interviews across 8 cases. Each case includes a sustainable entrepreneur with their corresponding investors – in this way, we can shed light on both sides of the relationship and understand key dynamics.

The results will contribute to the literature on sustainable entrepreneurship, responsible innovation, and responsible investment by highlighting the role that investment and investors play in enhancing the responsibility outcomes of sustainable innovations.

### **Sustainability communications: Some tools from improvisation practices**

Sophia Efstathiou, NTNU

Marius Korsnes

Laura Sommer

Bogdan Glogovac

Martin Loeng

Kristoffer Nergård

### *Track A – Institutions, governance and ethics*

“Climate change has collected so many meanings and associations, from endemic poverty to hyperconsumption, that it has created a political log jam of gigantic proportions.”  
Hulme (2009)

There are several challenges with action to ensure the achievement of grand challenges such as climate change and sustainability. Using sustainability as an organising framework involves addressing ethical questions about how Earth’s resources should be shared as well as understanding that sustainability is also about issues such as ‘cultural identities, social and environment equity, respect, society-nature relationships and tension between intrinsic and instrumental values’ (Wals and Jickling 2002, p. 223). What Hulme calls a ‘log jam’ of meanings and associations is indeed a paradox: having a great interest to contribute to taking a grand challenge like climate change paradoxically backfires when many different perspectives jam against each other and prevent any which one from going through to achieving its aims. In order to address such grand challenges, we must direct our attention to how such perspectives can be aligned and how communication and interaction can be achieved across boundaries. Here we flesh out the challenge of interdisciplinary and intercultural communication. We offer some ideas and theoretical perspectives from our respective disciplines of philosophy and ethics of science (SE), science and technology studies (MK), social anthropology (ML, KN), environmental psychology (LS) and environmental communication (BG) and then we work through the challenges through a practical engagement with workshop participants.

We articulate challenges along three dimensions where communication and engagement need to happen, if we are to address grand challenges such as climate change and sustainability. There are 1) an epistemological dimension, 2) a social/cultural dimension, 3) a practical dimension. We need tools for a. crossing over from everyday problems to scientific or theoretical articulations of these problems and back, b. from globally defined goals to national, cultural and individual contexts and back, c. from cognitive, theoretical frames to embodied, lived experiences and back. The practice-based part of the workshop invites participants to join

us in a selection of exercises using improvisation techniques to reflect on these three dimensions of the 'log-jam'. This is informed by a three-year experience with Gibberish, the only English speaking improvisational theatre group in Trondheim initiated by MK. Through these exercises, we argue that improvisation principles of a. acceptance, b. attentive listening, c. embracing failure are crucial for getting sustainability plans to work (cf. Berk and Trieber 2009).

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### **Why, and how will it look? Evaluating answers of energy experts concerning the German Energiewende and its implication for communication**

Sebastian Kreuz, Chair of Energy Economics, Brandenburg University of Technology Cottbus-Senftenberg  
sebastian.kreuz@b-tu.de, sebastian.kreuz@gmail.com

Eugenia Ploß, formerly Eugenia Umerkajew, Chair of Organization, Human Resource Management and General Management, Brandenburg University of Technology Cottbus-Senftenberg  
eugenia.umerkajew@b-tu.de

*Track A – Institutions, governance and ethics*

### **Introduction**

The implementation of the German energy transition (Energiewende) is unclear in its configuration and timeframe. The future of the transition

depends on more than factors such as technological development, economic feasibility and political framing. Rather, a positive attitude and understanding by society are significant influences. Therefore, effectively communicating the complex process of energy transition in an objective way is essential. This necessity is apparent from the strong polarization of debate on the status and future of the energy transition.

### **Methods**

We used qualitative, semi-structured, in-depth expert interviews with energy professionals to gain an overview of how the local and regional energy stakeholders perceive the status quo and future of the energy transition. We discussed two related matters: (1) the goals of the energy transition and (2) desired future lifestyles - both key elements for polarization and communicating the transition process understandably.

To gather an empirical basis for perceptions related to our questions, we interviewed 29 energy professionals in two German metropolitan regions in 2014 (Munich and Frankfurt- Rhein-Main). The experts are associated with different institutions and have diverse backgrounds (urban and rural perspectives, industry and small firm sector, interest groups and NGOs), as well as fields of expertise (e.g. mobility, buildings, electricity).

### **Results**

We firstly showed that despite the alleged clarity of goals, german stakeholders have diverse reasons for the energy transition. Our results show that one key reason is climate protection. Another important goal is the desired independence from energy imports, mentioned in connection with political events (conflict in eastern Europe in 2014). Other motives include abandoning fossil fuels, developing renewable energies, nuclear phase-out and reducing energy consumption. Therefore, we see a heterogeneity of goals which might trigger tradeoffs and conflicts.

Secondly, the communicated and desired lifestyles seem not to be radically different from the status quo. Rather, the existing quality of life should be enriched through nonmaterial improvements: Our stakeholders mentioned a desire for a more locally-focused way of living in urban areas with more open spaces. Interviewees preferred not to have excessive urban

noise or areas with a lot of traffic. Additionally, mobile integration and communication (“smart city”) are focal points for future lifestyles.

### **Discussion and Conclusion**

Following on from those responses, this paper illustrates essential conditions for communicating the energy transition process: Showing and explaining the (in our case heterogeneous) goals for the energy transition is highly relevant, especially if trade-offs occur. Climate change might be the most unifying and largely established reason for the transition.

The public’s future desired lifestyles must be compatible with their perception of the goals of the energy transition. For communication-related stakeholders, such as public institutions and interest groups, these findings help to understand arguments and to create possible objective narratives for the energy transition, and may assist them in comparable transition processes worldwide. Furthermore, the research project e-transform, in which the study was conducted, used these results and established media tools to explain and describe objectively the energy transformation for non-experts by homepages, serious games or graphics.

THURSDAY, 19 OCTOBER | SESSION 2 | 09:45-11:45



**Track A Institutions, governance & ethics**

**Abstract session 2B – Energy transition**

**Room: SPACE 2**

**Moderator: Espen Moe, Professor, Dept. of Sociology and Political Science, NTNU**

09:45-09:50	Session introduction
09:50-10:05	<b>Nick Pruditsch</b> Long-term Energy Governance for Sustainable Development. Energy Research from a Political Science Perspective
10:05-10:20	<b>Anna Martius, Samarth Kumar, Anne Flämig-Wolak, Alexander Sakowski, Rengin Cabadag, Falk Hanisch, Anna-Elisabeth Wollstein-Lehmkuhl, Alice Freiberg, Christoph Zöphel, Frederik Plewnia and Nick Pruditsch</b> Stronger together: An interdisciplinary approach towards defining and measuring sustainability in energy systems
10:20-10:35	<b>Luis Mundaca, Jonas Sonnenschein, Nicholas Dehod and Sandro Benz</b> Transitioning to a local sustainable energy system and rapid decarbonisation: A behavioural economics perspective
10:35-10:50	<b>Stefano Maran</b> Plotting a path to a friendly electricity grid: the INSPIRE-Grid project
10:50-11:05	<b>Tomas Moe Skjølvold</b> Sustainability transitions: expansion zones and transition processes. Insights from the distributed energy transition
11:05-11:20	<b>Simen Rostad Sæther</b> Climate policy choices and technological development – How do they influence OECD power sector emissions?
11:20-11:45	Joint questions and discussion



## **Long-Term Energy Governance for Sustainable Development – Energy Research from a Political Science Perspective**

Nick Pruditsch, Institute of Political Science, Technische Universität Dresden  
Boysen-TU Dresden-Graduiertenkolleg  
nick.pruditsch@tu-dresden.de

### *Track A- Institutions, governance and ethics*

The transformation of the European energy system(s) towards a sustainable and climate-friendly energy supply will take generations to complete. Therefore, the energy transition needs to be understood as a long-term project. Thereby, political actors are at the same time confronted with a strong need for action and high uncertainty. To manage this state of affairs, political governance needs to be balanced between openness, continuity, and sustainability. The goal of this research is to provide more clarity around this issue by (1) identifying the political factors that drive the sustainable development of the energy system, (2) assessing specific governance modes that cause or promote these driving forces, and (3) analyzing the institutionalization processes that allow such governance modes to have long-term effects. To attain these goals and to answer the questions related to them, the energy policies of member states of the European Union are analyzed.

An interaction of systematic review and document analysis is deployed to derive the possible political factors (or conditions) theoretically and from the results of empirical research. Those conditions are related to the outcome of the energy policies aimed at furthering a sustainable development of the energy system. The analytical approach is based on systematic comparative methods - especially Qualitative Comparative Analysis (QCA) - and combines detailed within-case studies and formalized cross-case comparisons. It is used to identify factors that influence the outcome of interest. Within-case studies and the methodological concept of process tracing allow for the assessment of governance modes and the testing of different institutionalization hypotheses. Regarding the theoretical framework, the research is based on theory derived from institutional, transition and governance research.

This abstract represents, at least in part, my doctoral project, which is concerned with the question of how political systems can induce sustainable and long-term governance in the field of energy-policy.<sup>1</sup> At the time the conference takes place, I will be able to provide original scientific information about the conditions causing a sustainable development of the energy systems within different European states. Building on this, the questions relating to the assessment of governance modes and institutionalization processes can be answered. In tangible terms, I will be able to present comprehensive results on sustainable energy policies and outline first findings on the institutions affecting the long-term governance for a sustainable development of the energy systems.

<sup>1</sup> The project is one of twelve research projects at the Boysen-TU Dresden-Research Training Group. The institute is concerned with the technical feasibility and the social impacts of energy transitions.

## **Stronger together: An interdisciplinary approach towards defining and measuring sustainability in energy systems**

Anna Martius, Boysen - TU Dresden - Research Training Group  
anna.martius@tu-dresden.de

Samarth Kumar, Boysen - TU Dresden - Research Training Group  
samarth.kumar@tu-dresden.de

Anne Flämig-Wolak, Boysen - TU Dresden - Research Training Group  
anne.flaemig-wolak@tu-dresden.de

Alexander Sakowski, Boysen - TU Dresden - Research Training Group  
alexander.sakowski@tu-dresden.de

Rengin Cabadag, Boysen - TU Dresden - Research Training Group  
rengin.cabadag@tu-dresden.de

Falk Hanisch, Boysen - TU Dresden - Research Training Group  
falk.hanisch@tu-dresden.de

Anna-Elisabeth Wollstein-Lehmkuhl, Boysen - TU Dresden - Research Training Group  
anna-elisabeth.wollstein@tu-dresden.de

Alice Freiberg, Boysen - TU Dresden - Research Training Group  
alice.freiberg@tu-dresden.de

Christoph Zöphel, Boysen - TU Dresden - Research Training Group  
christoph.zoepfel@tu-dresden.de

Frederik Plewnia, Boysen - TU Dresden - Research Training Group  
frederik.plewnia@tu-dresden.de

Nick Pruditsch, Boysen - TU Dresden - Research Training Group  
nick.pruditsch@tu-dresden.de

#### *Track A - Institutions, governance and ethics*

The multi-dimensionality of sustainable energy systems necessitates an interdisciplinary approach. Within this context, Boysen - TU Dresden - Research Training Group brings together researchers from different fields, namely, engineering, economics, business, communication, public health, and political sciences. The research training group is targeted towards studying 'Paths to ecologically friendly, safe and competitive energy systems – Technical feasibility and societal impacts'.

The first step towards finding interdisciplinary solutions on sustainability requires to establish a discourse that enables understanding between researchers in different fields. Each field has its own 'language' and approach towards problem solving. Without assertion of validity, in the paper we discuss the practices established and the methodology adopted within the group to enable interdisciplinary work. These are then used to answer a specific question "How do different fields' define and measure sustainability in energy systems?"

This question is of vital importance as on one hand, to achieve a goal it needs to be measurable and on the other hand there is an unavoidable interaction between different fields. This is especially true for multi-

dimensional challenge of sustainability in energy systems. For example, an ecologically sustainable energy system might be societally and economically unsustainable. This would render the solution inapplicable within the framework of sustainability. As an illustrative example, these definitions and measures are contextualized in a case study. The contribution of the paper is two-fold. Firstly, it gives suggestions, based on experience, on methodology to enable interdisciplinary discourse. Secondly, it provides better understanding on approaches different fields take to define and measure sustainability in energy systems and what is the interplay between the fields.

#### **Transitioning to a local sustainable energy system and rapid decarbonisation: A behavioural economics perspective**

Luis Mundaca, International Institute for Industrial Environmental Economics, Lund University  
luis.mundaca@iiee.lu.se

Jonas Sonnenschein, International Institute for Industrial Environmental Economics, Lund University

Nicholas Dehod, International Institute for Industrial Environmental Economics, Lund University

Sandro Benz, International Institute for Industrial Environmental Economics, Lund University

#### *Track A - Institutions, governance and ethics*

Behavioural economics (BE) can be broadly defined as the branch of economics that focuses on cognitive biases, and the motivational and contextual factors that affect individual decision-making processes and resulting choices. Whereas research on BE as applied to energy and decarbonisation is emerging 1–5, scientific knowledge (and resulting policy recommendations) are heavily confined to experimental settings and external validity remains as a challenge 6. Modelling studies addressing the 1.5°–2°C Paris target strongly suggest that not only a

radical technological change is needed, but also an accelerated social transformation 7–10.

Drawing upon BE insights, the purpose of this paper is to identify and discuss community-based perspectives underlying the transition towards local sustainable energy systems and rapid decarbonisation. Aware of the methodological challenges and limitations of BE research methods, (e.g. trade-offs between internal and external validity 5,6 and the 'Hawthorne effect' 11,12), we use an empirical and real-life setting for the study: Samsø, a 100% renewable energy-powered island that is labelled as one of the most inspiring cases for sustainable energy transitions. Energy-related CO<sub>2</sub> emissions have been negative, as the island produce more CO<sub>2</sub> neutral energy (wind and biomass) than it's used 13. BE and process tracing form the core of our methodology. Process tracing, understood as the use of evidence to make inferences about causal explanations of a case study 14,15, is used as a qualitative analytical tool to systematically identified and examine 'diagnostic evidence' in relation to four areas: loss aversion 16,17 and its ramifications (e.g. endowment effect, status quo bias), social norms 18, conditional cooperation 19 and salience 20.

Findings suggest that loss aversion combined with a socio-economic crisis (unemployment and depopulation) played a key initial role. Interviews revealed that once the crisis started, a different decision-making scenario under uncertainty arose, in which (future) gains and advantages had a relatively more impact on preferences than crisis-related losses and disadvantages. To avoid losses, a risk-seeking behaviour is identified. Thus, the status quo bias started to diminish. Social norms on behaviour also seemed to play a role, particularly pro-social and altruistic values. However, even if economic and social concerns drove a pro-transition behaviour, it is unclear whether normative behaviour was applicable to the entire island's population. Farmers benefited on multiple levels (e.g. due to tax reductions), which questions pure self-transcendent and pro-social values. Conditional cooperation was driven by trust, public commitment, and information sharing. Managing ingroup/outgroup dynamics and having "local champions" build trust and supported cooperation. Salience of the transition was driven by the above-mentioned crisis, actors facilitating the transition, and local political dynamics. However, salience became more of a factor as projects began to be implemented. In turn, the extent to which

social norms may have influenced behavioural change also depended on the saliency of new energy infrastructure and potential local economic benefits.

From a BE perspective, it is concluded that the socio-economic crisis combined with nationally-driven incentives seemed to affect behavioural anomalies and trigger motivational factors in favour of the energy transition.

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### **Plotting a path to a friendly electricity grid: the INSPIRE-Grid project**

Stefano Maran, Ricerca sul Sistema Energetico RSE SpA – Milano (Italy),  
<http://www.rse-web.it>  
 stefano.maran@rse-web.it

#### *Track A – Institutions, governance and ethics*

We all rely on the power transmission and distribution system in our daily lives; the European Commission, recognising its importance, has inserted the Energy Union in the top ten priorities for Europe. The main objectives of this initiative are to provide a secure, sustainable and affordable energy in Europe and one of the essential means to achieve these objectives is the development of an efficient electricity grid: in fact, the European Commission has set a target of 10% electricity interconnection by 2020 for

each European country. Notwithstanding its importance, works to develop and enhance the underlying infrastructure often arouses strong opposition in the affected communities. In response to this issue, the INSPIRE-Grid project was launched in 2013 by RSE with the aim to develop a methodology to better manage the consultation and to engage the stakeholders in the decision-making process; the final goal of the project is to contribute to the integration of stakeholders' views in the planning and permitting phases of new infrastructures and to improve the support for the development of the future electricity grid.

By way of an interdisciplinary approach, merging skills from social sciences and technical disciplines, methods to facilitate decision-making have been combined with engagement tools and tested with stakeholders from grid development project case studies.

The project activities included:

- the analysis of the needs, concerns, wants and expectations of the stakeholders
- the individuation of the existing best practices for the stakeholders' engagement
- the customisation of methodologies for assessing and comparing impacts and benefits
- a series of case studies with a double aim: to give elements to the methodological activities and to allow a proper testing
- a synthesis of the project results and a series of recommendations about the stakeholders' engagement.

The most important and innovative aspect of the project is the strong collaboration between different disciplines and the involvement of different actors, namely research institutions, industry, and civil society organisations (in the advisory group).

The most relevant results are a series of customised methodologies and tools that can be used to promote stakeholders' engagement. The roles of trust and justice (in its different specifications - procedural, distributional, interpersonal) were investigated; this yielded to recommend a participatory and structured decision-making process and an appropriate customization was developed. The use of a Multi-Criteria Analysis and of other integrated

assessment tools was tested and we found they can help to engage people, manage conflicts and finally support the choice of a good alternative. At the end, the project issued a set of recommendations to manage the consultation, to engage the stakeholders in the decision-making process, and to improve support for the development of future grid infrastructures.

Although we tested our approach in three real case studies, we were not able to implement the methodologies in the actual planning and permitting processes, because present procedures are regulated with very strict norms that leave little space to experiment new methods. In order to improve the present procedures, it would be necessary to introduce some flexibility.

### **Sustainability transitions: expansion zones and transition processes. Insights from the distributed energy transition**

Tomas Moe Skjølsvold, Department of interdisciplinary studies of culture, NTNU  
tomas.skjolsvold@ntnu.no

#### *Track A – Institutions, governance and ethics*

This paper sets out to do two things. It is a theoretical effort to explore how studying shifts towards more distributed energy systems (typically associated with intermittent renewables, storage technologies and “smart” technologies) could inform our understanding of sustainability transitions more broadly. The result is the identification of four expansion zones, where actors work to increase the reach of their interests. These are: 1) the policy zone, 2) the R&D zone, 3) the design zone and 4) the zone of use. Here, different actors engage with the distributed energy transition in different ways and for different reasons, the result being a relatively messy story. They engage the transition through four generic transition processes: a) the production of visions and expectations, b) network construction and re-configuration, c) scripting and d) domestication. The outcome is a process oriented, agency-centric and ontologically flat description of the processes of sustainability transitions that raises new questions about the manageability of such processes.

### **Climate policy choices and technological development – How do they influence OECD power sector emissions?**

Simen Rostad Sæther, NTNU  
Simen.r.sather@ntnu.no

#### *Track A – Institutions, governance and ethics*

Our energy system is changing. Renewable energy sources are being phased in at an increasing rate into the system. Solar and wind’s remarkable price reduction and technological development have astonished even the most optimistic environmentalist. However, scholars and activists alike are still raising concerns that these changes are not happening fast enough. Then in December 2015, our collective low-carbon future was politically cemented in the Paris-Agreement. Indeed, it marked a real shift in political and societal vision and staked out a very clear long-term goal. It is, however, important to emphasize that the agreement does not dictate clear policy options, nor any concrete strategies for how to collectively reach the long-term goal. What does seem evident is that transitioning to a clean and sustainable energy system will be at the core of the challenge. The remarkable synergy effects of a clean energy transition will set society on the course towards a low-carbon future. Transitioning, however, will undoubtedly be a major challenge. Therefore, knowledge about these systemic changes, how they may be accomplished, and what their consequences might be, is essential for any society.

I, therefore, propose an empirical study of power sector emissions in the OECD from 1990 to 2015 (time span preliminary depending on the data access) with 32 of the 35 current OECD countries (Chile, Israel, and Latvia lack sufficient data). I will investigate how various climate policies and technological development have influenced emissions in the power sector. My aim is to give a clearer picture of how these factors might have affected emissions up to this point.

I deploy a quantitative design using a regression technique called time-series cross-sectional analysis (TSCS). Of the various policy directions, I will 1). Focus on market-based solutions such as environmental taxes and cap-and-trade 2). Governmental and private research and development

(R&D) investment and expenditure and finally, 3). Technology-Support policy schemes like feed-in tariffs, tax credits, and renewable portfolio standards.

Given the importance of decarbonizing the power sector to reach a low-carbon society sooner rather than later, analysis like the one I propose can give a crucial insight of how these policies have influenced emissions in the real world. Theoretical arguments alone for preferring a given policy option can be dangerous if they build on assumptions that may or may not come to pass in the near-term future. Especially given the short timescale given to us by the leading climate scientists to solve these problems.

**THURSDAY, 19 OCTOBER | SESSION 2 | 09:45-11:45**



**Track B Smart & sustainable city services**

**Abstract session 2 – Participation and governance**

**Room: COSMOS 1&2**

**Moderator: John Krogstie, Professor, Dept. of Computer Science, NTNU**

09:45-09:50	Session introduction
09:50-10:05	Daniel Baer, Brita Fladven Nielsen and Carmel Lindkvist Towards Zero Emission Neighbourhoods: how smart do Norwegian city authorities integrate citizen into the transition process?
10:05-10:20	Francesco Gianni, Lisa Rebekka Klecha, Simone Mora and Monica Divitini Design of smart city services for and with citizens
10:20-10:35	Ida Nilstad Pettersen, Ole Smørðal, Kristina Ebbing Wensaas and Susana Lopez-Aparicio Citizen engagement in mobility-related sustainable urban development: Current practices, challenges and opportunities for change
10:35-10:50	Brita Fladvad Nielsen, Daniela Baer and Carmel Margaret Lindkvist Norwegian municipalities' efforts to integrate energy into city planning; early key challenges from the planning of smart energy communities
10:50-11:05	Beryl Bellman, Prakash Rao, Ann Reedy and Ken Griesi Enterprise Architecture Approaches to SDG and stages for sustainable development: Two Case Studies
11:05-11:20	Francesca Cappellaro, Roberta Chiarini and Claudia Meloni Growing up a new culture of intermediation in Italy: the case of Smart Community in peri-urban Rome Districts
11:20-11:45	Joint questions and discussion

## **Towards Zero Emission Neighbourhoods: how smart do Norwegian city authorities integrate citizen into the transition process?**

Daniela Baer, SINTEF Byggforsk  
daniela.baer@sintef.no

Brita Fladvad Nielsen, NTNU  
brita.nielsen@ntnu.no

Carmel Lindkvist, NTNU  
carmel.lindkvist@ntnu.no

### *Track B – Smart and sustainable city services*

Recent studies have highlighted the need for participatory approaches in city planning but few have evaluated them in terms of a smart city approach. Our study examines traditional and modern participatory approaches in order to identify a Smart City approach for citizen integration in planning which will aid in meeting wider political agendas on climate change. The existing built environment – buildings and infrastructure created for generations - accounts for a large part of global emissions and thereby offers an enormous potential to lower our carbon footprint. Norway has a national target to reduce emissions to 40% by 2030 compared to 1990 levels. In recent years, the political agenda has been to improve the existing and new building stock and to re-develop energy systems, which focuses increasingly on the neighbourhood level in the urban context. The Nordic European countries follow a top-down approach in their planning paradigm, characterized by national plans and strategies implemented on a regional level to transform the built environment of cities. Cities aim to reach their ambitious goals by creating neighbourhoods with a reduced energy demand and an (infra)structure which enables the citizen to live a nearly emission free life.

The success of these attempts is highly dependent on the human factor and its consideration within the built environment: in particular, how citizens behave and use their neighbourhoods. Will citizen behaviour follow cities goals of emission reduction? Former studies of zero emission buildings

in Norway doubt the inhabitants' will to behave in the intended way. Participatory and inclusive design and planning are traditional methods seen as one way of closing the gap between design intention and citizen needs. These methods of an inclusive design increases citizen ownership as well as improves design of the urban environment. By making it human centred in order to meet citizen's requirements, city goals integrated into the planning designs will be achieved more likely.

The specific research question focuses on how citizens are involved in the planning of zero emission neighbourhoods and evaluation of participatory approaches.

The question is examined through the study of seven neighbourhoods on the transition path to become zero emission and which are pilot cases within the Centre of Zero Emission Neighbourhoods at NTNU. The findings are based on qualitative interviews in these existing and planned neighbourhoods and two design-thinking workshops in two front running Smart Energy Community projects (PI-SEC project at NTNU). A literature study of Norwegian and international best practice cases further underpins the studies. The findings presents challenges of citizen participation in the seven neighbourhoods and implemented measures to involve citizens in the process. A particularly interesting preliminary finding is a description of which gaps exist between traditional participatory methods and modern city planning. The discussion will focus on whether and how smart the cities integrate citizens in the planning process.

### **Design of smart city services for and with citizens – Reflecting on the experience with TILES workshops**

Francesco Gianni, Dept. of Information Technology and Computer Science, NTNU  
Francesco.gianni@ntnu.no

Lisa R. Klecha, Dept. of Information Technology and Computer Science, NTNU



Simone Mora, Dept. of Information Technology and Computer Science, NTNU

Monica Divitini, Dept. of Information Technology and Computer Science, NTNU

### *Track B – Smart and sustainable city services*

The Internet of Things (IoT) promises to promote the development of innovative services for smart cities, bringing together connectivity, data sources and physical objects. These services will interleave in unprecedented way with the everyday life of citizens, both for work and leisure practices.

This opens a wide space of possibility as well as a number of concerns, like risks connected to privacy and security, just to mention two of the most widely mentioned.

To create services that are enhancing city life, it is important that citizens are involved in the design process in meaningful ways. However, this is challenging because of, e.g. lack of interest and adequate tools to support the process. This is a well known problem for example in the involvement of citizens in urban planning. In addition, the direct involvement of citizens in the design of IoT enhanced services might be hindered by lack of adequate digital competencies. A recent survey of the literature that we have conducted in the area of applications for sustainable mobility pointed out that citizens are seldom involved in the co-creation of this type of services, at most involved in the evaluation.

In this presentation we aim at reflecting on our experience with TILES, a card-based toolkit for rapid prototyping of the IoT. The toolkit was developed as a generic tool for promoting creativity in the design of IoT services through design workshops. TILES has then been specialized for the design of smart cities, including dedicated cards and scenarios and personas that can help focus the design effort.

After running workshops with more than 200 participants, we reflect on opportunities and challenges to the design of services for smart cities, addressing questions like: Which types of services are more popular?

Which characteristics seem more relevant? Are citizens succeeding in designing services that promote learning and therefore, potentially, long-term impact? Does co-creation have a value independently by the designed services as a way of understanding citizenship in smart cities and promoting critical thinking?

### **Citizen engagement in mobility-related sustainable urban development: Current practices, challenges and opportunities for change**

Ida Nilstad Pettersen, Associate Professor, Department of Design, NTNU  
ida.nilstad.pettersen@ntnu.no

Ole Smørdal, Associate Professor, Department of Education, University of Oslo  
ole.smordal@uv.uio.no

Kristina Ebbing Wensaas, Planning Contact, Norwegian Public Roads Administration  
kristina.ebbing.wensaas@vegvesen.no

Susana Lopez-Aparicio, Senior Scientist, NILU – Norwegian Institute for Air Research  
Susana.Lopez\_\_Aparicio@nilu.no

### *Track B – Smart and sustainable city services*

Mitigation of climate change requires fundamental change in the ways in which societal functions are fulfilled. Urban transport is one of the areas in which transitions are needed to reduce the dependence on fossil fuels. Changing the course of the development means changing sociotechnical systems that are complex and embedded. Doing so concerns the ways in which cities are planned as well as the everyday life of citizens, and requires the active involvement of different groups. In research on sustainability transitions, multi-actor approaches are proposed as relevant ways of exploring alternative futures, by enabling joint experimentation and learning. In city planning, citizen participation is a goal and requirement, but it is in practice often associated with challenges such as participation

happening too late in the process, excluding certain groups or being limited to a minimum level.

This paper presents findings from an interdisciplinary project exploring and experimenting with ways of improving citizen involvement in sustainable urban development. To identify directions for change that in turn can be explored in “democratic design experiments” the paper sets out to map current practices and the challenges and opportunities that exist today.

Theoretically, the paper introduces perspectives on participation and what are considered relevant approaches for enabling it from literature on participatory urban development and sustainability transitions. Practice theory, relevant here as it focuses on the sociomaterial aspects of everyday life activities, is introduced to help conceptualise and capture participation practices.

Methodologically, the paper builds on case studies conducted in two of Norway’s largest cities. The cases focus on initiatives aiming at e.g. reducing transport-related emissions and increasing the share of walking, biking and travels by public transport. The paper presents findings from interviews with professionals such as planners and developers, and from observations at participatory events involving citizens, planners and other professional actors.

Based on the data, current practices for facilitation of participation in mobility-related urban development are described and challenges and opportunities are identified and discussed in the light of theory. Emerging themes include the communication and understanding of plans, facilitation of a constructive dialogue, citizen experiences of their opportunities to contribute and the actual impact and value of participation. In conclusion, directions for future research and design explorations are outlined.

### **Norwegian municipalities’ efforts to integrate energy into city planning; early key challenges from the planning of smart energy communities**

Brita Fladvad Nielsen, NTNU  
brita.nielsen@ntnu.no

Daniela Baer, SINTEF Byggforsk  
daniela.baer@sintef.no

Carmel Lindkvist, NTNU  
carmel.lindkvist@ntnu.no

### *Track B – Smart and sustainable city services*

Current cross-disciplinary smart city studies focus on seizing the potential of smart city thinking and technologies in redefining urban planning. The opportunities and the challenges of introducing smart cities thinking requires that governance institutions have approaches in place that help them manage these opportunities in order to balance social, economic and environmental perspectives of their cities. The presented study builds on Zero Emission Building (ZEB) research because it has been a foundation for NTNUs recent Zero Emission Neighborhood initiative. At the same time the PI-SEC project is a frontrunner in developing tools for ZEN development, based on two municipalities’ Smart Energy Community (SEC) planning. The current ZEB definition targets a net zero emission result when taking into account emissions from materials, construction, building process and use. When moving towards community or neighborhood scale, Integrated Energy planning (IEP) and sustainable energy planning (SEAP) is also relevant due to its holistic area perspective. There is no agreed upon definition for neither SEC nor ZEN yet it is part of the projects’ objectives to propose definition for these.

In this paper, we seek to outline the main key challenges that the studied municipalities are confronted with in the pre-implementation stage of the 7 pilot cases.

The empirical part of our study consists of lessons from the planning of 7 community and neighbourhood projects; the PI-SEC project and the Zero Emission Neighbourhood project. PI-SEC (planning instruments for smart energy communities) is a cross-disciplinary research project at NTNU with the municipalities of Bergen and Oslo, while the pilot projects within the Centre for Zero Emission Neighborhoods in Smart Cities (ZEN) include also Trondheim, Elverum, Bodø, Evenstad and Steinkjer. Interviewwill contribute to the discussion about key challenges.

Early findings indicate that while the building sector has experienced strong regulatory changes, not enough emphasis has been put on regulating complex areas and large scale planning in order to achieve emission reduction. The challenges that involved stakeholders describe include a lack of clear definitions of SECs and ZENs and a lack of legal frameworks to enforce this neighborhood thinking, difficulties of addressing end-user concerns, and a lack of incentives and requirements for private sector to include social aspects from the beginning of a project. Challenges in early findings further include a misalignment of political processes with order of sequence, and conflicting stakeholder agendas and unclear responsibilities. Barriers to the involvement of energy utility in the early part of the planning process and lack of regulations that allow incremental learning, are also significant elements in the early findings that have implications for the emission reduction potential.

### **Enterprise Architecture Approaches to SDG and stages for sustainable development: Two Case Studies**

Beryl Bellman, Professor, Department of Communications, California State University Los Angeles  
bbellma@calstatela.edu

Prakash Rao, CEA, Enterprise Sherpa LLC  
prakashcrao@gmail.com

Ann Reedy, MITRE (retired)  
annreedy@comcast.com

#### *Track B – Smart and sustainable city services*

Enterprise Architecture (EA) as used by governments, defense and commercial organizations utilize models based on accepted frameworks (e.g. DoDAF, MoDAF, DNDAF, NAF, UAF, TOGAF, FEAF2, Zachman, etc.) to develop solutions incorporating business and technical infrastructure to complex problems and address capability needs. In our paper, we present how these are directly applicable to a holistic approach to sustainable development goals (SDGs) – and the three stages of sustainable

development – economic, environment and social. We begin with a case study we conducted to addresses the problem of the over population of sea lions and the related management issues in the San Diego area. The influx of sea lions in the La Jolla area is causing environmental problems leading to political, economic, policy, business, culture and environment conflicts. We demonstrate how EA addresses these problems and optimizes decisions that integrate operational, technical, data and social/cultural aspects allowing simulations of alternative solutions to examine their impacts across the wide range of stakeholders involved. This entails introducing a core set of EA primitives and models to as a case study in how to use EA in other environmental and humanitarian situations. We extend the methodology to the introduction of innovations in energy that offer a holistic approach to SDG goals. This involves a case study for the power industry: small nuclear reactors. This provides views from the multiple enterprise constituencies as sub-cultural “tribe-like” entities involved in a successful introduction of this technology. These tribes not only include the developer of the technology but also the various types of power companies that might implement it and the regulatory agencies and regulations that would be needed to ensure safety for this type of technology. The explores some of the potential changes that might emerge with this innovation, such as neighborhood power cooperatives, and identifies some of the critical issues and potential roadblocks to successful introduction of this innovation. We present the methodologies for both case studies. In the Sea Lion project, we conducted in-depth interviews with major stakeholder groups including Scripps Institute of Oceanography, Sea World, La Jolla Chamber of Commerce, San Diego city representatives, and more. In the nuclear reactor project, we utilized resources from industry and interviewed researchers working in the area. These materials will be discussed in the paper and presentation.

### **Growing up a new culture of intermediation in Italy: the case of Smart Community in peri-urban Rome Districts**

Francesca Cappellaro, ENEA Territorial and Production Systems Sustainability Department  
francesca.cappellaro@enea.it

Roberta Chiarini, ENEA Energy Technologies Department, Smart Energy Division  
roberta.chiarini@enea.it

Claudia Meloni, ENEA Energy Technologies Department, Smart Energy Division  
claudia.meloni@enea.it

Track B – Smart and sustainable city services

### **Introduction**

Culture is the sharing of values, behaviors, material and non-material goods from a community. The birth of a new culture depends on new spaces, new representations and new mediated relationships among institutions and citizenships. The importance of intermediaries in facilitating this process is increasingly recognized. The formal or informal intermediary role, can be affected from several kinds of factors: the acceptance by the community, the settlement of condition, the specificity of physical space. Intermediary often feels to mediate for a better condition of place, but its mediation is, first of all, an economic action of resource itself, in that place. Actually, one of key turning could be the establishment of institutional intermediate bodies, that means new societal profiles for the interpretation and orientation in complexity conditions, new community references and experts for a de-colonization from the economy of un-sustainability towards new economy models, such as green economy, circular economy and collaborative economy models.

### **Methods**

According to Sustainability Transitions Theories, at the niche level, the role of intermediaries helps to support the growth and the enhancement of grassroots innovations. At the regime level, intermediaries can influence important change of current practices and standards livelihood models. This paper presents the case of some Italian peri-urban districts in Rome, where pathways for the development of a smart neighborhood community have been started for the implementation of co-governance initiatives. These pathways foresee the definition of an open-innovation technological infrastructure (Social Urban Network platform) acting as intermediary-catalyst for the development of a local smart community.

The aim is to engage citizens in the co-governance of the district, enabling them to participate actively in collective life and to support smartly the behavior change. In that sense, a series of initiatives have been devised for the application of technical-economic models and co-governance, realized through workshops and participatory laboratory involving public administration-utility-citizens.

### **Results**

To strengthen the capacity of citizens and stakeholders to participate in local decision-making and local governance, a platform for community services has been implemented. These services allow to overcome the environmental impact of energy and to achieve more sustainable solutions. In the following table, different experimental settings implemented in peri-urban districts of Rome (Italy) have been described.

**THURSDAY, 19 OCTOBER | SESSION 2 | 09:45-11:45**



**Track C Biodiversity & ecosystem services**  
**Abstract session 2 – Methods and conservation**  
**Room: LIVING 4**

**Moderator: Francesca Verones, Associate Professor, Dept. of Energy and Process Engineering, NTNU**

09:45-09:50	Session introduction
09:50-10:05	Ron Smith The use of Bayesian Belief Networks to study the role of ecosystem services in decisions
10:05-10:20	Graciela Rusch, Verónica Rusch, Santiago Varela, Andrea Goijman, Pablo Peri and Dardo López Integrating State-and-Transition Models, ecosystem services and BBNs to support environmentally and socially sustainable decision-making
10:20-10:35	Alexandra Tisma, Henk van Zeijts and Ed Dammers Possible futures of nature in Europe: Communication with storylines and visualizations
10:35-10:50	Wenche Dramstad, Wendy Fjellstad, Christian Pedersen and Graeme Bell A Norwegian Map of Ecosystem Services (no-mess) – Visualising multiple services to improve land use planning
10:50-11:05	Len Blom and Walter Vermeulen Biodiversity conservation through landscape level voluntary standards
11:05-11:20	Signe Nybo How to measure good ecological status, an advice from a Norwegian Expert Commission

## **The use of Bayesian Belief Networks to study the role of ecosystem services in decisions**

Ron Smith, Centre for Ecology and Hydrology, UK  
ris@ceh.ac.uk

David N. Barton, Norwegian Institute for Nature Research, Norway  
David.Barton@nina.no

Jan Dick, Centre for Ecology and Hydrology, UK  
jand@ceh.ac.uk

Roy Haines-Young, Fabis Consulting Ltd, UK  
roy.haines-young@fabisconsulting.com

Anders L. Madsen, HUGIN EXPERT A/S, Denmark  
anders@hugin.com

Graciela M. Rusch, Norwegian Institute for Nature Research, Norway  
Graciela.Rusch@nina.no

Mette Termansen, Department of Environmental Science, Aarhus University, Denmark  
mter@envs.au.dk

Helen Woods, Centre for Ecology and Hydrology, UK  
Helen.Woods@hotmail.co.uk

+ 14 others<sup>1</sup>

*Track C – Biodiversity and ecosystem services*

### **Introduction**

A Bayesian Belief Network (BBN) is a decision support and meta-modelling tool that can be used to explore the usefulness of the ecosystem services and natural capital concepts in a variety of ways. Its advantages are that it can represent and help identify relevant processes and the links between them, quantify these processes and linkages, estimate uncertainty, and

make it possible to assess trade-offs (monetary and non-monetary) across multiple criteria. Within the EU FP7 OpenNESS project, 9 of the 27 rural and urban case studies chose to use BBNs (all for different reasons) and a summary of their experiences is presented here.

### **Positive experiences**

As it was a new methodology for many researchers, the initial use of BBNs was to explore their capabilities. The BBNs delivered particularly well on three aspects. First, the co-production of a BBN with stakeholders helped to integrate various sources of knowledge and generate a common understanding of the structures and the role of ES within the decision processes, leading to social learning about the concepts as well as the tool itself. Secondly, the transparency of a BBN structure was also very useful as it aids understanding. This was also important for stakeholders and researchers exploring the behaviour of the BBN for themselves, seeing how changes in the network are reflected in outputs, and communicating results to others. Finally, it was expected that estimating uncertainty might be a challenge when developing a BBN. However, as a concept, uncertainty was readily accepted by most stakeholders, who recognised why uncertainties were important to the modelling and why it was important to understand the level of evidence in support of any conclusions. Many case studies found that presenting the BBN within an interactive web interface was a helpful way to explore model structure, uncertainty, options and trade-offs,

### **Difficulties**

The case studies found that, especially for more complex models, BBNs were difficult to construct unless there was access to significant local expertise. Currently it is also time-consuming to distill stakeholder information for quantifying the uncertainties, and the whole exercise of consultation and model refinement can take quite a lot of time. There were various suggestions of improvements to software and implementing targeted training of staff to make BBNs more generally accessible. Several case studies wanted to develop the temporal and spatial aspects of an ecosystem services assessment and this required extensions to the available software. However, this was assisted by HUGIN EXPERT being one of the project partners.

## Conclusion

In summary, BBNs were instrumental in raising awareness of the importance of ecosystem services and biodiversity to both academics and stakeholders. Their application in a series of very different case studies highlighted the challenges and benefits of using BBNs for modelling ecosystem services, particularly exploring spatial and temporal extensions of the basic concepts.

1Laurence Carvalho, CEH, UK; Relu Constantin Giuca, University of Bucharest, Romania; Sandra Luque, IRSTEA, France; David Odee, KEFRI, Kenya; Verónica Rusch, EEA INTA, Argentina; Heli Saarikoski, SYKE, Finland; Cristian Mihai Adamescu, University of Bucharest, Romania; Rob Dunford, ECI, Oxford, UK; John Ochieng, KEFRI, Kenya; Julen Gonzalez-Redin, JHI, UK; Erik Stange, NINA, Norway; Angheluta, University of Bucharest, Romania; Peter Verweij, Wageningen University and Research, The Netherlands; Suvi Vikström, SYKE, Finland

## Integrating State-and-Transition Models, ecosystem services and BBNs to support environmentally and socially sustainable decision-making

Graciela Rusch, Norwegian Institute for Nature Research  
graciela.rusch@nina.no

Verónica Rusch, Instituto Nacional de Tecnología Agropecuaria  
rusch.veronica@inta.gob.ar

Santiago Varela, Instituto Nacional de Tecnología Agropecuaria  
varela.santiago@inta.gob.ar

Andrea Goijman, Instituto Nacional de Tecnología Agropecuaria  
goijman.andrea@inta.gob.ar

Pablo Peri, Instituto Nacional de Tecnología Agropecuaria  
peri.pablo@inta.gob.ar

Dardo López, Instituto Nacional de Tecnología Agropecuaria  
lopez.dardor@inta.gob.ar

## Track C – Biodiversity and ecosystem services

The theory of ecosystem services (ES) needs to be operationalized to contribute to practices leading to sustainable use of ecosystems, which include solving trade-offs between private and public benefits and incorporating monetary and non-monetary values to help inform decisions. We developed a framework that combines a model of ecosystem condition driven by the level of use, based on three conceptual and methodological approaches: i) a state-and-transition model of ecosystem condition and dynamics ii) indicators of the capacity to generate ecosystem services and ecosystem services flows, implemented as iii) a decision support tool based on a Bayesian network. We developed the model for a system of native Southern Beech forest under silvopastoral use in Argentina. We analysed the consequences of different levels of ecosystem services flows on the capacity of the system to generate private (farmer) and public benefits (as defined by the National Forest Law), when projected into short (0-10 yr), intermediate (10-40 yr) and long (70-140 yr) time horizons. We found that to a large extent, current levels of ecosystem services flows are incompatible with the long-term capacity of the system to generate ecosystem services “regulating and maintenance” services. The tool developed helps to show long-term impacts of management, and discloses cause-effect relationships between levels of use and multiple benefits. It can therefore support measures aiming to raise awareness about degradation trends, and improve the functional understanding of the system that can lead to identify solutions for socio-economic and environmental sustainability.

## Possible Futures of Nature in Europe: Communication with Storylines and Visualisations

Alexandra Tisma, PBL Netherlands Environmental Assessment Agency  
alexandra.tisma@pbl.nl

Henk van Zeijts, PBL Netherlands Environmental Assessment Agency

Ed Dammers, PBL Netherlands Environmental Assessment Agency

## Track C – Biodiversity and ecosystem services

## Introduction

Halting biodiversity loss is an important and persistent problem. The occurrence of many species in the EU is expected to decline further, up to 2050. Effective protection of nature areas requires engaging all stakeholders, including businesses and citizens, to increase public support and ensure adequate funding. However, these stakeholders are likely to have differing perspectives on nature. To find a new common agenda for the future, it is vital to understand and take into account the individual perspective that each party will bring into discussion. To support these objectives, PBL Netherlands Environmental Assessment Agency conducted a Nature Outlook scenario study ([www.pbl.nl/natureoutlook](http://www.pbl.nl/natureoutlook)). For this study, four perspectives on the future of nature in Europe were developed.

## Method

The four perspectives were developed during three interactive stakeholder dialogues, accompanied with literature reviews, model calculations and visualisations. Each of the dialogues had around 30 representatives from European environmental, research and economic sectors. Storylines were created, and visualisation techniques were integrated into the method, which is usually not a part of a scenario study. Combinations of photos, maps, icons, artist impressions, posters and videos were used, during the development of the perspectives as well as for dissemination of the final results.

## Results

The four perspectives represent four distinct ways of thinking about nature and society. In 'Strengthening Cultural Identity', people feel connected with nature and the landscape, and consider this an integral part of their local and regional communities. In 'Allowing Nature to find its Way', people are appreciative of the intrinsic value of species, while nature is defined by dynamic processes and should be left to its own devices. In 'Going with the Economic Flow', nature is meant to suit people's lifestyles, and businesses and citizens take the initiative in nature development. In 'Working with Nature', people aim to use natural processes, striving for optimal, long-term delivery of ecosystem services, for the benefit of society. Perspectives are textually and visually presented in a background report Storylines and

Visualisations. The perspectives are not meant as blueprints, but may inspire stakeholders to come to joint visions and policy strategies.

## Discussion and conclusion

The use of those visualisations during the development of the perspectives and presentation of the study's final results, was evaluated via participants' feedback and participative observations by the team members. This showed that visualisations (pictures) added value to storyline creation (text) and quantifications (numbers), during our scenario study. A combination of visualisation techniques attuned to the various parts of the process were found to have advantages over using only one visualisation technique. Visualisations inspired the participants, stimulated and structured the discussions, and enhanced understanding of the storylines and their spatial consequences. The Nature Outlook's storylines are presented in several reports, on a website and in oral presentations. We observed that particularly artist impressions and videos helped stakeholders to easily recognise the perspectives and to structure their thinking about the future of nature in Europe.

## A Norwegian Map of Ecosystem Services (No-Mess) – visualising multiple services to improve land use planning

Dramstad, W.E., Norwegian Institute of Bioeconomy Research (NIBIO)  
[wenche.dramstad@nibio.no](mailto:wenche.dramstad@nibio.no)

Fjellstad, W.J., Norwegian Institute of Bioeconomy Research (NIBIO)  
[wendy.fjellstad@nibio.no](mailto:wendy.fjellstad@nibio.no)

Pedersen, C., Norwegian Institute of Bioeconomy Research (NIBIO)  
[christian.pedersen@nibio.no](mailto:christian.pedersen@nibio.no)

Bell, G.B., Norwegian Institute of Bioeconomy Research (NIBIO)  
[graeme.b.bell@gmail.com](mailto:graeme.b.bell@gmail.com)  
*Track C – Biodiversity and ecosystem services*

Action 5 of the EU 2020 Biodiversity Strategy requires Member States to "...map and assess the state of ecosystems and their services in their



national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020" (Maes et al. 2013).

Simultaneously, we are transforming our terrestrial environment at unparalleled rates and scales (Seto et al. 2011). To some extent these transformations are a result of deliberately developed land use plans which aim to accommodate a wide range of interests; housing, infrastructure, recreation, etc. and rarely pay special attention to ecology (Ahern 2013, Thompson 2002).

For informed decision-making, research, education, and even for increasing people's enjoyment of particular places, we need to be able to understand and visualize ecosystem services in a broad sense over broad geographical areas. Only when we have this systematic overview will we be able to evaluate trade-offs and synergies between different areas of interest and make better informed choices in landscape management and planning (Raudsepp-Hearne et al, 2010, Naidoo et al 2008). As the total pressure on ecosystem services worldwide is expected to increase, there is an urgent need for swifter progress in mapping and documenting state and trends.

In Norway, an official report was published in 2013 (NoU 2013:10) focusing on the state and trends of development in Norwegian ecosystems. The report documents severe knowledge deficits on a variety of themes, and points to the need to map ecosystem services to ensure knowledge based management.

In our perspective, a major potential application of a map of ecosystem services is to visualize the range of services provided, and ensure that land use planning and decision making takes this information into consideration. We have therefore developed a model integrating a large range of ecosystem services in one map-based solution. Areas of land may support or relate to a variety of distinct ecosystem services in complex ways and the ideas of 'value' and 'service' and how to represent them quantitatively are not agreed upon. Our model aims to overcome this complexity by using a very large number of simple functions, arranged hierarchically. This allows an approximate but useful characterisation of the ecosystem services associated with an area, wherever data is available

to support it. In practice, based on data from existing maps and databases, we established a grid of points where each point receives a numeric value for each of the ecosystem services considered.

Our approach addresses a variety of qualitative and quantitative challenges in land value modelling and our resulting map presents the accumulated score for each point in colours, with the option to examine the breakdown of scores for each ecosystem service. By making all aspects of this model "open source" and available, we hope many will get involved or try it out and contribute to improving the model.

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### **Biodiversity Conservation through Landscape Level Voluntary Standards**

Len Blom, Utrecht University, Universidad de los Andes, and United Nations Environment World Conservation Monitoring Centre  
l.blom4@students.uu.nl

Dr. Vermeulen, Utrecht University  
w.j.vermeulen@uu.nl

Dr. Ruedab, Universidad de los Andes

Dr. Brooks, United Nations Environment World Conservation Monitoring Centre

#### *Track C – Biodiversity and ecosystem services*

In the light of unprecedented global biodiversity loss, due largely to increasing pressures from economic activity, this research aims to study the intersection between international supply chains and biodiversity conservation, and the role of voluntary sustainability standards (VSS). VSS are a market-based scheme to render domestic and international supply chains more sustainable. However, many VSS have neither incorporated biodiversity sufficiently nor appropriately and struggle to address

beyond site-specific elements. Landscape approaches – i.e. a holistic, multifunctional and integrated view on landscapes – also have difficulties with empirically proving effectiveness and often lack engagement of economic actors. This study explores the feasibility of combining both approaches in a 'landscape level voluntary standard', which has the potential to improve biodiversity conservation considerably in certain areas.

This explorative research fills the research gap of the juxtaposition of biodiversity conservation, VSS and landscape approaches, guided by the following research question:

'What are the barriers and opportunities of applying a landscape approach in VSS for biodiversity conservation, and how could such an approach be practically feasible?'

Methods - An initial exhaustive literature review grounds the landscape approach to certification in the socio-ecological systems theory. This is followed by a current practice review to scope biodiversity conservation approaches related to VSS, based on publications and 30+ interviews with experts in conservation and supply chain research. By drawing on the experiences and progress of existing VSS schemes, this project will explore the challenges and successes of integrating a landscape level biodiversity conservation approach. In close collaboration with key actors (e.g. ISEAL, UTZ Certified, UN Environment WCMC) this will be used to identify the key components of a landscape level VSS approach. Finally, a coffee and cacao case study in Colombia will explore the feasibility and desirability of such an approach by interviewing conservation organisations (e.g. IUCN & WWF), local NGOs (e.g. Fundación Natural), certified cacao farms and farmer organisations (e.g. Federación Nacional de cafeteros (FNC)) and (local) governments.

The results will show whether a landscape approach to VSS is feasible and desirable to improve biodiversity conservation in particular and be conducive in the road towards the 2030 targets in general. If so, what key elements should be present to initiate and sustain such an approach. A successful integration of certification in landscape approaches could build bridges between hitherto isolated initiatives and actors, and create new

business opportunities as well as engagement from national governments. Important building blocks to achieve this are highlighted, crucial barriers flagged and the implications discussed.

### **A new framework for measuring good ecological status in terrestrial, polar and marine ecosystems**

Signe Nybø, Research Director, NINA (Norwegian Institute for Nature Research)  
signe.nybo@nina.no

#### *Track C – Biodiversity and ecosystem services*

The Norwegian action plan for natural diversity has as its main aim that ecosystems shall be in good condition, in order to protect biological diversity and to deliver ecosystem services. Well-functioning ecosystems give a basis for sustainable development. Based on this, the Ministry of Climate and Environment selected an Expert Committee with a mandate to develop recommendations for a comprehensive technical system for the determination of good ecological condition.

The Expert Committee base its work on existing knowledge and classification systems. The Water Frame Directive (WFD), The Nature Index and the Norwegian Marine Management Plans has been especially important designing a framework that can apply to all natural ecosystems except those administered by the WFD.

The reference conditions and the normative description of good ecological status resembles the definitions in the WFD. Ecosystem structure, function and productivity are central elements of the definition. The Expert Committee has developed seven features that describes good ecological status in more detail. These features applies to all ecosystems and is related to primary production, the distribution of biomass between trophic levels, diversity of functional groups within trophic levels, important species and biophysical structures, species survival amongst them landscape ecological patterns, biodiversity and abiotic factors.

Indicators are used to measure these seven features. They are selected according to a set of criteria and available data. Norwegian monitoring programs and other sources of information has been search to identify indicators. The technical system suggests 336 indicators, where there are some available data for 213 indicators. Different indicators are used in different ecosystems; polar terrestrial ecosystems, mountains, forests, wetlands, semi-natural ecosystems, and natural open ecosystems below the forest line. Also marine areas are included; Barents Sea, the Norwegian Sea and North Sea

The technical system will be the first technical system as far as we know that is designed to evaluate ecological status of terrestrial ecosystems outside protected areas. The report is available here: [https://www.regjeringen.no/contentassets/7c4be071791f439b83fa035c03cdfc82/fagsystem-for-fastsetting-av-god-okologisk-tilstand\\_2017.pdf](https://www.regjeringen.no/contentassets/7c4be071791f439b83fa035c03cdfc82/fagsystem-for-fastsetting-av-god-okologisk-tilstand_2017.pdf)

THURSDAY, 19 OCTOBER | SESSION 2 | 09:45-11:45



## Track D Business models for sustainability

Abstract session 2 – *Sectoral studies and Circular approaches*

Room: COSMOS 3A

Moderator: Sigurd Vildåsen, Research Fellow,

Dept. of Industrial Economics and Technology Management, NTNU

09:45-09:50	Session Introduction
09:50-10:10	<b>Vibeke Stærkebye Nørstebø, Adrian Werner and Kjetil Midthun</b> Development and application of a circular economy analysis framework
10:10-10:30	<b>Julian Kirchherr</b> Conceptualizing the Circular Economy: An Analysis of 95 Definitions
10:30-10:50	<b>Roberto R. Hermann and Are Jensen</b> Unfolding circular economy technological opportunity discovery in Norwegian R&D public support programs through text mining methods
10:50-11:10	<b>Hogne Nersund Larsen, Christofer Skaar and David Brasfield</b> Low carbon procurement in the Norwegian public health sector: A case study of Sunnaas rehabilitation hospital
11:10-11:30	<b>Christofer Skaar, Anne Gunnarshaug Lien, Kristian Stenerud Skeie, Runar Skippervik and Erland Olsen</b> Identifying nearly zero-energy building candidates – a case study of the renovation potential of a Trondheim housing cooperative
11:30-11:45	Joint questions and discussion

## **Development and application of a circular economy analysis framework**

Vibeke Stærkebye Nørstebø, SINTEF Technology and Society  
vibeke.s.norstebo@sintef.no

Adrian Werner, SINTEF Technology and Society  
adrianTobias.Werner@sintef.no

Kjetil Midthun, SINTEF Technology and Society  
kjetil.midthun@sintef.no

### *Track D – Business models for sustainability*

Transitioning from a linear to a circular economy is essential for increasing the sustainability of businesses and value chains. The circular economy paradigm aims at decoupling economic growth from resource use and environmental impacts by e.g. using those resources more efficiently. Hence, it is a driver for innovation in the areas of material, component and product reuse as well as for new business models (such as technical solutions, leasing and reuse services). A more efficient resource usage contributes to reducing negative environmental impacts and, at the same time, generates more value, both through cost savings and through creating or expanding markets and business sectors. This way, a circular economy has the potential to provide economic benefits for companies while reducing their environmental footprint significantly.

Still, ensuring short and long term profitability represents a considerable barrier to a successful introduction of new circular business models. Also, businesses need guidance on how to implement circular economy solutions in practice. Restructured value chains and value networks, closer links between entities in the value chain, more interactions, new market models and new trade flow patterns indicate a growing necessity to handle dynamics and wider system perspectives. In this context, consistent, quantitative tools are crucial to investigate potentials and to help businesses find solutions achieving profitability and sustainability in a circular setting.

We describe a concept to couple methodology from areas such as techno-economic and environmental analysis in a comprehensive circular economy

framework. This comprises models and methods from e.g. operations research (including optimization models), macroeconomics (input-output analyses), life cycle assessment, sustainability impact factor analyses and data processing. Such a holistic framework will ease the analysis of emerging circular economy business models, services or value chain structures with respect to flexibility, profitability and sustainability / environmental impact aspects. By way of specific example cases, businesses and value chains e.g. the establishment of industry clusters, we demonstrate how the framework can be utilized in practice to support the transition to circular and more sustainable business structures.

## **Conceptualizing the Circular Economy: An Analysis of 95 Definitions**

Julian Kirchherr, Faculty of Geosciences, Utrecht University  
j.kirchherr@uu.nl

### *Track D – Business models for sustainability*

The circular economy concept has gained momentum both among scholars and practitioners. However, critics claim that it means many different things to different people. This paper provides further evidence for these critics. The aim of this paper is to examine if there is a coherent understanding of the circular economy concept. For this purpose, 95 circular economy definitions were gathered which were coded on 18 dimensions. It is found that these definitions are vastly different conceptually. Circular economy is most frequently depicted as a combination of reduce, reuse and recycle (35% of definitions), while recycling is the single most common component in the definitions examined (81% of definitions). Meanwhile, linkages of the circular economy concept to sustainable development are rare (9% of definitions). The main aim of the circular economy is considered to be improving economic prosperity (43% of definitions), followed by environmental quality (33% of definitions) and societal equity (17% of definitions). The needs of future generations are almost entirely neglected in the examined circular economy definitions (1% of definitions). It is discussed how different conceptualizations of the circular economy impede cumulative knowledge development on this topic as well as successful circular economy implementation. Overall, this

paper ought to raise awareness that deliberate conceptualizations of the circular economy are needed for its advancement.

### **Unfolding circular economy technological opportunity discovery in Norwegian R&D public support programs through text mining methods**

Roberto Rivas Hermann, Nord University Business School, Nord University  
roberto.r.hermann@nord.no

Are Jensen, Nord University Business School, Nord University  
are.jensen@nord.no

#### *Track D – Business models for sustainability*

Norwegian R&D policies increasingly support technological innovation through a combination of public subvention incentives, these schemes often require that companies fill very detailed application forms to explain the reasons behind engaging in new product development. Over the years, this archival data becomes a valuable source to explain why companies take strategic decisions as investing R&D resources in for example circular economy (CE) technology development. Extant research has set conceptual boundaries to CE, more research is indeed needed to define what constitutes a CE technology and how start-ups identify these as opportunities. We thus address the question: How do data mining methods can contribute to a better conceptualization of technological opportunities around circular economy? We use word co-occurrence analysis as methodological design to answer this question. We divide our research in three parts: i) developing of a dictionary of CE-technology highly frequent terms, ii) identifying the main “communities” of CE-technology start-ups developing new products through the tax-incentive program SkatteFUNN and iii) theorizing about the links between CE-technology opportunity identification and startup-success. In this conference, we share our preliminary results addressing the first two points. A survey in the Scopus database lead to 754 peer-reviewed English language papers about circular economy technologies. Using term co-occurrence patterns in the corpus of 754 abstracts, we identified the following underlying topics to define technology in the literature of CE: treatment, production, waste,

resource, circular and coal. Both authors scanned through the highly frequent terms composing these concepts and selected a final list of N=436 tokens that define a technology. The list of tokens was subsequently translated into Norwegian language and this became a dictionary that we later used in step 2. In total, our sample included 4073 SkatteFUNN project applications submitted between 2004-2015 by firms younger than four years old. Our text corpus was the answer to the questions: What is the project’s main goal? What is the project’s background?. Each document was subsequently processed into the bag-of-words representation with the purpose to represent the terms frequency within each document and compare them with the dictionary and each other. Our preliminary results indicate that text mining methods have the potential to contribute for a better conceptualization of CE technological opportunities in different industry contexts. We addressed one existing gap to improve the use of these methods in the analysis of CE innovation opportunities. To the best of our knowledge, this is a first systematic effort to create a dictionary of CE technological opportunities that go beyond the narrow understanding of CE as five to eight general principles distilled in the extant literature. On the other hand, the empirical testing of the dictionary of CE technological opportunities with archival data from a Norwegian public R&D support program sheds light on the complex diversity of the CE technologies, as many different sectors innovate in one way or another according to the CE principles.

### **Low carbon procurement in the Norwegian public health sector: A case study of Sunnaas rehabilitation hospital**

Hogne Nersund Larsen, Asplan Viak  
hognenersund.larsen@asplanviak.no

Christofer Skaar, SINTEF Building and Infrastructure/NTNU Department of Industrial Economics and Technology Management  
christofer.skaar@sintef.no

David Brasfield, Sunnaas Rehabilitation Hospital  
davbra@sunnaas.no

#### *Track D – Business models for sustainability*

Public health institutions are responsible for a significant part of the governmental carbon footprint in Norway – the sector contribution is approximately 15 % of the total, a total of more than one million tonnes of CO2 equivalents. The largest institution – Oslo University Hospital – alone counts for more than a quarter million tonnes of CO2 equivalents.

As most service areas, the carbon footprint of public health institutions are dominated by indirect – scope 3 – emissions. Consumables and services contribute with 30 and 26 percent of the total carbon footprint, respectively. Transport and energy, on the other hand, “only” contributes to 12 and 11 percent of the footprint. This indicates a clear need to initiate green procurement strategies that cover the wide range of products and services purchased. One key sustainability challenge in this sector is to ensure high quality health care with a low carbon footprint initiated by such strategies.

To address this challenge we have performed our study in three parts: First, we calculated and assessed the carbon footprint of Sunnaas rehabilitation hospital for the year 2014. Second, we compared Sunnaas’ carbon footprint with other institutions in South-Eastern Norway Regional Health Authority to analyse similarities and differences. Third, we analysed selected procurement hotspots and, based on this, recommended a procurement strategy.

The results from the carbon footprint analysis provided an overview of carbon footprint hotspots for Sunnaas. Three of the hotspots were selected for further analysis: medical-technical equipment, hygiene products and food. The three hotspots were selected based on a combined judgement of carbon footprint relevance, procurement relevance, procurement window of opportunity, carbon reduction potential and competence. For each product group we had five possible procurement strategies: ignore, incorporate, insist, integrate and innovate. As expected, no common procurement strategy could be identified across the hotspots. Salient strategies depend mainly on market maturity. Furthermore, the results indicate that procurement criteria based on a quantified carbon footprint is currently possible only for a limited number of product groups. For other product groups such quantified approaches must either be developed (e.g. through environmental labels or declarations) or be addressed through proxy criteria (e.g. energy consumption in the use phase). An example of a procurement is disposable versus reusable hygiene products. Here both options have implications on waste management

(types and volumes), ancillaries (e.g. material and energy for cleaning and sterilisation) and efficiency (time to prepare instrument or room for the next patient). Based on our findings we recommended using a functional approach for procurement for procurement, as the complexity of the health care system can make it difficult to compare on a product basis.

### **Identifying nearly zero-energy building candidates – a case study of the renovation potential of a Trondheim housing cooperative**

Christofer Skaar, SINTEF Building and Infrastructure/ NTNU Department of Industrial Economics and Technology Management  
christofer.skaar@sintef.no

Anne Gunnarshaug Lien, SINTEF Building and Infrastructure  
Anne.G.Lien@sintef.no

Kristian Stenerud Skeie, SINTEF Building and Infrastructure  
Kristain.skeie@sintef.no

Runar Skippervik, TOBB  
rsk@tobb.no

Erland Olsen, TOBB  
ero@tobb.no

#### Track D – Business models for sustainability

Two key challenges in the building sector are i) the focus on increased energy efficiency and ii) reduced carbon footprint of the building stock. One example of this is the goal of having regulations in place by 2020 that will require new buildings to be nearly zero-energy buildings (nZEB). But it is not sufficient to take action on new buildings alone. Approximately 80 % of today’s buildings will still be in use in 2050. It is therefore necessary to focus on nZEB renovation and rehabilitation.

In cooperative housing (housing co-op), each member owns the right to use a housing unit. Responsibility for the maintenance and upgrading inside each

housing unit belongs to the member, whereas the housing cooperative has the responsibility for maintenance and upgrading of the rest of the building. Typically the housing co-op is also member of an association for housing co-ops. This means that there are multiple stakeholders involved in a decision to renovate, and that there is potentially a large difference between housing units when it comes to standard and renovation needs. An nZEB renovation requires a coordinated effort on the whole building, and therefore needs a window of opportunity to perform the renovation.

TOBB is an association for housing co-ops in Trondheim, with approximately 700 housing co-ops as members and 20 000 dwellings. At the moment TOBB is project manager for renovation of 900 dwellings. Here we propose a method for mapping housing co-ops and identifying candidates for nZEB renovation. Key factors in the mapping include age of building, building type, demography, renovation status, energy use and housing costs. We then apply the method to TOBB's members to identify the housing co-ops with the highest potential for nZEB renovation. Having identified potential nZEB candidates, we discuss business models that may contribute to overcoming cost barriers for renovation. Finally, we calculate the energy and carbon footprint potential for an nZEB renovation of a pilot housing co-op.





# PARALLEL SESSION 3 SCHEDULE

## Track A Institutions, governance & ethics

**Abstract session 3** – *Ethics, governance*

**Room: COSMOS1&2**

**Moderator: Siri Granum Carson, Associate Professor, Programme for Applied Ethics, NTNU**

13:15-13:20 Session introduction

13:20-13:35 **Erling Holden, Kristin Linnerud and David Banister**  
The Imperatives of Sustainable Development: Needs, Justice, and Limits

13:35-13:50 **Rita Vasconcellos D'Oliveira Bouman, May Thorseth and Helge Brattebø**  
The Potential of Co-Benefits in Climate Change Mitigation Strategy: An Opportunity for Environmental and Social Justice

13:50-14:05 **Hermann Sæther**  
Social sustainable development: the art of creating a better world - Redistribution versus institutional aid

14:05-14:20 **Chandreyi Sengupta and Debajit Datta**  
Ethnic Identity, Electoral Democracy and Separatism: Deconstructing the Politics of Marginalization in North-east India

14:20-14:35 **Line Barkved, Susana Lopez-Aparicio, Harald Throne-Holst and Selamawit Molla Fossum**  
Sustainability and Responsibility in ICT-enabled urban environmental research and decision-making

14:35-14:50 **Espen Stabell and Daniel Steel**  
The precautionary principle and fair distribution

14:50-15:05 **Karsten Klint Jensen**  
Individual responsibility vs. the duty to coordinate

15:05-15:15 Joint questions and discussion

## **The Imperatives of Sustainable Development: Needs, Justice, and Limits**

Erling Holden, Western Norway University of Applied Sciences  
erling.holden@hvl.no

Kristin Linnerud, CICERO Center for International Climate and  
Environmental Research  
kristin.linnerud@cicero.uio.no

David Banister, School of Geography and the Environment, Oxford  
University  
david.banister@ouce.ox.ac.uk

### *Track A – Institutions, governance and ethics*

Sustainable development is a normative value system, on a par with human rights, democracy, and freedom (and it is closely interlinked with all those other normative systems). Thus, sustainable development is essentially a strong ethical statement that tells us what we should do. *Our Common Future* left no doubt about that: 'We have tried to show how human survival and well-being could depend on success in elevating sustainable development to a global ethic'. *Transforming Our World* pledges to foster 'an ethic of global citizenship'. Thus, any attempt to conceptualize or operationalize sustainable development must seriously consider these messages. The importance of putting ethical considerations at the heart of sustainable development was almost lost during the 1990s, however. This is now turning. In a lecture hosted by University of Oxford about how to tackle climate change, former Chief Economist at the World Bank, Nicholas Stern referred to 'an ethical turn' as to why we ought to act. This is true for tackling climate change, and it is equally true for achieving sustainable development.

The paper presents a five-step, normative model of sustainable development. The first step acknowledges that sustainable development is a normative value system, which consists of three moral imperatives: satisfying human needs, ensuring social justice, and respecting environmental limits. The second step presents relevant theories that give weight to those imperatives. The third step derives key

themes from those theories, including Sen's capability approach, Rawls' theory of justice, and the planetary boundary approach. The fourth step suggests headline indicators for each key theme. The fifth step assigns thresholds to the indicators and thus completes the model.

The six thresholds form a six-dimensional space within which we find the sustainable development space. Simply speaking, being inside the sustainable development space means that a country has achieved sustainable development, whereas being outside it means that a country is in an unsustainable state. Importantly, each country faces specific challenges in its pursuit of sustainable development. Thus, low-income countries face different challenges than high-income countries do; the former need to focus on increasing human development, whereas the latter need to focus on decreasing climate gas emissions.

The normative model is in conflict with the popular three-pillar model of sustainable development, which seeks to balance social, environmental, and economic targets. Rather, we argue that sustainable development constitutes a set of constraints on human behaviour. Moreover, we argue that economic growth is not one of the imperatives of sustainable development. Thus, economic growth is neither inherently sustainable nor inherently unsustainable. Likewise, we argue that deploying new technology is neither inherently sustainable nor inherently unsustainable. The paper ends with a critique of the UN's sustainable development goals.

## **The Potential of Co-Benefits in Climate Change Mitigation Strategy: An Opportunity for Environmental and Social Justice**

Rita Vasconcellos Oliveira, Programme for Applied Ethics and Department of Philosophy and Religious Studies, NTNU  
rita.bouman@ntnu.no

May Thorseth, Programme for Applied Ethics and Department of Philosophy and Religious Studies, NTNU  
may.thorseth@ntnu.no

Helge Brattebø, Industrial Ecology Programme and Department of Energy and Process Engineering, NTNU  
helge.brattebo@ntnu.no

*Track A – Institutions, governance and ethics*

Climate change mitigation policies can have associated other positive consequences besides greenhouse gases decrease which are known as co-benefits. By analyzing several examples of climate change mitigation actions, we establish that the co-benefits discourse is strongly influenced by utilitarianism. However, there are important, but disregarded limitations to utilitarianism when applied to co-benefits. We sustain that, in this context, they promote environmental and social inequality. We further argue that including a deontological perspective in the co-benefits discourse better guarantees the safeguard of dignity and respect for all individuals affected by the climate change mitigation actions. This integration creates also concrete opportunities for the life improvement of the worst-off. Finally, we discuss the potential, for scientists and politicians, to promote public understanding and approval of climate change mitigation strategies by including rights and moral obligations when considering the impacts and trade-off of co-benefits.

**Social sustainable development: the art of creating a better world – Redistribution versus institutional aid**

Hermann Køhn Sæther, Ph.D. candidate, Department of Philosophy and Religious studies and  
NTNU Sustainability, NTNU  
Hermann.sather@ntnu.no

*Track A – Institutions, governance and ethics*

One of the three pillars of Sustainable Development is concerned about the betterment of the social conditions in the world. Sustainable Development should ultimately deliver more fairness to the world. Although the modern world have enough resources and technical means to deliver a decent life

for every human being, millions of people are still struggling within the frame of harsh poverty.

In my talk, I will discuss the different aspects that together hamper the aim of social development and global fairness. It is no doubt a complex matter, and if one wants to take further steps towards more fairness, the problem has to be discussed in a broad way, both technically and morally. Such a broad approach is supported by the economist Kenneth Boulding. According to him, there exists no dichotomy between moral and instrumental concerns in political measures, such as development goals. The betterment of the social world is not solely driven by moral aims, is the claim of Boulding.

The starting point for the discussion will be the International Monetary Fund (IMF) and the World Bank (WB), the two most powerful development instruments of the world. The discussion will revolve around their understanding of the concept of “fairness”. For them, providing social fairness is concerned about giving poor and undeveloped countries the opportunity to prosper on their own. In practice, this means that the IMF and the WB want to help these nations through the implementation of a functioning and effective market economy. Fairness is therefore not about redistribution, in their regard. Further, I will present both technical critique of how they carry out their preferred development strategy *and* critique of their understanding of fairness.

First, IMF and WB is criticized by William Easterly for their policy implementation strategy. According to Easterly, the strategy of the institutions is best described as market economic shock-therapy. Such comprehensive reforms do not work in practice, Easterly asserts. Second, Joseph Stiglitz claims that the institutions are dishonest about their intentions. Their basic motive is not about helping the undeveloped nations, but rather about serving the interests of the rich and developed countries, Stiglitz claims. Third, some theoreticians believe that the market economic measures employed by the IMF and WB cannot provide lasting prosperity to the world as a whole. According to Yanis Varoufakis, the financial crash of 2008 removed the foundation that are necessary for continued global economic growth for good. Thus, one have to create a new path of

development through collaboration and planned trade operations between nations, Varoufakis continues.

Lastly, I will make use of the pragmatic approach to the problem presented by Kenneth Boulding and come up with suggestions for how the world can come closer to a fulfillment of the goals of sustainable development. In this regard, I will draw on the theories of Easterly, Stiglitz and Varoufakis and see if their stands can be merged with the strategy of the IMF and the WB.

### **Ethnic Identity, Electoral Democracy and Separatism: Deconstructing the Politics of Marginalization in North-east India**

Chandreyi Sengupta, Department of Geography, Jadavpur University, Kolkata. chandreyisengupta@gmail.com

Debajit Datta, Department of Geography, Jadavpur University, Kolkata debajit.geo@gmail.com

#### *Track A – Institutions, governance and ethics*

Policy failure or defective strategy at the governmental level is often found to be an underlying cause of economic unsustainability. The northern parts of West Bengal in India have been experiencing pervasive socioeconomic and political instability since the last three decades and are perfect examples of this phenomenon. This region has been beset with a multitude of identity conflicts since the last thirty years having their roots in land resource based confrontations among the various tribes, migrants and ethno-cultural communities. The Koch-Rajbanshi community is such an indigenous group of this region, thriving at the helm of this struggle along with other regional native tribes. They have faced severe marginalization primarily from Hindu Bengali immigrants in northern West Bengal and upper caste Assamese as well as the Bodo tribe in western Assam.

In the present paper, the key objective was to make an assessment of the role of various governmental policies and strategies in addressing the Koch-Rajbanshi identity conflict and the repercussions on the society and political economy of West Bengal. A hybrid framework of methods comprising participant observation, visual validation, videography of

personal interviews and political enactments, focus group discussions in consort with schedule-based surveys of government officials as well as members of Koch-Rajbanshi, other native tribal and Hindu Bengali communities had been applied in course of the study. These findings were synergized with secondary data sources and literary citing to obtain a comprehensive and nuanced understanding of this socio-political turmoil. Results highlighted that the bias of the erstwhile Leftist government (1977-2011) in favour of the immigrant Hindu Bengali community was a substantial factor in the disillusionment of the indigenous communities on the very necessity of the statehood of West Bengal. Despite being equipped with rudimentary agricultural technologies in comparison to the advanced immigrants, the native Koch-Rajbanshi community and other tribes did not receive any financial or infrastructural support from the then government. They lost their lands, socio-political hegemony and even their ethno-cultural identities to the Hindu Bengali community and were gradually transformed into second order citizens in what was their homeland. The Koch-Rajbanshi populace continued to be deprived of socioeconomic advantages even after the political regime change in West Bengal in 2011. Findings indicated that the attitude of the present government of West Bengal towards the conflict was a combination of pacification as well as retaliation. This government was observed to confer short-term benefits such as monetary aids to the poverty-stricken rural population. However, no concrete long-term effort to salvage the indigenous communities from the economic and identity crisis was observed. The study also revealed that supporters of the identity movement were often threatened verbally as well as physically by members of the ruling party. Such insensitivity towards the indigenous population served as an impetus for the movement and fuelled it further. Under such circumstances, a sustainable socioeconomic and political situation in northern West Bengal shall remain unattainable unless comprehensive long-term development policies are undertaken in favour of the indigenous communities of the region.

### **Sustainability and Responsibility in ICT-enabled urban environmental research and decision-making**

Line Barkved, NIVA  
line.barkved@niva.no

Susana Lopez-Aparicio, NILU  
sla@nilu.no

Harald Throne-Holst, SIFO  
Harald.Throne-Holst@sifo.hioa.no

Selamawit Molla Fossum, IFI-UiO  
selamawm@ifi.uio.no

### *Track A – Institutions, governance and ethics*

#### Introduction

Environmental research is per definition about tackling challenging environmental issues. Yet, reaching the goals set by the 2030 Agenda for Sustainable Development depends on a holistic and interdisciplinary consideration across environmental, social and economic systems. Furthermore, with an increasing digitalization and use of information and communication technologies (ICTs) in all aspects of our lives, ICT is now “everybody’s business”. This introduces new opportunities in environmental research, ways of working and methods like crowdsourcing, online co-creation and public participation GIS. However, new opportunities bring also new challenges and responsibilities within research. Potentially conflicting interests are for instance the responsibility of protecting the rights of the individuals along with the importance of achieving common and collective goals needed for transformation towards sustainable urban systems. Within the research agenda, the framework of Responsible Research and Innovation (RRI) has developed over the last years. Yet, there is still a call for making the concept of RRI more operational and applicable. Research must reflect awareness and incorporation of the interactions, feedbacks and overlaps between the various dimensions and actors (e.g. society, decision makers, citizens, researchers). A systems approach, including working across disciplines and sector boundaries, is, therefore crucial.

#### Methodology and Outcomes

Our study combines theoretical and conceptual deliberations with an empirical case work to address the following issues:

How do considerations of sustainability and responsible research and innovation (RRI) relate to each other in practical terms?

How can a joint consideration of sustainability, including the sustainable development goals, and principles of RRI enable positive impact and systemic change in urban systems?

How can researchers working with ICT-enabled methodologies establish practices and collaborations essential for the implementation of both sustainability and RRI strategies?

We present findings that support the need of looking at urban sustainability and RRI in a joint manner. We combine the theoretical base with empirical work in the ongoing activities within the research project iResponse (<http://iresponse-rri.com/>, 2015-18) on social responsible crowdsourcing for environmental research and decision-making in the urban environment funded by the Norwegian Research Council’s program “SAMANSVAR” on RRI in ICT.

The outcomes from the literature review on how the concepts of sustainability and RRI are applied within urban environmental research is presented and evaluated in the context of sustainable urban systems. In the context of usability of ICT-based crowdsourcing tools in environmental research and subsequently in the decision-making process, empirical material is developed through interviews and joint stakeholder workshops, as well as survey data. We present the outcomes from the reflection and lessons learned on how the RRI aspects, i.e. engagement, anticipation, reflection, social relevance, have been applied and operationalized during the process and how the project activities are situated within the urban sustainability agenda.

#### **The Precautionary Principle and Fair Distribution**

Espen Stabell, NTNU  
espen.d.stabell@ntnu.no

Daniel Steel, University of British Columbia  
daniel.steel@ubc.ca

*Track A – Institutions, governance and ethics*

The current paper explores how costs from taking precautionary measures should be distributed among parties involved in activities and processes where a precautionary approach to environmental risk is to be adopted. At first glance, the question of who should bear the economic burden of taking precautions may seem trivial in comparison to the question of the environmental and social costs of *not* taking precautions against environmental threats. In fact, however, these questions are closely connected. For, besides the fact that unfair distributions are morally problematic, they may also be problematic from a pragmatic point of view, since distributions that are perceived to be unfair are less likely to be accepted by the parties involved. Nevertheless, distributional concerns are not much expressed in existing formulations, guidelines and discussions of the precautionary principle. As a consequence, it is not clear how distributional concerns are to be taken into account. The current paper undertakes to develop a conceptual framework for the distribution of costs from taking precautions. It does this by tracing a set of distributional principles and discussing their rationale in relation to philosophical theories of justice. A case study of so-called deep sea mining is conducted to investigate how the framework can be applied in concrete cases.

**Individual responsibility vs. the duty to coordinate**

Karsten Klint Jensen, Umeå University  
karsten.jensen@umu.se

*Track A – Institutions, governance and ethics*

It seems important to justify that each individual has an unconditional duty to reduce his or her emission of greenhouse gases. Otherwise it would appear that an individual does nothing wrong by continuing to emit. A few philosophers have tried to demonstrate that. However, it is implicitly assumed that the choice is either to reduce or not. But how much should an individual reduce? And is it not likely to be very cost inefficient if each individual decide on its own how to reduce?

It seems very odd if there is not a duty for each individual to try to coordinate the efforts in reducing emissions. However, the literature on the ethics of coordination is unfortunately rather sparse. Taking departure from sketches by Parfit and Regan I shall suggest some preliminary guidelines and discuss how the duty to coordinate relates to one's responsibility as an individual agent.



## **Track B Smart & sustainable city services**

### **Urban Europe Research Alliance Workshop –**

#### **Urban transition: Windows for opportunity for an improved science-policy interface**

**Moderator: Judith Borsboom-van Beurden, Senior Researcher, Dept. of Architecture and Planning, NTNU**

**Room: SPACE 2**

Urban Europe Research Alliance (UERA) is one of the key initiatives of JPI Urban Europe. It connects nearly a hundred knowledge institutes and research organisations across Europe with a specific focus on urban challenges. Smart and sustainable cities are at the heart of this research. The NTNU Sustainability Science Conference focuses on transition to sustainable systems. To reach the Sustainable Development Goals and the Paris Agreement, the three dimensions of sustainable development – economic, environmental and social – must be considered holistically. The conference is a platform to share evidence-based research for sustainable decision-making.

Currently, many cities are experimenting in pilot projects and living labs with methods and technologies bringing about urban sustainability. For example electrification of urban transport, deep energy-efficient renovation of neighbourhoods, and closing local resource cycles. However, it is a big challenge for urban stakeholders to come from this urban acupuncture to real urban transition. What are the barriers preventing this transition? How can science help to achieve a breakthrough, for example by helping to identify the most promising options and assess their broad impact on environment and sustainability? How can the interface between science and policy be improved in order to foster upscaling and replication, and to deliver the desired transition of urban areas?

As part of NTNU's Sustainability Science Conference, a special session is organised by Urban Europe Research Alliance on the topic of urban transition and the windows of opportunity for an improved science-policy interface. Isidoros Ziogou and Theodoros Zachariadis will present their abstract, "Analysis of the implementation of green roof technology in the residential building sector of Cyprus."

The session will also brainstorm on different aspects of the urban transition and translate these into first ideas for a COST Action, bringing together European researchers with a key interest in urban transition towards smart and sustainable cities. Fostering of such networks can help to build a better evidence base for policy makers but also prepare the ground for new research proposals and operationalisation of JPI Urban Europe's Strategic Research and Innovation Agenda.

### **Analysis of the implementation of green roof technology in the residential building sector of Cyprus**

Isidoros Ziogou, Department of Environmental Science and Technology, Cyprus University of Technology  
isidoros.ziogou@cut.ac.cy

Apostolos Michopoulos, Department of Environmental Science and Technology, Cyprus University of Technology  
a.michopoulos@cut.ac.cy

Vasiliki Voulgari, Department of Environmental Science and Technology, Cyprus University of Technology  
vvoulgar@hotmail.com

Theodoros Zachariadis, Department of Environmental Science and Technology, Cyprus University of Technology  
t.zachariadis@cut.ac.cy

#### *Track B – Smart and sustainable city services*

The increasing concentration of people in cities around the world alters the local landscape and has a clear environmental impact. The building sector, which directly accounts for a 3% increase in total annual anthropogenic greenhouse gas emissions, along with other energy consuming human activities, has an increasing impact on the climate stress. In order to efficiently mitigate the impact of buildings that affects the well-being of citizens, many techniques have been employed so far, with green roofs being one of them.

This study focuses both on the possible energy conservation and sustainability related aspects of two alternative green roof solutions applied to typical single-family and multi-family buildings in representative climatic areas of Cyprus, under various building thermal insulation scenarios. Attention was given to the selection of native plants, the use of conservative irrigation regimes, and exploitation of recycled urban resources (rubber crumbs and waste compost).

The necessary simulations regarding the buildings' energy demand were conducted using EnergyPlus software. Based on these results and using an in-house developed algorithm, the primary energy consumption for each alternative solution was calculated on an hourly basis, utilizing an air-to-air split type heat pump system. The environmental analysis related to carbon dioxide (CO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>) and sulphur dioxide (SO<sub>2</sub>) was performed by taking into account the emissions related to energy use. Moreover, the economic viability of the proposed green roof solutions was considered for an economic lifetime of 30 years, attempting to encompass the initial construction cost, the annual energy and maintenance costs, and the environmental cost in terms of CO<sub>2</sub> and local pollutants reduction potential.

The proposed green roof solutions offer great energy and environmental benefits. Cooling and heating primary energy consumption is substantially reduced, as well as the net emissions. Regarding the economic feasibility of these green roofs, more monetary incentives should be given in order to make them more cost-effective. In addition, a broader application of green roofs could positively affect the micro-climate in urban neighborhoods; this would contribute to the enhancement of urban resilience to climate change and lead to major extra environmental and economic gains.

The results of this study could assist the central governmental and municipal authorities in order to elaborate sustainable green interventions applied to the residential building sector and establish environmental urban policy schemes for the years after 2020.





## Track C Biodiversity & ecosystem services

### Workshop – National ecosystem assessments:

*Biodiversity and ecosystem services assessments for facilitation of political awareness, management and sustainable development*

**Room: LIVING4**

Assessment of biodiversity and ecosystem services is a key component for strengthening the science-policy interface for sustainable use and conservation of resources. However, good assessments of biodiversity and ecosystem services are often lacking, hampering management and political awareness as well as scientific advances in the field of biodiversity and ecosystem services research. In this workshop, we want to involve researchers, managers and other stakeholders for discussing the framework for National Ecosystem Assessments (NEA) and draw on the experiences from the NEA from France, Portugal and Spain.

Some discussion questions:

- (1) How to organize an assessment, what is the main focus (specific nature types, sectors, challenges) and constraints? How to get access to relevant data, and who should be involved (research community, stakeholders)?
- (2) What type of impact/implications should the assessment have/ are you hoping for: policy, management, research agenda?
- (3) Which type of follow up actions could be relevant?



## Track D Business models for sustainability

### Abstract session 3 – *Organizational aspects and motivation*

Room: Room: COSMOS 3A

Moderator: Fritz Balkau, International Advisor, Sustainable Solutions, Paris

13:15-13:20	Session Introduction
13:20-13:40	<b>Hanna Lindén, Henrikke Baumann and Andreas Diedrich</b> Translating environmental life cycle management through an organization
13:40-14:00	<b>Rodrigo Lozano and Robin Von Haartman</b> Analysing the importance and influence of sustainability drivers in organisations
14:00-14:20	<b>Barbro Elisabeth Fjørtoft, Richard Glavee-Geo and Siv Marina Flø Grimstad</b> Corporate Social Responsibility: What are the motivations for a particular CSR activity?
14:20-14:40	<b>Karianne Olsen, Linn Ornum, Martin Fauske Tho and Arild Aspelund</b> Entering a Brave New World – Market Entry into a Born Global Industry
14:40-15:00	<b>Satu Lähteenoja, Tyyra Linko, Roope Mokka, Mika Kuisma and Armi Temmes</b> Bees and Trees - a novel way for large companies and startups to co-create sustainable innovation
15:00-15:15	Joint questions and discussion

## Translating environmental life cycle management through an organization

Hanna Nilsson-Lindén, PhD candidate, Environmental Systems Analysis, Chalmers University of Technology  
hanna.linden@chalmers.se

Henrikke Baumann, Associate Professor, Environmental Systems Analysis, Chalmers University of Technology  
henrikke.baumann@chalmers.se

Andreas Diedrich, Associate Professor, Gothenburg Research Institute, School of Business, Economics and Law, University of Gothenburg  
andreas.diedrich@gri.gu.se

### *Track D – Business models for sustainability*

Introduction: The business logic of corporations working with environmental management has traditionally focused on corporate in-house aspects of environmental issues. Some corporations are extending this focus towards all stages of a product life cycle, referred to as environmental life cycle management (LCM) (Hunkeler et al., 2003; Baumann and Tillman, 2004; Poikkimäki, 2006). But research describing LCM integration is rare (Seuring, 2004; Vermeulen and Seuring, 2009) and often fails to describe difficulties of organizing LCM in practice (Nilsson-Lindén et al., 2014). In this paper, we explore the processes of integrating LCM into an organization, using a model of translation (Czarniawska and Sevón, 1996). The traditional diffusion theory of innovation imply that an idea diffuses through an organization with the help only of the attractiveness of the idea itself. This is not reflected in our study, instead we have seen a process of change, where change is a result of the actions of many. Thereby, it is useful to apply the translation model, as another theory for the study of innovation, in order to gain improved understanding of LCM practice.

Methods: Using interviews, observations and documents, we studied how the idea of life cycle thinking (LCT) traveled in a multinational

manufacturing corporation, and how it was translated into practice in two settings: the sustainability and the purchasing departments.

Results: An idea of LCT was picked up when a development unit started using life cycle assessment (LCA) to calculate environmental burden along product life cycles. LCT then got picked up at the Sustainability Department and translated into LCM as new concepts, policies, and practices developed, e.g. the development of a green business portfolio. Here, LCT influenced environmental management from being corporate-oriented to product chain oriented (LCM). Members of the Sustainability Department enacted these ideas and practices with the ambition to spread the idea of LCM into the different departments. At the Purchasing Department, another translation process instead took place, picking up sustainability with LCT elements from standards and regulation. Here, the translation process put focus on the upstream supply chain—the context in which purchasing operates.

Discussion and Conclusion: LCM became the ambition of the organization, but the translation processes in different departments were not in sync. We found different varieties of the life cycle idea, picked up from different sources. The ambition was to spread a business idea of LCM in the organization, but in the Purchasing Department only upstream sustainability management was in focus, thus differentiating from LCM with business discussions based in the full product chain. Drawing on translation theory, we suggest that practitioners need to go beyond LCM *implementation* and *diffusion*, to engage actively in understanding interpretations and translations of LCM elsewhere in the organization. Cross-departmental collaboration is one way to enhance practitioners understanding for how sustainability-related issues provides opportunities or challenges for different parts of the organization and thus a way to strengthen LCM uptake in the organization.

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### **Analysing the importance and influence of sustainability drivers in organisations**

Rodrigo Lozano, University of Gävle and Organisational Sustainability, Ltd.  
rodrigo.lozano@hig.se; rodlozano@org-sustainability.com

Robin von Haartman, University of Gävle  
Robin.vonHaartman@hig.se

#### *Track D – Business models for sustainability*

Organisations are an integral part of modern societies, and part of a larger environmental system. Although a number of drivers have been recognised for different organisations. There has been limited research comparing the drivers between organisations, and analysing which drivers have are considered to be the most important. A survey was sent to more than 1000 organisations (companies, education institutions, and public agencies) to analyse sustainability drivers, of which 166 responded. The survey assessed eight internal drivers, six connecting ones, and twelve external

ones. The responses were analysed using descriptive statistics and rankings of sustainability drivers together with Friedman, Kruskal-Wallis and Mann-Whitney U tests. The analysis shows that the most important drivers tend to be internal such as proactive leadership and a sense of moral obligations, whereas external drivers are less prominent. The analysis also indicates that internal drivers are significantly more highly ranked among private enterprises, whereas some external drivers such as increased (external) levels of social awareness and national/regional policies has significantly more impact on public agencies. The research highlights that it is important to recognise which drivers have the highest importance and influence for each type of organisation, in order to foster them and make organisations more sustainable.

### **Corporate Social Responsibility: What are the motivations for a particular CSR activity?**

Barbro Elisabeth Fjørtoft, Department of International Business, NTNU  
barbro.e.fjortoft@ntnu.no

Richard Glavee-Geo, Department of International Business, NTNU  
rigl@ntnu.no

Siv Marina Flø Grimstad, Department of International Business, NTNU  
sika@ntnu.no

#### *Track D – Business models for sustainability*

Introduction: CSR has received increasing attention in the last few decades from both academics and businesses. The general awareness in society of CSR combined with the complexities of globalization has made CSR a topic of high interest and importance. The purpose of this paper is to explore the nature of CSR in the maritime industry in Møre and Romsdal (M&R) and to investigate the relationship between firm's motivation for particular CSR activities.

Methods: The study used multiple/mixed methods involving in-depth interviews and an online survey of 65 informants from M&R maritime

cluster. The interviews helped in getting a better understanding and knowledge of the maritime industry regarding CSR and provided very useful insight into the quantitative study. SmartPLS was used in analyzing the survey data in view of the small sample size.

Results and discussion: The qualitative study shows the difficulty in use of the right terminology for CSR. The word 'samfunnsansvar' and 'bedriftens sosiale ansvar' seems to be used interchangeably to refer to CSR. Findings show increased focus on social issues at both the workplace and the community level, 'fueled' primarily by legal regulations. Focus on the environment and safety are regarded as highly relevant CSR themes in the maritime industry. Additionally, sponsorship was mentioned to be an important CSR issue. Interestingly, since most SMEs in the cluster are family owned, the owners strongly influence company's CSR vision. Management's role is to be able to execute the CSR vision of the company. Using stakeholder theory, with a focus on suppliers, environment, customers, employees and the community the paper shows that firms in M&R have differing motivations for embarking on CSR. Firms in the maritime industry are highly motivated by extrinsic considerations for embarking on CSR activities geared towards suppliers and the environment while intrinsic considerations explains firms' CSR focus on the community, customers and employees. We controlled for the level of internationalization, global sourcing, firm's size and turnover. Turnover is highly related to intrinsic motivation and the community; but weakly related to extrinsic motivation, and the environment. Firms with higher level of internationalization also tend to place more emphasis on the environment. Hence, customers, suppliers, employees and the community are important stakeholder groups, which explains the close relationships and networking within the maritime cluster.

Conclusion: CSR vision and mission determines how the companies engage with employees, the community and the environment. The firms engage in a particular CSR activity because of differing motivations for doing so. The dwindling international oil price and its impact on businesses in the cluster means that the SMEs should take advantage of contemporary new business models with a focus on smart technology, digitalization, efficient production systems and renewable energy sources in order to be competitive and sustainable.

## **Entering a Brave New World – Market Entry into a Born Global Industry**

Karianne Olsen, Department for Industrial Economics and Technology Management, NTNU

Linn Ornum, Department for Industrial Economics and Technology Management, NTNU

Martin Tho, Department for Industrial Economics and Technology Management, NTNU

Arild Aspelund, Department for Industrial Economics and Technology Management, NTNU  
arild.aspelund@iot.ntnu.no

### *Track D - Business models for sustainability*

Climate change and population growth spur the need for a green energy transition. This has also spurred a lot of research on why and how firms enter new emerging renewable energy industries in order to understand how a green transition can be facilitated and accomplished more rapidly.

In earlier research, the emerging offshore renewables sector has been classified as a Born Global industry (Løvdaal and Aspelund 2011, 2012). As such, this industry has certain characteristics that shapes the competitive landscape and the strategic behavior of firms that seeks to enter it. More specifically for the offshore wind industry, these characteristics are instant internationalization, capital intensity, high project complexity, long cycles and significant business uncertainty related to technical solutions and market offerings, market development and governmental subsidies.

This study contributes by providing new insight on how these characteristics shape firm entry into new and emerging international industries. We have adopted a qualitative multi-case research approach targeting six Norwegian companies in the offshore wind industry. Cases were selected through convenience sampling to obtain a stratified and heterogeneous sample with both new and established firms along the supply chain. We collected data from public sources related to the industry

and each case company and through interviews with top management of the case companies.

The study's main findings are threefold. First, we identify a strong relationship between sources of financing and timing of entry. Due to the immaturity of the industry, several sources of financing (such as banks) are not available for actors that seeks entry. Hence, unless significant private equity is available, entry will be delayed until suitable funding can be found. Second, the immaturity of the industry increases value of relevant business networks. More specifically, since formal arenas and channels of communication are not established, relevant business information flows are limited, incomplete and asymmetrical. Hence, informal arenas and social relationships becomes more important and more valuable. Third, due to the immaturity of the industry there is no established standard or industry norms when it comes to size and content of contracts down the supply chain. This has led to great heterogeneity and flexibility in partnerships and business models among suppliers. Hence, what is deemed to be appropriate 'whole product' packages differs from project to project, and actors need to be flexible in their partnering strategies and business models in order to accommodate to the varying requirements of the project owner. However, the tendency of flexibility in business models and partnerships is negatively moderated the availability of private equity. Actors that are more resourceful prefer to avoid it in order to increase the efficiency of the use of their own resources and capacity.

The study contributes with increased theoretical understanding of market entry into emerging international industries. Implications for practitioners and policy are discussed.

### **Bees and Trees - a novel way for large companies and startups to co-create sustainable innovation**

Lähteenoja Satu, Head of Resource Smart Economy, Demos Helsinki  
satu.lahteenoja@demoshelsinki.fi

Linko Tyyra, Research assistant, University of Helsinki  
tyyra.linko@helsinki.fi

Mokka Roope, Founder, Demos Helsinki  
roope.mokka@demoshelsinki.fi

Kuisma Mika, Senior researcher, Aalto University  
mika.kuisma@aalto.fi  
Temmes Armi, Professor of Practice, Corporate Sustainability, Aalto University  
armi.temmes@aalto.fi

### *Track D – Business models for sustainability*

To solve the most burning challenges related to climate change and use of natural resources, we need radically new products, services, and business models. Strategic partnerships are necessary for the co-creation and development of groundbreaking products and services. This need is particularly relevant in the field of consumer cleantech, which refers to new consumer targeted products and services related to food, housing, mobility and energy. In these sectors radical changes in consumer behaviour are expected to cause systemic changes. Bees and Trees project is studying the most optimal ways for large companies and startups to organise strategic collaboration that aims to foster innovation in consumer cleantech sector. This paper describes the lessons learned from four strategic business experiments between large companies ("trees") and startups ("bees").

Small companies and startups are known to initiate industry transformation, but often lack the resources and/or knowhow for broad implementation. Incumbents, on the other hand, tend to be more path dependent and may not be able to change their business models. Especially large corporations in traditional industries such as construction, real-estate or retail may find it challenging to adopt radical sustainability-oriented innovations. Combining the greater innovation-capacity and flexibility of new entrants and the resources and downstream complementary assets of incumbents, it is possible to mobilize cleantech-related ideas through co-creation and alliance-based business models better than through individual action.

The paper is based on action research carried through facilitating four business experiments as well as interviews with the companies involved. The large companies in the project include Finland's biggest retail and hospitality business, energy and space maintenance service providers and a real estate development company. The small companies develop radically new services and innovations that reduce food waste, save energy or nudge people to change their behavior. The first business experiments were carried out during the spring and summer 2017.

Provisionally, we present four different types of business collaboration experiments: (1) fast experimentation of a service innovation between a startup and a large company, (2) experimentation with a co-created solution to a mutual client, (3) experimentation with a solution, which requires technical changes in building infrastructure, and (4) long-term experimentation to scale the startups solution more widely and achieve a cultural change in a giant corporation. Based on the lessons learned, we present a preliminary model for successful Bees and Trees partnerships, which include aspects like matchmaking, early trust building, equal co-creation, agreement of common targets, lean experimenting and the role of intermediate organisation to facilitate the partnership development. For trees, the value of experimenting comes from testing new innovative, sustainable business models. The bees get access to customers and possibility to scale up faster.

# PARALLEL SESSION 4 SCHEDULE



## Track A Institutions, governance & ethics

### Abstract session 4 – Policy, economics, innovation

Room: Room: COSMOS 1&2

Moderator: Pia Otte, Senior Researcher, Centre for Rural Research (Bygdeforskning)

09:00-09:05	Session introduction
09:05-09:20	<b>Marius Korsnes</b> A Social Sustainability Revolution?
09:20-09:35	<b>Johannes Mikkonen</b> Scenarios for the hyperconnected Nordic Society 2040
09:35-09:50	<b>Jan Froestad</b> Energy and the Anthropocene: Security Challenges and Solutions
09:50-10:05	<b>Jens Viliam Hoff and Martin Møller Boje Rasmussen</b> Barriers and opportunities in developing and implementing the Green GDP
10:05-10:20	<b>Maryse Chappin, Joost Koch and Marko Hekkert</b> Innovation policy and network evolution: the case of the Dutch sustainable energy systems
10:20-10:30	Joint questions and discussion



## **A Social Sustainability Revolution?**

Marius Korsnes, Department of Interdisciplinary Studies of Culture, NTNU  
marius.korsnes@ntnu.no

*Track A – Institutions, governance and ethics*

Looking at the total amount of resources that humans use on Earth, as well as the alarming pace with which we are getting closer to having passed the 1.5°C warming threshold, a 'revolution' might be an option to avoid dystopia. Entertaining this idea for a moment, this paper employs the 'method of agreement' (Moses and Knutsen, 2007) and reviews two types of literature. First, drawing on the work of Skocpol (1979) and more recent theorizing of the 'Arab Spring', it reviews social revolutions and springs of the past in order to identify common features that caused these in their various localities. Second, it reviews current literature on sustainability transitions and social change (e.g. Markard et al. 2012) and aims to identify what this literature appears to recommend to achieve 'transitions'. The paper then compares and contrasts these diverging approaches in order to contribute two things: First, it provides a more strict definition of the word 'revolution' by showing that it cannot be used to describe what is happening in today's green movement (as e.g. Burns, 2012 claims). Rather, large-scale change is perhaps more likely to take place outside or at least alongside the realm of this 'green movement'. Second, by describing more in detail the way in which revolutions and 'springs' have come about in the past, and how 'sustainability transition' is theorized today, the paper discusses the likelihood of large-scale sustainability-related change today and in the immediate future.

## **Scenarios for the hyperconnected Nordic Society 2040**

Johannes Mikkonen, Demos Helsinki  
johannes.mikkonen@demoshelsinki.fi

*Track A – Institutions, governance and ethics*

Technologies that combine physical and digital realms are emerging (Vermesan & Friess 2013). This doesn't mean that the Internet will be everywhere. It means that the physical and the virtual world will collide, come together, and exchange qualities. Digital will become physical as much as physical becomes digital. That development can be called hyperconnectivity.

Hyperconnectivity refers to the development, where people and businesses can communicate with each other instantly, and where machines are equally interconnected with each other. Unlike technological terms for the current technological development such as Internet of Things, hyperconnectivity is more applicable to describe how technology change our relationship to the physical world and our relationships with other people, affecting communities, societies, and economies. Hyperconnectivity is introducing new opportunities but also new challenges and risks in terms of individual rights and privacy, security, the flow of personal data, and access to information (Dutta & Bilbao-Osario 2012).

This paper explains the current tension developments that have an uncertain outcome. In order to achieve the goals of sustainable development, it is crucial, how those tensions are solved. The paper investigates how by emphasizing Nordic values of trust, respectfulness, and collaboration and by making conscious choices when regulating, developing, and using hyperconnected technologies the tensions can be solved leading to two different scenarios of hyperconnected planet.

The most important current tensions are: 1) Tension on limited resources: Well-being versus planetary boundaries 2) Tension on equity and capabilities: Participation versus control 3) Tension on new economic systems: Converging markets versus fragmenting structures 4) Tension on subsistence: Liberation from work versus the end of work 5) Tension on values: Liberties versus security (Anttila et al. 2015). Demos Helsinki has formulated scenarios in strategic research opening Naked approach. Scenarios are based on multiple workshops, expert interviews, and previous research on megatrends (Annala et al 2015).

## LITERATURE

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### **Energy and the Anthropocene: Security Challenges and Solutions**

Jan Froestad, University of Bergen  
jan.froestad@uib.no

Clifford Shearing

*Track A – Institutions, governance and ethics*

This paper explores the crucial role that energy production has played in reshaping earth systems in ways that have undermined the ecological services upon which homo sapiens, along with many other biophysical

beings, have depended for their survival as earthlings. For humans, the pursuit of well-being, and indeed the realisation of human well-being, has been inextricably linked to forms of energy that have enabled us to move beyond the energy outputs of our biophysical bodies. These energy enrolments have changed significantly over time and across space. With each significant shift in enrolments there has been a shift in human ways of being, and in the social worlds that these ways of being have enabled.

A central feature of energy enrolments, through most of human existence, has been the release of stored energy through burning. This release - for example the energy of organic materials (recently stored sunlight) by fire - has been enormously consequential for human lives and for the planet. We humans have built our societies on successive fire regimes. Our societies have been built on fire. Understanding this linkage between fire and human societies provides a key to understanding a deep history that underlies the Anthropocene and, at the same time, provides guidance to how humans might cope with the unintended consequences of our pyrogenic proclivities. The discovery and use of fossil-fuel – stored “ancient sunlight” – to drive machinery gave birth both to the industrial revolution and to the associated belief that fossil fuels provided humans with unlimited access to vast, and endless, reserves of stored energy that could be enrolled to fuel ever-expanding energy demands. With growing concerns for global warming and a looming global environmental crisis this framing has been increasingly contested.

The paper explores the various ways in which energy security have been perceived in the Holocene. There are lessons to be learned from each of these understandings. Our conclusion will be, however, that each is insufficient to cope with the realities of the Anthropocene. This conclusion provides a point of departure for an exploration of human civilizations as founded upon ever more energy-rich fire regimes. We argue that these developments have placed us in an entropy trap from which the principal, and indeed the only, solution is a radical energy transition. Electricity we argue provides an escape route towards a sustainable energetic foundation upon which to build the next generation of industrial societies. We argue further that for this escape route to be realized it is not enough to produce clean electric power from renewable energy sources as “adds on” to the current energetic regime. Only a radical electrification of our industrial

society, based on a decentralized, modular “green” energy infrastructure, will enable us to realize our escape. We conclude with a consideration of the socio-political opportunities and challenges that this electrification pathway presents and what progress has been realized in moving along it.

### **Barriers and opportunities in developing and implementing the Green GDP**

Jens V. Hoff, University of Copenhagen  
jh@ifs.ku.dk

Martin M. B. Rasmussen, University of Copenhagen  
mbr@ifs.ku.dk

#### *Track A – Institutions, Governance and Ethics*

The purpose of this paper is to describe and analyze the transition from a warfare and welfare GDP to an “Green GDP”; the ideas, institutions and actors involved in this process, and the barriers to introducing environmental considerations in measures of social welfare. This in order to identify a possible pathway to making the green GDP a dominant measure of social welfare, and to use the current confluent crises as a windows of opportunity to make this happen. The most dominant and influential economic metric across the world is probably the GDP (gross domestic product.) Developed during the 1930’s to measure national it was transformed during WWII to allow policy- and decision makers to gauge the relative domestic warfare-capacity, armaments-production and the availability of able-bodied men. In the postwar-era it has preserved its focus on production volume, and remained a core economic metric among the developed, capitalist countries a.o. underpinning the establishment of welfare states. However already from the very beginning, the metric was problematized as a relevant or even accurate measure of societal economic performance, wealth or well-being. In recent years, such criticisms have re-emerged focusing a.o. on the metrics lacking ability to incorporate negative environmental externalities. Among multilateral organizations strong calls have been made to move “beyond GDP” i.e. to

develop and implement new metrics of societal economic performance, that better capture and encompass intuitions about “successful societies” (e.g. the UN SDG process, the EU “Beyond GDP” initiative, World Bank WAVES project, the Stiglitz-Commission) In analyzing this development, we will revisit James Mahoney and Kathleen Thelen’s theory of institutional change. Building upon their concepts of ‘displacement’, ‘conversion’ and ‘layering’ and Kingdon’s concept of ‘window of opportunity’ this paper will aim to, first, describe how the “warfare”-GDP in the post-war period was “converted” into a “welfare”-GDP- concept; second, describe how multilateral organizations and governments in recent years have attempted to both “layer” new metrics of green GDP upon existing GDPmetrics or even “displace” old GDP’s with green GDP, third. contrast and compare the two processes of institutional change in order to understand what the barriers are for a wider adoption of the green GDP, and finally, identify if and how the current confluent crises create a “window of opportunity” for an extended use of the green GDP. As such the paper constitutes an attempt to situate and address the core question of the research track Institutions, Governance and Ethics – i.e. how to achieve a sustainable transition – within the theoretical framework provided by recent new institutionalist scholarship on the actors, barriers and opportunities involved in long-term processes of incremental institutional change.

### **Innovation policy and network evolution: the case of the Dutch sustainable energy systems**

Maryse Chappin, Innovation Studies, Copernicus Institute of Sustainable Development, Utrecht University  
m.m.h.chappin@uu.nl

Joost Koch, Netherlands Enterprise Agency  
joost.koch@rvo.nl

Marko Hekkert, Innovation Studies, Copernicus Institute of Sustainable Development, Utrecht University  
m.p.hekkert@uu.nl

### *Track A – Institutions, governance and ethics*

The transition to sustainability requires innovation. Central in innovation and technology development is the idea of accumulation and that it seldom happens in isolation. Innovation policy often aims to stimulate interaction and collaboration between actors. Since organizations take part in multiple projects, innovation networks emerge. These networks might enable the accumulation of knowledge. It is, however, not known to what extent these policy measures indeed result in a network and how these networks evolve and accumulate

over time. Moreover, it is not obvious how one should analyze this accumulation. Especially, since “normal” network measures will only provide a limited understanding of the accumulation. In this paper we focus on the energy innovation policy in the Netherlands for the period 2003 until 2013. In that period three policy agendas were relevant: the energy research strategy, the energy transition policy and the top sector energy policy. Our research question is: how do innovation networks in the Dutch energy system evolve and accumulate?

We collected data for all innovation projects (~1500) that were granted within the different agendas. We focus on three most important sustainable energy systems for the Netherlands: solar energy, wind energy and biofuels. For each project we also classified the innovation stage: research, development, or demonstration. This resulted in a project database that enabled us to construct yearly networks for each of the energy systems (solar, wind and biofuels) and each innovation stage.

The first analysis step was to provide descriptives and common network measures (e.g. density). This enabled us to describe how the networks evolved over time, but not to understand the accumulation.

The next step was our in-depth study. We analyzed which organizations are prominent in the networks by analyzing who is present in the networks over the years (stable core) as well as in different innovation stages (brokers). The results show that for none of the energy systems there are actors that are present in all stages and in all years. The majority of the actors only participates in one or a few projects and is only present in one of the

innovation stages. For all energy systems we observed small stable cores (of 2 to 4 actors) for the research networks.

For solar there is a relative big stable core (of fourteen actors, mainly firms) in the demonstration networks

The number of brokers differs for the energy systems: for solar six actors connect different innovation stages, for wind four organizations, and for biofuels eighteen organizations broker.

We can conclude that “normal” network measures are less relevant to understand the accumulation. Our alternative in-depth network analysis showed to what extent for the current energy innovation policy induced networks accumulation took place. Nor for solar, wind or biofuels there were actors present in all stages and years. Nevertheless for all three sustainable energy systems we identified some stable cores and brokers. These might enable the accumulation of knowledge necessary to achieve a sustainable transition. This might be relevant to consider while developing future energy innovation policy.



**Track B Smart & sustainable city services**  
**Abstract session 4 – *Sensor-based solutions***

**Room: Room: SPACE 3**

**Moderator: John Krogstie, Professor, Dept. of Computer Science, NTNU**

09:00-09:05 Session introduction

09:05-09:20 **Hai-Ying Liu and Sonja Grossberndt**  
Collective air quality awareness platform for sustainability and social innovation – the hackAIR approach in Norway

09:20-09:35 **Dirk Ahlers, Patrick Driscoll and John Krogstie**  
Urban Emission and Greenhouse Gas Monitoring: Multidisciplinary Technical and Organizational Considerations

09:35-09:50 **Susana Lopez-Aparicio, Matthias Vogt, Matt Pierce and Philipp Schneider**  
The application of Web-crawling in urban environmental research: a pilot study on emissions from residential wood burning

09:50-10:05 **Nathalie Labonnote, Edvard Sivertsen and Berit Time**  
The use of flood and stormwater data in Norway: review and recommendations

10:05-10:20 **Monika Heyder, Fabrice Casciani, Lydiane Philippe, Gwenaelle Becker, Stephanie Zaba, Thomas Lacroix and Christine Malé**  
Modélisation Urbaine Gerland: enhancing integrated urban planning by a model base approach in Lyon

10:20-10:30 Joint questions and discussion

## **Collective air quality awareness platform for sustainability and social innovation – the hackAIR approach in Norway**

Hai-Ying Liu, NILU – Norwegian Institute for Air Research  
hai-ying.liu@nilu.no

Sonja Grossberndt, NILU – Norwegian Institute for Air Research  
sg@nilu.no

*Track B – Smart and Sustainable City Services*

### **Introduction**

Air pollution is an environmental issue with serious health and lifespan implications. However, it remains difficult for citizens to assess their exposure to air pollution in their immediate environment. Official air quality (AQ) monitoring stations are often few, coverage outside cities is poor, and their data is not always easily accessible.

The main objective of the EU H2020 funded project hackAIR is to develop an open technology platform for citizens' observatories and collective awareness on AQ that enables communities of citizens to be involved in generating and publishing information relevant to outdoor air pollution. This approach combines citizen science, online social networks, mobile app and open hardware technologies, and engagement strategies. The platform will be tested in Norway and Germany in September 2017. This paper focuses on the hackAIR approach in Norway.

### **Methods**

We complement official AQ data with community-driven data sources through the following tools: i) low-cost open hardware sensors assembled by citizens, including Arduino node (static) and PSoC Bluetooth Low Energy Node (portable); ii) AQ information derived from mobile phone pictures of the sky, Flickr and Webcams; iii) low-tech measurement set-ups involving empty milk box and petroleum jelly; iv) a mobile app for participants' perception of AQ right where they are; and v) Open-source social media to extract AQ related Volunteered Geographical Information via text and images. To generate and publish outdoor AQ information,

hackAIR specifically targets the following citizen communities in Norway: i) members of the general public who are interested in AQ related issues; ii) at risk groups who suffer from AQ related diseases; iii) students who are willing to learn about AQ related topics; iv) the scientific community who is involved in AQ related activities; and v) environmental NGOs who are dedicated to the promotion of health and fighting air pollution. We divide these targeted communities of citizens into two types of participants, one is basic participants who contribute to the project by using any of the hackAIR tools, and the other one is dedicated participants who contribute to the project by hosting or carrying low-cost open hardware sensors.

### **Results**

In Norway, we aimed to involve 3,000 basic participants and 90 dedicated participants who contribute to the hackAIR collective sensing activities. The project products will be composed of a website and a complementary mobile application that provides citizens with improved information about air pollution levels where they live and recommendation on how to reduce emissions and minimize exposure. The societal importance of these services arises from a need to mitigate the effects of air pollution, and through raised awareness contribute to behavioral changes.

### **Discussion and conclusion**

The hackAIR platform provides tools for citizens' engagement in AQ issues, insight into AQ patterns and information for informed decision-making. We believe the hackAIR platform will contribute to the improvement of AQ data in Europe, engaging citizens directly in measuring outdoor AQ levels, raising awareness about AQ and encouraging behavioral changes towards better AQ.

### **Urban Emission and Greenhouse Gas Monitoring: Multidisciplinary Technical and Organizational Considerations**

Dirk Ahlers, Department of Computer Science, NTNU  
dirk.ahlers@ntnu.no

Patrick Driscoll, Department of Architecture and Planning, NTNU  
patrick.arthur.driscoll@ntnu.no

John Krogstie, Department of Computer Science, NTNU  
john.krogstie@ntnu.no

### *Track B – Smart and sustainable city services*

Anthropogenic climate change has a major impact on our lives and challenges us to develop fast, cheap, and sustainable solutions for mitigation actions. With growing urbanization, a majority of energy use and emissions is increasingly attributed to cities, which therefore need to be at the forefront of climate action.

Complementing approaches for cities to understand their emissions are top-down statistical emission inventories and bottom-up measurements within the city boundaries. However, traditional methods of building and maintaining municipal emission inventories alone are expensive, time-consuming, and of limited utility for mitigation decision and planning support processes. Since statistical emission inventories often only are built only yearly and with some delay, fast feedback loops on alternatives are not possible, and the influence of short-term temporal influences or small-scale changes within the geographic area of a city not well understood.

To address these issues, we have built an Internet-of-Things sensor network for urban emission and greenhouse gas monitoring. To address spatial and temporal granularity issues and to complement existing sparse high-quality measurement stations, we have decided to follow a low-cost approach to allow for a larger amount of sensors, thereby enabling a more fine-grained overview within the urban area. The Carbon Track and Trace (CTT) project is intended to provide cities with real-time greenhouse gas (GHG) measurement capability. It couples low-cost sensors to Big Data analytics that is expected to provide cities and regions with a unique capacity to measure impacts of their policy and planning decisions.

The issue was addressed with a mix of methodologies, ranging from technical implementation and integration issues to conceptual and governance contributions. We have demonstrated a prototype implementation and delivered deeper conceptual insight into integration

into larger frameworks, such as whole city systems, city sustainability, GHG management and climate goals, governance and policy. Gap analyses of the current state to sensor-based systems have been performed as a roadmap from manual to automatic data gathering and emission monitoring and inventories. City integration and policy issues are important for this type of approach and can be achieved by engaging with pilot cities. This includes issues of how to work with cities, how to anchor such projects within city departments, ownership, permissions, integration with city ICT systems, and collaboration with urban, mobility, and environmental planning, to name a few. Further general governance issues are financial issues and bankability of climate actions that can be eased with better measurements.

This approach will give cities detailed insights into the emission footprint on an intra-level scale. It will help set up proper baselines and monitoring for mitigation actions and allow evidence-based prioritization of climate investments by doing a reality check on assumptions and test reduction policies' impact.

We want to specifically highlight the need of a multi-sectorial and multi-disciplinary approach that explores the issue from a multitude of angles. This approach ultimately provides a better understanding and deeper integration of different stakeholders' views as well as enabling us to conceptualize a more integrated solution.

### **The application of Web-crawling in urban environmental research: a pilot study on emissions from residential wood burning**

Susana Lopez-Aparicio, NILU - Norwegian Institute for Air Research, Norway sla@nilu.no

Matthias Vogt, NILU - Norwegian Institute for Air Research, Norway mvo@nilu.no

Matt Pierce, Latitude Geographics Group Ltd., Canada piercemattd@gmail.com

Philipp Schneider, NILU - Norwegian Institute for Air Research  
ps@nilu.no

*Track B- Smart and sustainable city services*

### **Introduction**

Air quality models (AQM) are essential tools to support decision-making processes, by evaluating the possible impact of local emission abatement options on air quality and human health. Examples can be the evaluation of shifting from old to newer, more efficient wood stoves or the impact of banning wood burning for residential heating during pollution episodes. AQMs rely on meteorology, boundary conditions and emission inventories as input data, being the quality of the latter one the most critical factors. In the case of wood burning, emissions are estimated based on the amount of wood consumed and type of stove used. This information is needed at high spatial and temporal resolution when addressing the urban scale in order to capture the variability in the urban environment; however, those data are rarely available. Due to the scarcity of such data, we evaluated the use of different methods for data collection.

### **Methodology**

Data collection is one of the most crucial steps in environmental research and the methods have evolved following technology and society. With the development of information and communication technologies (ICT), new efficient techniques within both natural and social science are published in the scientific literature. We will present an application of web-crawling for gathering open data to improve the development of an emission inventory for air pollutants from residential wood burning. Our aim is to build up a cost efficient methodology to establish a well-structured database for the update of urban emission inventories.

Web-crawling is defined as the automated data mining process by which specific information about a particular process is obtained from Uniform Resource Locators (URLs). We implemented a web crawler and tested it in a pilot study aiming at the improvement of emissions from residential wood burning. Wood burning is one of the main contributors to particulate matter (PM) in Norwegian cities, and it often causes high pollution episodes in

winter. This brings the need for designing strategies to reduce PM levels towards a sustainable city.

We designed a web-crawling process, which retrieves the geographical position of the dwellings being sold or rented out on Finn.no, a Norwegian classified advertisements website that covers the vast majority of real estate transactions. The announcements have a detailed description of the dwellings, their characteristics and their primary and supplementary heating systems. We developed a dictionary with keywords of interest, and configured an automatic system to gather the geographical position of dwellings fulfilling or not fulfilling the search request defined by the keywords.

### **Outcome**

We have gathered geo-positioned data during one year from all of Norway and classified them based on the type of supplementary heating source (e.g. wood burning, district heating, heat pump, central heating) and type of wood burning appliance (e.g. wood burning stove, old stove, new stove, stove). The data is treated and combined with existing information to provide a comprehensive spatial distribution of wood burning potential in an urban area. We will present the pilot study and main findings for a Norwegian urban area.

### **The use of flood and stormwater data in Norway: review and recommendations**

Nathalie Labonnote, SINTEF Building and Infrastructure  
Nathalie.labonnote@sintef.no

Edvard Sivertsen, SINTEF Building and Infrastructure  
Edvard.sivertsen@sintef.no

Berit Time, SINTEF Building and Infrastructure  
Berit.time@sintef.no

*Track B – Smart and sustainable city services*



Floods and stormwater events are the costliest natural catastrophes. Costs are expected to increase due to urbanization and climate change. Mitigation is needed, and is already on-going in certain cases. Different stakeholders with different motivations unfortunately often evaluate vulnerability by using fragmented and incomplete data sources. This study intends to review the different approaches for collecting and analysing data, and to evaluate their usefulness within a well-defined framework for a "smart" use of data. The scope of the study is limited to Norway.

The main objectives have been: to review qualitatively and quantitatively a selection of national inventory databases, to define a framework for assessing about the "smart" use of data to evaluate the current Norwegian situation with respect to this framework, and to propose measures for improvement.

Methodology was based on questionnaires and face-to-face interviews with relevant stakeholders. Results show that data are spread around a heterogeneous community of stakeholders concerned with different motivations, different needs, and different levels of data processing. In general, the needs of the different stakeholders have not been surveyed and defined systematically enough. There is therefore a substantial potential in upgrading from the delivery of passive raw data to the delivery of knowledge-driven decision-support tools.

The discussion identifies the following opportunities for further work: Exploiting more efficiently available sources of urban data and exploring alternative sources of data such as participatory sensing technologies, Achieving a more efficient transformation of data into knowledge via the development of analytical tools that match the identified needs of relevant end-users by efficiently processing several relevant sources of data, Providing ergonomic and user-friendly digital solutions to support workers in their daily tasks and to efficiently document the actions within the system, and Triggering the implementation of evaluation processes within the national agencies for business purposes, and at a national scale for providing the policymakers with useful knowledge about the societal risks associated with climate changes.

The study concludes by distinguishing technical challenges from organisational challenges. Technical challenges can relatively easily be solved by digitization and its opportunities for improvement of the workflow and for higher quality of data. Organisational challenges must be solved by an end-users-focused approach to identify needs and expectations.

This study was founded by the Centre for Research-based Innovation Klima 2050 and intends to trigger the development of a global data-driven evaluation system to provide policymakers with knowledge on societal risk associated with climate change, and to strengthen national agencies and private companies' innovation capacity for addressing climatic changes.

### **Smart Sustainable Cities: Unprecedented Shifts in Urban Analytics and Planning in Light of Big Data**

Simon Elias Bibri, NTNU  
simoe@ntnu.no

#### *Track B – Smart and sustainable city services*

The model of contemporary cities is drastically changing with regard to the way urban systems as operating and organizing processes of urban life can function and be managed and planned in line with the goals of sustainable development. Marking this change predominately is the increasing use of big data in urban analytics for advancing urban sustainability. This unprecedented shift has been brought by data science and data mining becoming a more accessible tool for city government, more extensive data being able to potentially allow urban authorities and departments to see and respond to a wide variety of factors (e.g. mobility, energy, transport, healthcare, and education) in real time, coupled with citizens emitting to an increasing extent spatiotemporal data through the use of various technologies. Data science fundamental concepts and data mining techniques are associated with extracting useful knowledge from large masses of urban data for enhanced decision making and insights in relation to various urban domains in the context of sustainability. Accordingly, we define big data with respect to their humongous size and wide diversity but pay particular attention to the fact that the data referred to are urban data, i.e. data invariably tagged with spatial and temporal

labels, largely streamed from a large number of sensory sources, and generated automatically and routinely. This epitomizes a sea change in the kind of data that we generate about urban domains and activities as to what happens where, when, and why in cities. This in turn provides the possibility of monitoring, understanding, analyzing, evaluating, and planning cities to improve their performance of and contribution to sustainability under what is labelled smart sustainable cities of the future. This paper describes, explains, and illustrates what urban analytics entails in light of big data, and to discuss and analyze in what ways such urban analytics shapes and influences urban planning in the context of smart sustainable cities. We argue that the increasing proliferation and variety of urban data are shifting the emphasis from longer term strategic planning to short-term (and dynamic) thinking about how smart sustainable cities can operate and be managed and developed. With big urban data driving decisions and providing deep insights pertaining to different dimensions of sustainability, the big data paradigm is in a penetrative path towards safely fueling unhindered progress on many scales and thus paving the way for boosting sustainable urban development processes towards achieving the required level of sustainability. By way of conclusion, we provide some useful thoughts with respect to the emerging wave of smart sustainable urban planning driven by the use of big data in urban analytics.

### **Modélisation Urbaine Gerland: enhancing integrated urban planning by a model base approach in Lyon**

Monika Heyder, European Institute for Energy research (KIT/EDF)  
heyder@eifer.org

Pierre Imbert, European Institute for Energy research (KIT/EDF)  
imberty@eifer.org

Gwenaelle Becker, Veolia Research and Innovation  
gwenaelle.becker@veolia.com

Fabrice Casciani, EDF R&D  
fabrice.casciani@edf.fr

Thomas Lacroix, The CoSMo Company  
thomas.lacroix@cosmo-platform.org

Christine Malé, Métropole de Lyon  
cmale@grandlyon.com

Lydiane Philippe, ForCity  
lydiane.philippe@forcity.com

Stephanie Zaba, 2EI Veolia  
stephanie.zaba@2ei.com

#### *Track B- Smart and sustainable city service*

The applied research project Modélisation Urbaine Gerland aims at studying novel approaches to urban planning and thus implements a decision support tool which combines a computerized simulation with an urban planning platform. This is achieved by a triple helix project conception, encompassing large urban utility companies, start-ups, academician and municipality actors. The study area in this case is the urban district Gerland in Lyon (France), which is an ideal laboratory to achieve and evaluate those objectives, due to its ongoing urban transformation and the associated challenges.

The main objectives of the project are:

To reflect on city of the future by merging visionary urban planning and computerized modelling

To reflect on new ways of governance, by linking domains in urban planning in a holistic and integrated way;

To prepare for tomorrow's urban planning challenges, by developing a decision-support tool for long-term planning of the district Gerland; and,

To support the development of new tools by accompanying the process of urban and social transition in the urban district Gerland.

Current areas of urban transformation and challenges in Gerland have been identified in workshops with the Métropole de Lyon, the city of Lyon and other stakeholders (e.g. local companies). Current areas of

urban transformation and challenges are for example the residential attractiveness, economic shift as well as the quality of life of its residents.

This lead to a co-design of the models integrated in an interactive planning platform. The platform will allow to define, simulate and compare possible urban planning measures and scenarios within a time horizon of up to 25 years. This enhances the state of the art in urban modelling, by integrating these domain specific models and a Land Use Transportation Interaction model (LUTI). The LUTI triggers change to which the interlinked domain specific models respond.

The LUTI integrates the evolution of the local traffic and transportation, the demographic evolution of the local population, the evolution of the local economy and job creation, the evolution of the building and dwelling stock, and the evolution of public space including parking facilities. Domain specific models for energy model the energy production and distribution in the district heating network expansion and techno-economic analysis, the residential heating needs influenced by renovation measures, the fuel poverty, the energy needs of the tertiary sector, the photovoltaic potential and techno-economic analysis, the distribution of electrical charging infrastructure. In addition an analysis of urban heat island effect considering different urban greening strategies. Domain specific models on residential waste model the production and collection.

The planning platform will empower the planning authority of the Métropole de Lyon to model different future scenarios of the district Gerland. The visualization of the interdependencies of the developed scenarios will help the planning authority to facilitate an interdisciplinary and transdisciplinary exchange among the different stakeholders. Furthermore this innovative approach could tear down the traditional silo approach to urban planning by engaging in a dialog between the different city departments which are organized in topics like water, waste, energy, transportation, urban development etc.



**Track C Biodiversity & ecosystem services**

**Abstract session 4 – *Vegetation studies***

**Room: Room: COSMOS 3A**

**Moderator: Bente Jessen Graae, Professor, Dept. of Biology, NTNU**

09:00-09:05	Session introduction
09:05-09:20	<b>Inger Auestad, Knut Rydgren and Rune Halvorsen</b> Vegetation recovery of hydropower spoil heaps - assessing restoration success using ordination methods
09:20-09:35	<b>Knut Rydgren, Inger Auestad, Rune Halvorsen, Liv Norunn Hamre, Jan Sulavik and Joachim Paul Töpper</b> Restoring ecosystems: an evaluation of methods for predicting time to recovery
09:35-09:50	<b>Victoria T. Gonzalez, Bente Lindgård, Rigmor Reiertsen, Snorre B. Hagen and Kari Anne Bråthen</b> Vegetation bites the dust: No recovery of <i>Empetrum nigrum</i> heaths in response to an extreme event suggests allelopathy can facilitate Arctic browning
09:50-10:05	<b>Kenny Helsen, James Speed and Bente Graae</b> Assessing the impact of an invasive plant on ecosystem functioning using a functional trait-based framework
09:05-10:20	<b>Anders L Kolstad, Gunnar Austrheim, Erling J Solberg, Aurel M A Venete and Sarah J Woodin</b> Impact of moose on soils: are high moose densities in Norwegian forests sustainable?
10:20-10:35	<b>Emma Marjakangas, Nerea Abrego, Vidar Grøtan, Milton Ribeiro, Mauro Galetti, Renata de Lara Muylaert, Richard Stevens, Laurence Culot, Lucas Pereira, Erica Hasui, Fernando Lima, Paulo Inacio Prado, Alexandre A. Oliveira, Renato de Lima, Ricardo Bovendorp, Carolina Bello and Otso Ovaskainen</b> Effects of forest fragmentation on seed dispersal networks in Brazilian Atlantic rainforest

## **Vegetation recovery of hydropower spoil heaps - assessing restoration success using ordination methods**

Inger Auestad, Western Norway University of Applied Sciences, Department of Science and Engineering inger.auestad@hvl.no

Knut Rydgren, Western Norway University of Applied Sciences knut.rydgren@hvl.no

Rune Halvorsen, University of Oslo, Natural History Museum rune.halvorsen@nhm.uio.no

### *Track C – Biodiversity and ecosystem services*

Renewable energy development is a part of the Green Shift, and as such warmly welcomed by the environment-friendly opinion. However, many renewable energy projects has large physical footprints and degrade nature through severe vegetation disturbance. To reduce such negative effects, we need successful and cost-effective restoration measures, as well as indicators for evaluating and selecting the best of these measures. In this case study, we studied vegetation recovery in ten hydropower-related spoil heaps (large piles of surplus blasted rocks from hydropower tunnels). We calculated two ordination-based indicators; successional rate and time to recovery. Both have previously proved useful, but we know little about their performance and suitability when applied to heterogeneous data sets, such as ours.

The studied spoil heaps were established in 1954-1984 situated from southern boreal to mid alpine zones in Southern Norway, and included a range of restoration measures that varied in inclusion of soil application, seeding and fertilization.

Lichens, mosses and vascular plant species were recorded in the spoil heaps at two time points, and the spoil heap vegetation was compared to undisturbed, surrounding vegetation by means of global non-metric multidimensional scaling ordination. To investigate the indicators' performance, we ran parallel ordination analyses for four data sets that included a range of variation: all ten sites (Total), seven sites (Reduced;

three diverging boreal sites removed), the five alpine sites only (Alpine) and the five boreal sites only (Boreal).

We found that the primary ordination axis reflected vegetation variation over time, from early successional phases in 1991/94 via more mature vegetation in 2008/2011 to late successional phases in the surrounding vegetation. The second most important vegetation variation reflected climate, as it separated low-altitude sites from high-altitude sites.

For time to recovery, the five relatively homogenous, alpine sites showed resembling patterns across the analyses; the vegetation of these spoil heaps would become fully recovered (i.e. resemble their surroundings) after 30-60 years. The boreal sites, on the other hand, included larger variation in restoration treatment, climate and age. This gave a wide range in predicted time to recovery between the analyses, varying almost fivefold (80 vs 385 years to recovery) in the most extreme example.

Our study showed that restoration treatment, age and climate affects ordination-based recovery indexes. The calculations appeared most reliable in homogeneous data set and under average environmental conditions. We conclude that ordination-based calculations of successional rates and recovery time are useful measures of restoration success, but underline the need for further development of the methods to further benefit restoration success.

## **Restoring ecosystems: an evaluation of methods for predicting time to recovery**

Knut Rydgren, Western Norway University of Applied Sciences knut.rydgren@hvl.no

Inger Auestad, Western Norway University of Applied Sciences inger.auestad@hvl.no

Rune Halvorsen, University of Oslo rune.halvorsen@nhm.uio.no

Liv Norunn Hamre, Western Norway University of Applied Sciences  
liv.hamre@hvl.no

Jan Sulavik, Western Norway University of Applied Sciences  
jan.sulavik@hvl.no

Joachim Paul Töpper, Norwegian Institute for Nature Research  
Joachim.Topper@nina.no

#### *Track C – Biodiversity & ecosystem services*

Restoration ecology are becoming increasingly important in a world of continuously ecosystem degradation. Since restoration of ecosystems may be slow, we need methods to predict the time to recovery for well suited characteristics of ecosystem, such as species composition. However, few studies have so far tried to estimate time to recovery based on such data, and we have little knowledge of the suitability of current methods. Based on analyses of several datasets from alpine and boreal environments, we evaluated the most relevant methods for estimating time to recovery. The basis for our analyses was ordination (DCA—detrended correspondence analysis, and GNMDS—global non-metric multidimensional scaling) of plant species composition data that had a prominent successional gradient, and consisted of both restored and references from several time points.

For each ordination we interpreted the primary axis as a successional gradient, calculated successional rates of the restored vegetation and used these rates to estimate time to recovery, i.e. when the species composition of a restored site becomes (more or less) similar to a reference sites. Both calculations are based on distances along the ordination axes, either between restored sites at different times, or between restored and reference sites. We also applied a more direct approach calculating time to recovery without the step of successional rates, using regression analysis between age of the restored sites and distances along the ordination axis between restored and reference sites.

Our study shows that all evaluation methods have their strengths and weaknesses. Used with care, we argue that they provide restoration ecology

with much needed tools for underway evaluation of restoration measures. In particular, they are valuable for ecosystems with slow recovery, i.e., when several decades or even centuries are needed for recovery, because they provide indications both of the direction and the rate of change.

#### **Vegetation bites the dust: No recovery Of Empetrum nigrum heaths in response to an extreme event suggests allelopathy can facilitate Arctic browning**

Victoria T. González, Department of Arctic and Marine Biology, UiT- Arctic University of Norway and Nibio Svanhovd  
victoria.gonzalez@uit.no

Bente Lindgård, Department of Arctic and Marine Biology, UiT- Arctic University of Norway  
bente.lindgard@uit.no

Rigmor Reiersen, Department of Arctic and Marine Biology, UiT- Arctic University of Norway  
rigmor.reiersen@uit.no

Snorre B. Hagen, Nibio Svanhovd  
snorre.hagen@nibio.no

Kari Anne Bråthen, Department of Arctic and Marine Biology, UiT- Arctic University of Norway  
kari.brathen@uit.no

#### *Track C – Biodiversity and ecosystem services*

Extreme events in northern ecosystems have the potential to arrest or even reverse Arctic greening. These events such as winter warming episodes, pest outbreaks or high small rodent activity can alone or in interaction cause considerable damage to Arctic vegetation with likely consequences to ecosystem resilience. Here, we simulated an extreme event at five sub-Arctic heathlands dominated by the allelopathic evergreen dwarf shrub *Empetrum nigrum*, covering a 200 km long gradient from oceanic

to continental climate in Northern Norway. We removed aboveground vegetation from Empetrum heaths, and then studied the recovery during an 8-year period.

After the 8 years, no new species had established in the disturbed plots and only a handful of seedlings were registered during the entire course of the study. The recovery speed of Empetrum and subordinate species was extremely low at all locations along the climatic gradient, finding barely any vegetation cover at the end of the study. Furthermore, the low recovery flattened out after four years. Addition of biochar to alleviate the allelopathic effects of Empetrum had a marginal effect.

Our results suggest that sub-Arctic Empetrum heaths have a low recovery rate in response to extreme events. Furthermore, we illustrate the strong niche-constructing legacy Empetrum has on the vegetation and how these effects appear independent from climatic conditions. Under the scenario of a predicted increase in extreme events, our study suggests that vast areas dominated by Empetrum will potentially contribute to a browning of the Arctic.

### **Assessing the impact of an invasive plant on ecosystem functioning using a functional trait-based framework**

Kenny Helsen, Department of Biology, NTNU  
kenny.helsen@ntnu.no

James David Mervyn Speed, Department of Natural History, NTNU  
University Museum, NTNU  
james.speed@ntnu.no

Bente Jessen Graae, Department of Biology, NTNU  
bente.j.graae@ntnu.no

*Track C – Biodiversity and ecosystem services*

Predicting when invasive species will strongly affect ecosystem functioning remains problematic, with seemingly strong contingency upon both the invasive species identity and the recipient community's composition. Adopting a functional trait-based approach might overcome this context-dependence observed at the species level. In this study, we used this approach to evaluate the effect of invasion by the non-native plant *Impatiens glandulifera* on litter decomposition (ecosystem function) along a latitudinal gradient in Europe, ranging from Ghent (Belgium) to Trondheim (Norway). We compared litter decomposition of standardized litter of plant communities invaded by *I. glandulifera* to those of adjacent uninvaded communities for five populations at each of five locations along the latitudinal gradient. At each sampling location plant community composition was assessed and several functional plant traits were measured. This allowed us to evaluate if invasive species effects on ecosystem functioning (litter decomposition) are solely due to direct effects of invasive species presence, or if their effects are (partly) driven by indirect effects, mediated by the native community (functional trait) composition and whether these patterns are consistent across the latitudinal gradient. Invasion by *I. glandulifera* simultaneously introduced new trait values into the communities and altered the average trait values of the native community, likely through competition effects. Invaded communities were furthermore characterized by a faster litter decomposition compared to uninvaded communities. Variation in litter decomposition rate was partly explained by the functional traits of both the native community and *I. glandulifera*, illustrating the potential strength of a functional trait-based approach to predict invasive species effects on ecosystem functioning. However, invasion effects were not consistent across the full gradient, with contrasting patterns for invaded communities in the northernmost sampling location (Trondheim), where a reduction in litter decomposition rate was observed in invaded communities.

### **Impact of moose on soils: Are high moose densities in Norwegian forests sustainable?**

Anders Lorentzen Kolstad, NTNU University Museum, NTNU  
anders.kolstad@ntnu.no

Gunnar Austrheim, NTNU University Museum, NTNU  
Erling J Solberg, Norwegian Institute for Nature Research

Aurel M.A.Venete, Institute of Biological and Environmental Sciences,  
University of Aberdeen

Sarah J Woodin, Institute of Biological and Environmental Sciences,  
University of Aberdeen

James D.M. Speed, NTNU University Museum, NTNU

#### *Track C – Biodiversity and ecosystem services*

Large herbivores are capable of modifying entire ecosystems with a combination of direct (e.g. browsing/ grazing, trampling, defecation) and indirect effects (e.g. affecting plant species composition that again alters soil properties). In Norway, moose (*Alces alces*) populations have increased drastically since about 1970 and concern about over-browsing has spurred research about the ecological and socioeconomic implication of this. Both moose populations and boreal forests are managed, through hunting and forestry practices, therefore stressing the need for science-based management advice for a sustainable solution.

In a recent study from an eight-year moose exclusion experiment in 15 recent boreal forest clear-cut sites in central Norway we used a multivariate Bayesian Network structure learning approach to objectively assess the potential mechanistic pathways for indirect effects on soils and soil fertility, and combined this with standard univariate analyses of multiple ecosystem properties.

Excluding moose had predictable direct effects on the ecosystem, such as increasing the ratio of deciduous to coniferous biomass and the canopy cover and decreasing soil bulk density and temperature. However, we found no treatment effects on any measures of soil processes or quality (decomposition, nitrogen availability, C:N ratio, pH, nutrient stocks) and furthermore, we found only limited evidence that the direct effects had cascading (indirect) effects on soils.

These findings lend no support to the commonly held belief that moose exclusion will increase soil fertility by increasing the dominance of

palatable tree species, which provide higher quality litter compared to unpalatable trees with recalcitrant litter. This also highlights the potentially large lag time before aboveground changes become manifested in soil characteristics. However, the direct effects on canopy composition were strong enough to warrant concern about the sustainability of high moose densities, especially considering the apparent recruitment failure of preferred browse species.

#### **Effects of forest fragmentation on seed dispersal networks in Brazilian Atlantic rainforest**

Emma-Liina Marjakangas, NTNU – Norwegian University of Science and Technology  
emma-liina.marjakangas@ntnu.no

Nerea Abrego, University of Helsinki

Vidar Grøtan, NTNU – Norwegian University of Science and Technology

Milton Ribeiro, Universidade Estadual Paulista, Brazil

Mauro Galetti, Universidade Estadual Paulista, Brazil

Renata de Lara Muylaert, Universidade Estadual Paulista, Brazil

Richard Stevens, Museum of Texas Tech University

Laurence Culot, Universidade Estadual Paulista, Brazil

Lucas Pereira, Universidade Estadual Paulista, Brazil

Erica Hasui, Universidade Federal de Alfenas, Brazil

Fernando Lima, Universidade Estadual Paulista, Brazil

Paulo Inácio Prado, Universidade de São Paulo, Brazil  
Alexandre A. Oliveira, Universidade de São Paulo, Brazil



Ricardo Bovendorp, Universidade Estadual Paulista, Brazil

Carolina Bello, Universidade Estadual Paulista, Brazil

Renato de Lima, Universidade de São Paulo, Brazil

Otso Ovaskainen, University of Helsinki, Finland

### *Track C – Biodiversity and ecosystem services*

Forest cover loss and degradation due to land use activities is one of the principal causes of global biodiversity loss. Deforestation rates are disproportionately high in tropical biodiversity-rich areas. Indirectly, forest fragmentation can reduce biodiversity by disrupting species interaction networks. Species interaction networks, such as pollination or seed dispersal networks, are fundamental in maintaining ecosystem functioning. In tropical forests, frugivorous animals act as the most important means for seed dispersal and thus are one of the main agents of forest regeneration. The long-lasting anthropogenic defaunation of tropical forest ecosystems has strongly altered the interaction networks of seed dispersers, which has in turn affected the composition of plant communities and important ecosystem services, such as carbon storage. Moreover, recorded observations on seed dispersal interactions are usually biased taxonomically, temporally and geographically. Therefore, knowledge on potential interactions and on a more mechanistic perspective on the processes behind observed changes in community composition are called for. The overarching objectives of this study were to examine how fragmentation-related factors affect interactions between and among seed dispersers and trees in highly fragmented Brazilian Atlantic rainforest. We used spatially and taxonomically comprehensive data sets on frugivorous animal (including bats, birds, large mammals, primates and rodents) and tree occurrences within Brazilian Atlantic rainforest biome. We fitted a spatially explicit joint species distribution model to each taxonomical group occurrence data to combine information on traits, environmental covariates, phylogenetic correlations, and the spatially explicit data structure. The models were fitted separately for each taxonomical group. To examine the co-occurrence associations among the taxonomical groups, we first used the group-specific models to generate predicted

communities spanning over the entire biome. We then used the predicted species communities to produce spatial maps on species richness, regions of common profile in community composition, and trait composition over the biome. On average, fragmentation, topography and climatic factors had equally strong effects on the variation in community structure, but the effect of fragmentation was smaller in avian frugivore groups. Positive interactions within the taxonomical groups were scarce after accounting for shared environmental requirements, whereas negative interactions were nearly non-existing. This could be due to the manifold indirect interactions among the species at the same trophic level. Species richness and the number of interactions links were higher in areas with larger overall forest cover. This highlights the importance of area conservation over individual species conservation. Our results give guidance to land use policy and sustainable use of natural resources in Brazil, when predicting the existing community and interaction links is possible based on the generally available information on climate, fragmentation, occurrences of other species, and species traits in large spatial contexts.



**Track D Business models for sustainability**  
**Seminar – Green investment tools for sustainable development**  
**Room: LIVING4**

Presented by NTNU Sustainability,  
Sustainable Development Solutions Network Northern Europe and  
Sustainable Development Solutions Network Turkey

This talk-show format session will discuss how green investment tools can be scaled up and become more holistic in the Agenda 2030 perspective by simultaneously addressing environment, social and governance issues. Speakers will present experiences with green investment tools, and discuss issues of how to make green investment tools more holistic from the UN Agenda 2030 perspective.

Speakers include:

- Fritz Balkau, International Advisor at Sustainable Solutions, Paris (Moderator)
- Jan Erik Saugestad, CEO Storebrand Asset Management
- Björn Bergstrand, Head of Sustainability at Kommuninvest in Sweden
- Idil Bilgiç, Principal Economist at The European Bank for Reconstruction and Development (EBRD)
- Kristina Alnes, Senior Advisor, CICERO
- Anders Olstad, CFO, Entra ASA

# POSTER SESSION



Posters will be on display during all conference days with a manned session on Wednesday, 18 October, 17:00-18:00

## Track A Institutions, governance & ethics

### Grasping the New Wave of Environmental Movements in Denmark

Maria Toft, PhD Fellow\*, Department of Political Science, University of Copenhagen  
mt@ifs.ku.dk

*Track A – Institutions, governance and ethics*

In this paper, I demonstrate how a new wave of collective environmental advocates and practice movements in Denmark are emerging. While not only mapping the new types of environmental communities in Denmark, I also explore the current theoretical perspectives on how to create sound environmental behaviors among citizens. The theoretical and empirical mapping indicate that we do not have sufficient theoretical tools to grasp these new types of communities. Additionally, I find that local and national governance practices do not recognize how the collective level of civil engagement manages to change environmental norms and behavior among citizens. In order to understand these communities and hence make full use of their transformative potential, I therefore suggest using network based methodological tools along with more holistic theoretical approaches. The

argument in this paper springs from the old paradigm of thinking globally and acting locally. I find that Denmark is a good case for studying governance of the environmental behavior of citizens, even though some might think of Denmark as a positive outlier when it comes to environmental behavior. However, while a strong narrative of a Danish 'State of Green' is prevalent due to ambitious renewable energy policies, other more holistic environmental indicators display distressing state of affairs. In this regard, the ecological footprint measure indicates that Denmark is doing poorly due to a high consumption of goods often produced far away added the fact that many goods are wasted. This collective behavior have resulted in Denmark having the 4th highest ecological footprint in the world – just behind countries like the United Arab Emirates, Kuwait and Qatar. Taking an all-inclusive perspective of global re-source usage urge us to ask questions concerning consumption, limits to growth and environmental behavior of citizens. This arena is precarious because it collides with the robust discourse of ecological modernization where the solution to climate change merely is a matter of technical fixes. However, a main focus on structural changes in energy systems have shown not to be sufficient in keeping global warming below the stated goal of 2°C. In this regard, most policy tools trying to influence environmental behavior of citizens and dealing with climate politics build on a reductionist standpoint; meaning economic and individualistic rationality perspectives of climate politics. These traditional approaches have shown to fall short when seeking to create deep behavioral changes among citizens. Conversely, other approaches trying to influence behavior through community based initiatives and collective social norms have demonstrated great effectiveness. Thus, in this paper I strike a blow for the local and collective level of civil engagement in environmental governance.

Conclusively, I suggest a methodological and theoretical holistic approach to research in order to sufficiently grasp and enable the transformative potential of the new types of environmental movements.

\*This Ph.D. Fellow is part of the interdisciplinary research project called Collective Movements and Pathways to a Sustainable Society (COMPASS). The project is an interdisciplinary partnership between the Department of Political Science, the Department of Anthropology and several practitioners within the field, i.e. the Danish Stop Food Waste movement, the National Union of Ecovillages, the Copenhagen Food Co-op, etc.

**Resilience and efficiency of sustainability in academic research: the politics of dealing with feedback loops – What can we learn from experiments in structural policy changes for sustainability in the academic research landscape of Flanders, Belgium? How should we translate sustainability into tangible and realistic research actions for higher education institutions?**

Filip Colson, Ecocampus, Sustainable Higher Education, Department of Environment, Government of Flanders, Belgium  
filip.colson@lne.vlaanderen.be

The 2030 Agenda for Sustainable Development (SD) is the context of a story in which higher education (HE) plays a leading role. An innovative, goal-oriented approach to dealing with the agenda is the overarching target of Sustainable Higher Education (SHE). Only with this concrete approach and a sense of urgency in mind will HE deliver graduates that are able change agents and will it contribute to society steering a sustainable course.

SHE is a self-organising system that creates space for niche experimentation (resilience) on the one hand, and on the other hand efficiently absorbs and promotes these new paradigms and behaviours, which are better attuned to an ever-changing context. Higher education can thus create the conditions that enable graduates and researchers to act within this window of resilience and efficiency, in light of the 2030 Agenda.

Ecocampus is a program of the government of Flanders, Belgium, a region of 6.5m inhabitants with a diverse HE landscape that consists of 5 universities and 13 “universities of applied science” (hogescholen) with a total of 235k students. With Ecocampus, we aim to promote a debate on SHE and to work towards structural policy changes that enable the long-term viability of SHE.

More specifically, within the framework of sustainability in academic research, we have published an advisory paper (Hugé 2015, translated and reworked as Hugé et al. 2016) and an accompanying interview film (Ecocampus 2016), we organize debates at the highest levels of HE research policy making, and we published an in-depth webinar with a Flemish key player in SHE transitions (in cooperation with the University of Zurich). Most importantly, we regularly call for, set up and support pilot projects on sustainability in research at different HE institutions, in which we focus on different types of actions, in (1) research funding, (2) research & career evaluation, (3) research organization, (4) capacity building, and (5) policy. Together with these HE institutions we aim at creating the much-needed space for both resilience and efficiency, when working towards the 2030 Agenda.

*At the NTNU conference, I would like to interactively present some of these pilot projects: the processes involved, critical success factors, why certain choices were made, what our call for pilot projects looks like, how we build trust to achieve common (but quite disruptive) goals, the role of language and discourse, the potential leverage of concepts like Sustainable Development Goals and Responsible Research & Innovation, etcetera.*

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## Track B Smart & sustainable city services

### Smart Toll Systems

Marina Bakhtina, Independent researcher  
marina.bahtina@gmail.com

Alejandra Madero, Norwegian University of Science and Technology  
alemadero.96@gmail.com

Evmorfia Andritsopoulou, AIA Science AS  
eua.andri@gmail.com

Tripti Mahaseth, Norwegian University of Science and Technology  
triptimahaseth@gmail.com

#### *Track B – Smart and sustainable city services*

Norway has recently ratified the Paris agreement, aiming to reduce their greenhouse gas emissions by 40% by 2030 in comparison to their 1990 report. The reduction of Greenhouse Gases requires a decrease of local emissions in the short term, with a combination of technological implementations and innovative strategies in the long term. The local challenge “Reduction of the CO<sub>2</sub>-emissions from the transport sector in the City of Trondheim” was the target on an international competition: Climathon Trondheim 2016. The idea presented in this poster was developed and awarded the first place by a jury of members from the Trondheim Municipality, Technoport and the Norwegian University of Science and Technology.

The proposal of Smart Toll Systems is a long term proposal aimed to trigger behavioral changes to reduce CO<sub>2</sub> emissions. On the short term, a smart toll

system will create revenue in a fairer way, taking into account the number of kilometers and the area that vehicles were driven. In the medium term, the smart toll system will replace the existing toll, help build capital and collect private commute data. Our projects’ focus requires deep behavioral changes, which cannot be triggered or modified in short term. This requires a long-term strategy, where gathered data can help to understand private commutes, predict future movement patterns, and develop new tools to understand commute data, and gathered revenue helps to improve the public transport system. This proposal’s main challenge is the privacy of the gathered data privacy. Another is the applicability of the project limited to wealthy developed countries.

A successful attempt at a similar intervention is Germany’s high-tech Toll Collect truck system operated from 2005. This system uses GPS technology to track distances travelled and wireless networks to transmit data for billing. The onboard units locate the position of vehicles, track routes, calculate fees, and transmit data to the data center. Since the toll collection is based on the combination of satellite and mobile technology, roadside infrastructure isn’t required. Privacy concern is highlighted as a hesitation in enforcing a similar system for private cars. In Smart Toll system we have attempted to address the problem of privacy by using Altin as an intermediary. In addition to Germany’s high-tech Toll Collect truck system, we introduce a progressive payment in case of amount of kilometers driven and differentiation of the payments by city zones.

To start, a pilot project with a small car sample can help to understand the implementation challenges and feasibility of the proposal. A preliminary stage can help to find technical equipment, set up fares, regulations and algorithms for payment, establish collection and distribution system for revenue, and collect movement patterns from sensors. This is essential to test and improve the system before it’s implemented in a broader scale. This can be done with a strict monitor and evaluation system including user surveys, data evaluation and analysis, and operator and stakeholder analysis.

## Track C Biodiversity & ecosystem services

### Identifying relevant impact pathways for marine invasive species within Life Cycle Assessment

Maximilian Koslowski, Industrial Ecology Programme, Department of Energy and Process Engineering, NTNU  
maximiko@stud.ntnu.no

John S. Woods, Industrial Ecology Programme, Department of Energy and Process Engineering, NTNU

Francesca Veronesi, Industrial Ecology Programme, Department of Energy and Process Engineering, NTNU

#### *Track C – Biodiversity and ecosystem services*

Invasive alien species are, together with climate change, a major concern for marine ecosystems and cause difficult-to-reverse impacts (Mace et al., 2005; UNEP, 2006). Recent research shows that the annual total rate of first records of alien species in marine habitats has increased over the past decades with no sign of saturation for most taxa (Seebens et al., 2017). Invasive species may threaten local species communities and may lead to the extinction of already threatened species.

However, invasive alien species may not only pose a threat to biodiversity, but also to various ecosystem services, e.g. degradation of habitats affecting food provisioning and coastal protection (Katsanevakis et al., 2014).

Studies suggest that there is a strong link between the introduction of alien species and certain anthropogenic vectors in the marine environment (Bax et al., 2003; Keller et al., 2011). Of these anthropogenic vectors, ballast water and hull fouling are of major concern. Discarded or (un-)intentional releases of aquaculture species also act as primary pathways for introducing invasive species (Bax et al., 2003; Molnar et al., 2008), which can range from microflora to megafauna.

Life Cycle Assessment (LCA) is a commonly used approach for conducting holistic environmental impact assessments across the whole life cycle of a product or service. However, so far there is no approach available for quantifying impacts of marine invasive species on marine biodiversity or ecosystem services within the LCA framework. We present the results of a literature review, identifying the most important pathways for introducing invasive species. We take a spatially-explicit approach to account for the differences between ecosystems and their vulnerability. With the identification of the impact pathways and relevant data, we propose first models for quantifying the effect of invasive species on marine communities within an LCA framework.

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### **Identifying appropriate indicators for measuring the ecological status of African savannah ecosystems**

Koen J.J. Kuipers, Industrial Ecology Programme, Department of Energy and Process Engineering, NTNU  
koen.kuipers@ntnu.no

Kenny Helsen, Department of Biology, NTNU  
kenny.helsen@ntnu.no

Francesca Verones, Industrial Ecology Programme, Department of Energy and Process Engineering, NTNU  
francesca.verones@ntnu.no

Bente J. Graae, Department of Biology, NTNU  
bente.j.graae@ntnu.no

#### *Track C – Biodiversity and ecosystem services*

African savannah ecosystems are subject to rapid change due to external stressors such as climate change and stressors resulting from human population growth. Since these stressors are not expected to diminish, interest has grown in assessments of how African savannah ecosystems are affected by external drivers of change. Research in this endeavour has primarily been focusing on specific stressors and impacts in specified locations (i.e., small-scale case studies). Measures for ecosystem-level responses to disturbances are scarce in current literature.

The use of indicators for measuring the ecological status of an ecosystem is an attempt to (1) understand the ecosystem state without going into every detail, component, and aspect of the respective ecosystem; (2) isolate key aspects of the ecosystem condition (abiotic and biotic); (3) document large-

scale patterns of ecosystem state change; (4) identify ecosystem responses to certain stressors; (5) and help determine appropriate conservation actions. Development of appropriate indicators for measuring ecological status is therefore essential for informing policy makers regarding ecosystem responses to disturbances in order to facilitate sustainable ecosystem management.

Currently, there is no clearly defined and widely accepted set of ecological indicators for measuring the environmental and biological status of African savannah ecosystems. This implies that a tool is missing to translate ecological research results into ecosystem-level impacts. However, understanding ecosystem-level impacts is relevant for the development of strategies to protect African savannah ecosystems.

Based on a literature review of indicators and ecosystem stressors, we have compiled a set of useful ecological indicators to establish a typology for measuring East African savannah ecosystem-level responses to various prevalent stressors (i.e., land use change, climate change, invasive species, overexploitation, and pollution). Using the Serengeti-Masai Mara ecosystem in Tanzania and Kenya as a case study, we present key indicators for how specific disturbances affect the ecosystem structure, composition, and function.

The indicators development was performed in close collaboration with contributors to the EU-funded AfricanBioServices project. By applying a collaborative and cross-disciplinary approach, we provide a systems-perspective approach of drivers of change for East African Savannahs.

In doing so, this research facilitates the interpretation of various studies on stressor impacts in East African savannahs, lays the basis for further developments of indicators for (sub)tropical savannahs in other regions, and contributes to sustainable resource and land use management by identifying key indicators for important drivers of change for East African savannahs.

## **Value trade-offs in multifunctional landscapes – insights into northern environments**

Maria Tuomi, University of Turku  
Maria.tuomi@utu.fi

Sonja Kivinen, University of Eastern Finland  
Sonja.kivinen@uef.fi

### *Track C – Biodiversity and ecosystem services*

Every landscape contains a unique combination of natural environments and anthropogenic activities over time. Multifunctionality is present in the landscapes through a wide variety of ecological, economic, social, cultural, historical and aesthetic features. Multifunctional land-use means implementation of more than one use or activity in a certain space over a time period considered. In general, sustainability of landscapes is often related to their multifunctionality, pluralism of services, and/or resilience. Importantly, a multifunctional landscape includes multiple values and contains various meanings for different people. This plurality of values and preferences results in conflicts in cases where different land uses are considered competitive or mutually exclusive.

Despite its fundamental nature, the arguments and implications of value trade-offs in landscapes are too rarely explicitly considered by scientists in academic or public discourse or other forms of public participation on matters of sustainability or environmental management. We postulate that this may profoundly weaken the science-policy interface and hamper holistic and multi-value solutions in sustainable management of landscapes. We explore the implications of incorporating value judgements explicitly by scientists when partaking in some form of policy formulation, public or scientific discourse in complex social-ecological systems.

Which functions are considered and preserved in the landscape when formulating policy, and what is the reasoning behind the decisions? What constitutes the scientific knowledge base for knowing to which extent different land uses can or cannot coexist in a certain landscape? How to take into account the fact that landscape is dynamic, in which properties, including

the capacity for different functions, vary in space and time? We examine two different land use conflicts in northern Finland to demonstrate that land use discussion and conflict management need: 1) better recognition of the wide variety of values, 2) better separation of scientific arguments and values, 3) recognition of knowledge gaps in science, and 4) inclusion of wider space-time aspects in discussions.

## **Recovery of species and trait compositions at restored alpine spoil heaps**

Jan Sulavik, Faculty of Engineering and Science, Western Norway University of Applied Sciences/ Natural History Museum, University of Oslo  
jan.sulavik@hvl.no

Rune Halvorsen, Natural History Museum, University of Oslo  
rune.halvorsen@nhm.uio.no

Rydgren Knut, Faculty of Engineering and Science, Western Norway University of Applied Sciences knut.rydgren@hvl.no

Auestad Inger, Faculty of Engineering and Science, Western Norway University of Applied Sciences  
inger.auestad@hvl.no

Hamre Liv Norunn, Faculty of Engineering and Science, Western Norway University of Applied Sciences  
liv.hamre@hvl.no

### *Track C – Biodiversity and ecosystem services*

Hydropower comprises a substantial share of world's renewable energy, with potential for further growth. However, hydropower development causes habitat degradation and destruction, which conflicts with its role as a sustainable energy source. Hydropower potential is high in the mountain areas, but the negative impacts are long lasting in these due to short growing season and slow biological processes. Construction, management and restoration activities there must be therefore carefully planned and evaluated. Construction of spoil heaps is among conspicuous negative impacts of



hydropower development. Construction types of the spoil heaps vary. This affects possibly their restoration, which is implicitly aimed at the recovery of species' composition similar to undisturbed surroundings. However, recovery of functional trait composition can be a superior goal. Functional trait composition and diversity has direct links to ecosystem processes and provision of ecosystem services. Besides, divergence of species and convergence of functional trait compositions between restored and reference sites have been observed. Sole focus on the species composition may thus obscure the recovery of ecosystem processes. We therefore evaluated restoration status of spoil heaps using both species and functional trait compositions, and used observed changes to predict future development.

We studied four alpine spoil heaps and their undisturbed surroundings. Three heaps consisted of coarse, and one of fine material. We used data on vascular plant, bryophyte and lichen species composition from three censuses (early 1990's, 2008 and 2015), and gathered functional traits' values related to species' dispersal, establishment and persistence from databases and literature. After weighing the species trait values by species abundances, we obtained two analogous datasets: species and functional trait compositions. These were subjected to parallel ordination techniques, of which two-dimensional local non-metric multidimensional scaling (NMDS) gave the most stable and reliable results, and was used further. We used positions and distances in the ordination spaces to assess successional changes, heap-surroundings' differences and natural variation in the surroundings. Linear mixed models were used to handle nested sampling and repeated measures properly, and we modelled the spoil heaps-surroundings differences as a function of heap age. We calculated confidence intervals for model fit to account for uncertainty. We used the natural variation as a gauge for target heaps-surroundings difference at recovery.

Modelling results suggested convergence of both species and functional trait compositions of the heaps towards the surroundings, but at different rates. Functional trait composition was predicted to recover 21-56 years before the species composition. Recovery rates of fine versus coarse heaps differed as well, with the fine predicted to recover 30-45 years before the coarse ones. Results suggest that the functional trait composition can be used as a relevant measure to evaluate restoration success, especially if the restoration aimed at the ecosystem processes, not specific species assemblages per se.

### **Land-use change emissions embodied in Brazilian pork and poultry meat**

Dario Caro, Department of environmental science, Aarhus University and Department of Animal Science, University of California, Davis  
dac@envs.au.dk

Steven J. Davis, Department of Earth System Science, University of California, Irvine  
sjdavis@uci.edu

Ermias Kebreab, Department of Animal Science, University of California, Davis  
ekebreab@ucdavis.edu

Frank Mitloehner, Department of Animal Science, University of California, Davis  
fmmitloehner@ucdavis.edu

#### *Track C – Biodiversity and ecosystem services*

Pork and poultry meat production drives a large amount of processed agricultural crops, and associated greenhouse gas emissions from land-use change (LUC). Given the rapid growth in meat production in Brazil for domestic consumption and international export, the link between LUC emissions and consumption of pork and poultry meat is central to evaluating the role of Brazilian meat production and the implications for international climate policies. We estimate LUC emissions embodied in Brazilian pork and poultry in 2012 and exported to 189 countries. Although the majority of the pork and poultry LUC emissions are tied to the domestic consumption, 17% and 39% of the emissions embodied in Brazilian pork and poultry, respectively, are exported to other countries. The most prominent destinations of Brazilian pork and poultry in terms of embodied LUC emissions are Eastern Europe, Asia and South America. Concerning the pork meat, the fluxes of emissions from Brazil to Ukraine (1.28 Mt CO<sub>2</sub>-eq) and Russia (1.18 Mt CO<sub>2</sub>-eq) are particularly large. Concerning poultry, the largest transfers of embodied emissions are from Brazil to developing countries and especially the Middle East. These results are relevant to

environmental policies and international agreements aimed at achieving the sustainability of Brazil's meat sector.

### **Raised bogs in Norway: much rarer than expected - new insights from remote sensing surveys**

Marte Fandrem, NTNU University Museum, Department of Natural History  
marte.fandrem@ntnu.no

Anders Lyngstad, NTNU University Museum, Department of Natural History  
anders.lyngstad@ntnu.no

Dag-Inge Øien, NTNU University Museum, Department of Natural History  
dag.oien@ntnu.no

#### *Track C – Biodiversity and ecosystem services*

Knowledge of our surrounding nature – where, how much, what type, and in which state – is critical to evaluate and plan for a sustainable future use of areas. Typical raised bog is a rare and threatened peatland type in Europe, and it is one of the peatland types that contain the largest carbon stores. Degradation of raised bogs will lead to vast releases of CO<sub>2</sub> to the atmosphere, and destroy the habitat of many specialised species. To evaluate the overall state of raised bogs in Norway, knowledge of the current and historical distribution and condition is necessary. Typical raised bogs have long been threatened by drainage for agriculture or forestry, peat extraction and infrastructure construction. Historically raised bogs are assumed to have covered roughly 2 000 km<sup>2</sup> in Norway, but more than half of this has been destroyed as functional mire ecosystems.

The project was initiated in 2012, and a systematic survey of raised bogs in the south-eastern distribution area of raised bogs in Norway has been completed, comprising the main distribution, lacking the northernmost and westernmost parts of the distribution. Field surveys of all possible raised bog localities would be costly and time consuming, so we have used digitised aerial photographs (remote sensing) in stereo model on screen in our survey. Remote sensing methods are increasingly used for mapping and monitoring

nature, and the methods are continuously improved. We assessed the state of the mire complexes subjectively, based on the extent of human intervention (ditches, roads, cultivation etc.) visible on the aerial photographs.

The raised bog region of Norway is ca. 60 000 km<sup>2</sup>, and about 75 % of this has been surveyed, yielding 471 raised bog localities. Based on this, we estimate the present cover of raised bogs in Norway to about 150 km<sup>2</sup>, while a former estimate of distribution is 750-1000 km<sup>2</sup>. 233 localities were not registered previously, and 107 of these have been assigned a national or regional value. The majority of localities has to some extent been degraded by drainage and land-conversion, and the condition is considered good or very good in only 35.8 % of the localities.

The use of remote sensing methods for surveying typical raised bogs is well suited to discover intact and well-developed raised bogs, but the method can give a more positive picture of the present condition of typical raised bogs of Norway, than what is historically correct, as there is great uncertainty attached to the registration of heavily degraded mires and weakly developed raised bogs, and there are certainly localities that have been fully destroyed and converted that are beyond recognition.

This project yields new insight into the state of raised bogs in Norway, and highlights the non-sustainable use of these peatlands. The state of the remaining raised bogs is overall poor, and there are few intact localities. The former estimates of raised bog area are much higher than our results indicate, suggesting that raised bogs are rarer than anticipated.

### **Designing a sustainable composting model to overcome peat-cutting**

Ayten Pehlivan, NTNU  
aytenp@stud.ntnu.no

Jolanta Rieksta, NTNU  
jolantaj@stud.ntnu.no

Selena Truc Van Nguyen, NTNU  
selena.ngtrucvan@gmail.com

Ernest Asante, NTNU  
ernestas@stud.ntnu.no

Ilina Yusra, NTNU  
ilina@stud.ntnu.no

Qiqi Deng, NTNU  
dengq@stud.ntnu.no

Project work from Experts in Teamwork-BI 2098 - Saving the world isn't rocket science – creating structures for conserving biodiversity and ecosystem services (Spring 2017), Norwegian University of Science and Technology

#### *Track C – Biodiversity and Ecosystem Services*

Peatlands provide society with many ecosystem services, such as livelihood support by providing with goods, carbon storage, water regulation and biodiversity conservation. Despite all provided benefits, peatlands are degraded more rapidly than any other ecosystems according to Millennium ecosystem assessment. There is a need to reduce the peatland destruction caused by industrial activities such as peat cutting, to sustain ecosystem services provided by peatlands. The goal of this project was to reduce peatland destruction as stated above by creating a sustainable composting model and use a capacity building approach in learning by doing within the Trondheim community to engage and educate people in urban gardening as well as reducing organic waste production as a secondary target.

The method included a single and multi-unit bin model, based on the amount of compost the user wishes to produce. The single bin model was designed as a simple container unit, capable of storing a significant amount of organic waste with some form of perforations to enable aeration. The multi-bin model on the other hand, had two or more single bins fixed together to form one unit and to avoid the slow composting process by preventing the continuous addition of waste to the organic waste pile. Following the designed composting models, a workshop as part of the capacity building – learning by doing was carried out. With this workshop, we were aiming to educate our target group by giving a lecture about the basics of composting, the science

behind composting and the positive outcomes of composting in reducing peatland destruction as well as reducing the food waste.

Thus, an affordable, easy to use and efficient compost vessel was designed and an informative workshop was carried out. Most importantly, it was vital for the group to encourage the locals in Trondheim and give them a solid reason on why they should start composting. With additional future work and support it will

be possible for households to produce their own nutrient rich soil as an alternative to the soil being removed from the peatlands as well as reduce their food waste production.

#### **An Analysis of Visions and Pathways for Sustainable Forestry at the European and Norwegian Levels**

Victoria Berger, NTNU  
victober@stud.ntnu.no

James David Broome, NTNU  
jdbroome@alaska.edu

Karen Margrete Lie Christensen, NTNU

Jeremy Ferrante, NTNU

Winta Gebreyohannis, NTNU

Farhana Haque, NTNU

#### *Track C – Biodiversity and Ecosystem Services*

The ongoing discussion about climate change, environmental degradation, loss of biological diversity and overall threat to human well-being has provoked much concern in recent years. International efforts have been undertaken in an attempt to combat these issues, while also maintaining the capacity for socio-economic development and human well-being. Such efforts include the Sustainable Development Goals (SDGs) of the 2030 Agenda for

Sustainable Development, established in January 2016 by the United Nations (UN). Forests are among the key drivers in regulating, provisioning and supporting ecosystem services. As such, the UN has established clear goals for forests by 2030, in SDG number 15. The goal of SDG 15 is to “sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss.” The aim of our report has been to uncover visions in the sector of forestry at the European and Norwegian scales, and identify the pathways to achieving these visions. Moreover, these visions and pathways have been further analyzed and interpreted to determine their potential impacts on ecosystem services. To achieve this, we have searched for and selected three publications/case studies at the European scale (Forest Strategy and Forest Action Plan, Forest Europe Work Programme, and European Forest-Based Sector Technology Platform ), in addition to three publications/case studies at the Nordic/Norwegian scale ( Nordic Forest Solutions , SKOG22 Nasjonal Strategi for Skog og Trenæringen and Visions and Expectations for the Norwegian Bioeconomy ). We have identified and discussed various synergies and trade-offs between visions. We have found a common theme of economic transition based solutions at European and Norwegian scales, and an emphasis on collaboration at the Nordic scale. Synergies can be found in Provisioning, Regulating and Supporting Ecosystem Services, in relationship to job creation, skilled based trades and rural community development. Common trade-offs are made within Cultural Ecosystem Services.

### **Visions and Pathways for Sustainable Development of the Aquaculture Future**

Steffen Risstad Larssen, NTNU  
steffl@stud.ntnu.no

Jonas Michael Dombrowsky, NTNU

Ådne Messel Nafstad, NTNU  
aadne.messel.nafstad@gmail.com

Sofia Soloperto, NTNU  
sofisas@stud.ntnu.no  
Nele Markert, NTNU

Project work from Course RFEL 3082 – Sustainable Management of Ecosystem Services (Spring 2017)

### *Track C – Biodiversity and Ecosystem Services*

The current increase in the global population entails a tremendous challenge for food provisioning and the “Zero hunger” UN goal for a sustainable development. The aquaculture industry represents an important contribution to this challenge supplying high quality food. However, as one of the fastest growing food-producing sectors, it is important to develop this industry sustainably. In the past years several visions and pathways for a sustainable development have been designed by various stakeholders focusing on research, development, improved management plans and cross-sectoral collaborations. The objective of this study is to evaluate these visions on a Norwegian, European and global scale, including reports from businesses, governments, the academic sector and NGOs. The visions will be examined to identify patterns of either a “strong” or “weak” sustainability and to correspond to the UN Sustainable Development Goals. Our results show that differences in the visions can be identified due to stakeholder’s contrasting aims. Governmental visions are generally trying to balance economic growth and environmental protection while the EU Commission supports environmental sustainability, animal welfare, and consumer protection as quality standard of the EU aquaculture. Businesses visions usually support a “weak sustainability” concept with a focus on long-term economic growth. Contrary, NGOs often focus on environmental issues, promoting a “strong sustainability” and accepting lower short-term profitability. A critical analysis of future visions for aquaculture is therefore needed to ensure a true sustainable development of this sector. A recommendation would be to strengthen dialogue and cooperation between all stakeholders to pursuit possibilities for sustainable development of aquaculture, supporting strong sustainability.

## Track D Business models for sustainability

### A maturity model for communicating progress toward sustainable development for small and medium enterprises

Cecilia Haskins, Dept. of Mechanical and Industrial Engineering, NTNU  
cecilia.haskins@ntnu.no

#### *Track D – Business models for Sustainability*

Introduction: This paper reports on research about how to measure and communicate about sustainable development and conduct systematic assessment of sustainability practices using methods and principles from systems engineering and industrial ecology. The challenge facing any company, but especially SMEs that have smaller budgets for investment, is where to start on the progression toward sustainable development. What they need is a simple explanation of the steps they can take to meet sustainable development goals, without being overloaded with the wealth of theory and principles from the academic literature.

Methods: The research is a case study of over 50 small and medium firms localized in a small Norwegian community. A business model of stepwise maturity was based on interviews and workshops with CEOs and other leaders. This model helps define and track the stages of progression toward sustainable development. The four stages of progression are Awareness, Application, Integration, and Leadership. A company passes through these four stages as they work to achieve sustainable development goals while simultaneously maintaining a healthy firm.

Results: The paper describes the results of the following research activities:

- How to apply systems engineering to the implementation of the model – especially relevant for SME and developing companies.
- Develop indicators of sustainability, especially related to the communication about and the assessment of best practices; standardization in communications becomes critically important when concepts must be shared across national and regulatory boundaries, and when difficulties arise that require cooperation between partners of diverse backgrounds and cultures.

- Refine the definition of the maturity stages of sustainable development, and link them to specific and measurable sustainability practices.

Discussion: Firms in this small community are a good place to work; the management is concerned about their employees and follow national directives to ensure a safe and equitable workplace. This means that even the smallest firms rate very high for their attention to social concerns. One possible area of improvement might be the potential to create even more and stronger ties between the firms and the local community. Regarding the economic and environmental performance based on this minimal data, the respondents appear to have a minimal awareness of the concepts of eco-efficiency, but their eco-performance is probably better than one might suppose. The result indicated that the sustainability profile is very good for a group of company leaders who for the most part had not heard the term before the study began. Areas for improvements include using their power to influence other's behavior through the supply chain and through acquisition practices; and, improvements in planning by integrating recycling and care for natural environments into strategic level decision making.

Conclusion: A systematic view of the community combined with suggestions from the literature, yielded a business model with corresponding indicators that can be applied by SME as they improve their sustainability profiles.

WHAT DOES IT TAKE? Modelling the transformation of the Hammarby Sjöstad energy systems, exploring potentials for increased efficiency and reduced impacts

Örjan Svane, KTH Environmental Strategies Research  
svane@kth.se

#### *Track D – Business models for sustainability*

### What does it take to reduce energy use and climate impacts in city district Hammarby Sjöstad, Stockholm by fifteen per cent in ten years?

This is the aim of the local initiative ElectricITY. A similar aim was formulated in the recently finished FP7 project CIVIS. ElectricITY members could initiate

and coordinate the transformation, but they have no direct influence over energy use. Residents have that influence in their flats, and enterprises have it in their premises. Real estate owners can improve the buildings' energy systems and reduce energy use in its common spaces. These are the primary agents of change. In this report, we first explore the magnitude of transformation quantitatively. How much energy is used, how much can it be reduced, how much do climate impacts decrease? In qualitative terms we then outline what other organizations and enterprises that need to be involved in a network-type project organization in order to bridge the gap between the primary agents of change and the ElectriCITY initiative. Results indicate that the actors' combined reduction potentials are twice the aim. Thus, transformation has two extremes: If all participate, each actor needs to utilize half of the potential available, if half of the actors participate, each needs to use the full potential. However, for ElectriCITY to involve all households, businesses and real estate owners seems equally difficult as for all participants to realize their full savings potential, so an intermediary is more realistic. How demanding is transformation, then? Which is its Path of Least Resistance? The real estate owners' potential alone is sufficient to fulfil the aim, the households' contribution is at most half of the aim and the businesses' contributions are under all circumstances negligible. Two contrasting scenarios illustrate the transformation practices of "Helping many" and "Efficient implementation" respectively. Both have ElectriCITY as initiator and coordinator of transformation. They also outline which intermediate actors that are needed in transformation, such as consultants, energy managers, marketing people, local authorities etc. For these actors to meet, ElectriCITY members need to provide real arenas or virtual, ICT-based ones, support and facilitate match-making and finally make themselves superfluous.

### **Environmental Saving Potential of Circular Approaches for Traction Batteries**

Anika Regett, Forschungsstelle für Energiewirtschaft (FfE) e.V.  
aregett@ffe.de

Sebastian Fischhaber, Forschungsstelle für Energiewirtschaft (FfE) e.V.  
sfischhaber@ffe.de

Constanze Kranner, Forschungsstelle für Energiewirtschaft (FfE) e.V.  
ckranner@ffe.de

### *Track D – Business models for sustainability*

#### **Introduction**

The energy transition – including the transformation of the mobility sector – requires new technologies, many of which come with an increasing demand for critical resources. Approaches from the circular economy, such as sharing and reuse, can lead to increasing resource productivity as well as new opportunities for value creation due to innovative business models. This poster illustrates the methodological challenges of using Life Cycle Assessment (LCA) methods to identify environmental saving potentials of circular approaches for lithium-ion traction batteries.

#### **Methods**

For the systematic identification of possible circular approaches for traction batteries a methodology building on the affected life cycle phases as well as the product's architecture and quality is developed. Then a systematic literature review is conducted so as to give an overview on current LCA studies of reuse and sharing of traction batteries. Building on the analysis of the goal and scope definition of existing studies with regard to aspects of the ISO 14040/44 standards, a case study is derived for an exemplary quantification of the environmental saving potential of circular approaches.

#### **Results**

Sharing and reuse are identified as two technically feasible circular approaches for traction batteries. During its first life in the vehicle the traction battery can for example be used for load management by offering vehicle-to-grid and thereby sharing storage capacity and power among the vehicle owner and a company. Furthermore, used traction batteries can be deployed in stationary applications such as photovoltaic home storage systems for a second-life. The literature review shows that existing LCA studies on circular approaches for traction batteries differ with regard to the methodological choices. The case study on vehicle-to-grid for industrial peak

load management demonstrates that the environmental saving potential of sharing traction batteries depends strongly on the allocation method, the substituted reference technology, the change of load profile as well as battery ageing processes.

### **Discussion**

The assessment of circular approaches for traction batteries constitutes a complex case because multiple applications are feasible. Depending on the chosen application the battery system delivers different services, having an impact on the choice of allocation and the substituted technology. The chosen application also has an effect on the load profile and therefore the emissions associated with electricity demand and supply, which can be accounted for using hourly emission factors of the electricity mix or the marginal power plant.

### **Conclusion**

The environmental saving potential through sharing and reuse of traction batteries depends amongst others on the load profile and the substituted reference technology due to repercussions with the energy system. In order to point out system effects, static LCA methods can be complemented by more dynamic approaches such as system dynamics modelling.

### **Overview of criteria and tools for assessing environmental sustainability at the corporate level**

Paritosh C. Deshpande, Department of Industrial Economics and Technology Management, NTNU  
Paritosh.deshpande@iot.ntnu.no

Roberta Moschetti, Department of Energy and Process Engineering, NTNU  
roberta.moschetti@ntnu.no

Annik Magerholm Fet, Department of Industrial Economics and Technology Management, NTNU  
annik.fet@ntnu.no

Helge Brattebø, Department of Energy and Process Engineering, NTNU  
helge.brattebo@ntnu.no

### *Track D – Business models for sustainability*

The past two decades observed the significant surge in the development of different initiatives and approaches to monitor and report sustainability at the various levels of corporate sector, i.e. process, product and organization. These tools form the basis of the environmental management systems (EMS) and enable corporations to track their progress towards achieving the sustainable development goals. Although sustainability, in itself, is an all-inclusive term, its scope varies significantly among the various levels of corporate sector. The presence of diverse criteria and multiple tools to track the progress of these criteria has potentially caused complications for corporate stakeholders in making informed selections of relevant criteria and tools for their sustainability appraisals.

This paper provides a comprehensive overview of existing tools and their applicability for assessing environmental sustainability at various levels of corporate sector. The criteria essential to ensure environmental sustainability for corporate sectors are selected and filtered from different sources, such as the available global corporate frameworks, standards, ratings and indices. Furthermore, a matrix is developed to map these criteria against the list of current tools and methods for sustainability assessment. This matrix is envisaged to assist stakeholders in making informed decisions with respect to the selection of relevant criteria and set of tools to assess the environmental sustainability of the corporation for the selected level.

This study aims at extending and complementing the current state-of-the-art by providing a consistent framework of environmental assessment criteria and possible evaluation tools at the corporate level. This framework can constitute a guidance for companies to evaluate their environmental performance and can aid embedding sustainability in their business models. Furthermore, this study paves the way for future works that could explore the significance of the identified indicators and tools for companies in different contexts.

## **Turning the Tanker – Organizational Challenges by Going from Brown to Green**

Nina Hovd, Department of Industrial Economics and Technology Management, NTNU

Thea Sitek, Department of Industrial Economics and Technology Management, NTNU

Arild Aspelund, Department of Industrial Economics and Technology Management, NTNU  
arild.aspelund@iot.ntnu.no

### *Track D – Business models for sustainability*

“...the risk of doing the same old thing is far higher than the cost of change”,  
Bill Clinton, The President’s Radio Address, February 13th, 2003

Mounting scientific evidence of climate change combined with the unescapable obligations to the Paris agreement and future generations make a transition from brown to green necessary. This is especially the case for the energy sector, which is one of the most significant contributors to global climate change. However, regardless of necessity, the innovation and change literature tells us that the transition from brown to green is troublesome for energy companies because the transition influence everything from decision-making processes, value-creating activities to business models. In this study, we ask the question of how established firms in the energy sector have successfully mitigated these challenges and diversified into the renewable energy sector.

The study is a qualitative case study of seven Norwegian diversified companies that all have successfully diversified from the petroleum sector into offshore wind. The data is based on public sources and interviews with top management and the analysis follows a grounded theory logic.

First and foremost, the findings supports the notion that diversification into an emerging renewable sector represents a considerable organizational challenge for firms. Not only does challenges relate to internal processes

and existing business models, but firms also face considerable challenges associated with lack of an established industrial regime that efficiently can reduce transaction costs and business risk. These are challenges that are generally associated with emerging industries and needs to be dealt with in any new industry establishment. Moreover, our study shows how a set of diversifying firms have been able to mitigate these challenges by changing value-creating processes and business models to accommodate to new customers in the new industry. Simultaneously, they have made significant adaptations to a new and immature industrial regime. These finding provides valuable insight to practitioners, however we also argue that this insight is pivotal in order to improve policies for the establishment and growth of new industries.

In Norway, we have failed to build a significant offshore wind industry so far – despite presence of competent actors in the energy and maritime sectors as well as considerable governmental spending on publicly funded R&D. Hence, there is no lack of resources, capable actors or technical solutions. Rather, insight might be found on the organizational level and in the process of transition itself.

## **Balancing Power Respecting Nature**

Michael Martin Belsens, SINTEF Energi AS  
michael.m.belsnes@sintef.no

Ove Wolfgang, SINTEF Energi AS  
ove.wolfgang@sintef.no

Ingeborg Gråbak, NTNU  
ingeborg.graabak@sintef.no

Ingeborg Helland, NINA  
ingeborg.helland@nina.no

Magnus Korpås, NTNU  
magnus.korpaas@ntnu.no



Julie Charmasson, SINTEF Energi AS  
julie.charmasson@sintef.no

#### *Track D – Business models for sustainability*

##### Introduction

The paper is a survey of main findings in the project CEDREN Hydrobalance combined with recommendations for large scale balancing from Norwegian hydropower. The HydroBalance project runs along the three axes of CEDREN: technology, environment, and society. Under the technology umbrella we have investigated the energy storage technologies competing with hydropower, compared the cost for different flexibility options, looked at the benefits gained from connecting and operating common energy markets, and calculated the revenues for a hydropower producer utilizing the flexibility of hydropower in several parallel markets. Regarding environmental issues related to hydrobalancing, we have worked with consequences of pump-storage in reservoirs and with impact on fish and water temperature in particular. In the project we have investigated the social acceptance on several levels, looking at strategic components on regulatory and management level, and acceptance, and what measures that impact the acceptance, on a local level.

##### Method

In our work we use four future energy system scenarios as the basis for the multi-disciplinary research. The key question for building the scenarios was which role balancing and energy storage from Norwegian hydropower can play in the future European electricity market?

We will show how the present Norwegian hydropower system has sufficient storage capacity to balance all variability in West Central Europe (UK, Germany, France etc.) in a future power system where wind and solar resources supply 60-70% of the yearly consumption. However, a future role for Norway as a major exporter of balancing power requires large expansions in the capacity of both the production and the transmissions system.

Through development of environmental design of hydropower, Norway has illustrated that it is possible to find knowledge-based solutions that optimizes the trade-offs between hydropower production and other socioeconomic

benefits. We will show how environmental impact can be incorporated in the strategy for balancing from hydropower.

The paper will show how our research, as other similar studies on grid projects for export purposes, indicate that measures such as community compensation and early involvement may sufficiently enhance community acceptance.

##### Conclusion

While it is clear that Norway has a large potential for improving and expanding the hydropower system a feasible strategy is currently not clear. In the paper we propose some steps to overcome barriers and realise hydropower in Norway as a green battery.

#### **Sustainable Business Development by Product Communication**

Marit Moe Bjørnset, Department of Industrial Economics and Technology Management, NTNU  
marit.moe.bjornset@sintef.no

Kjersti Øverbø Schulte, SINTEF Raufoss Manufacturing  
kjersti.schulte@sintef.no

Odd Myklebust, SINTEF Raufoss Manufacturing  
Odd.Myklebust@sintef.no

#### *Track D – Business models for sustainability*

Many manufacturing companies are realizing the need for a more sustainable business development. To achieve less environmental impact from products and services, many scientifically based tools and frameworks are stressing a life cycle perspective. However, manufacturing companies are still lacking trustworthy and relevant insights and understanding of product's lives after leaving the factory gate.

One overall trend in society is digitalization and Internet of things. The manufacturing industry is experiencing a shift towards increased use of sensors, machine learning and integrated value chains, also referred to as

industry 4.0. Accompanying the shift, the amount of available technologies for tracking information and communicating with products is increasing. The discussion on how new technology can be used to develop better products, zero defect processes, transparent and effective value chains etc. are central elements in the industry 4.0 initiative. However, less attention is so far given to how these new possibilities may contribute to a more sustainable business development.

Embedded sensors are a potential environmental challenge both in terms of the added materials and resources as well as the potential for complicating the disassembly process. On the other hand, one- or two-way product communication technology can provide information that is difficult for manufacturers to access. In particular, data on user behaviour; use and misuse of the products and waste handling are restricted. Nevertheless, insights into these stages are important for facilitating a long-term sustainable business development. Therefore, we want to investigate how sensor technology and product communication can contribute to improved environmental performance of products and thereby a sustainable business development.

Embedded sensors are a potential environmental challenge both in terms of the added materials and resources as well as complicating the disassembly process. On the other hand, one- or two-way product communication technology can provide information that is difficult for manufacturers to access but necessary for sustainable business development. In particular, data on user behaviour; use and misuse of the products and waste handling are restricted. Nevertheless, insights into these stages are important for facilitating a long-term sustainable business development. Therefore, we want to investigate how sensor technology and product communication can contribute to improved environmental performance of products and thereby a sustainable business development.

This paper describes an exploratory case study where implementation of sensor technology on products made by Norwegian manufacturers are investigated in the light of the environmental performance. The overall goal is to investigate the potential for product communication contributing to more sustainable business development.

## **SUSTAINABLE ROAD INFRASTRUCTURE IN A NORWEGIAN CONTEXT: A state-of-art survey of evaluation schemes and recommendations for decision-makers**

Cristina Ramos Martinez. SINTEF Building and Infrastructure  
cristina.martinez@sintef.no

Terje Kristensen. SINTEF Technology and Society  
Contact: Terje.kristensen@sintef.no

Christofer Skaar. SINTEF Building and Infrastructure  
Contact: christofer.skaar@sintef.no

### Track D – Business models for sustainability

Sustainability is a term that is commonly used in the description of evaluation tools and analysis methods in many sectors, including road infrastructures. But what makes a road environmentally sustainable? How can we assess the level of sustainability in road designs – what tools, methods and standards are currently available – what are their strengths and weaknesses, and which one of them are suited for the needs and conditions of Norway?

Today, there are several tools and methods available that address aspects of sustainability, but currently there is no standardised or generally accepted methodology to ensure that sustainability is included in the appraisal and evaluation of road projects, in a life-cycle perspective; or to evaluate and compare the different aspects of sustainability in such projects.

Developers can therefore evaluate the sustainability of infrastructure design and construction from a variety of tools, such as (i) traditional decision-making process techniques, including multi-criteria analysis, (ii) road design processes, including standards and codes, (iii) life-cycle assessment and (iv) a number of different sustainability rating schemes.

Furthermore, since each of these tools have their own strengths and weaknesses and the choice of one evaluation method over another comes at an expense of inadequately addressing the full aspect of sustainability, it is a challenge to apply these tools and methods to address environmental,

economic and social aspects of a project in a life-cycle perspective- including the design life (from concept to construction) and the road life (from cradle to grave).

Sustainability is a broad concept. This project will explore the terminology and analyse what sustainability means in this context of road infrastructure and how it can be evaluated through a mapping and evaluation of the different assessment tools available. A survey of the state-of-art of evaluation frameworks for road infrastructure will be the foundation for a gap analysis, to identify which sustainability aspects are not currently addressed in each of the different methods and discuss how the tools best can be combined to ensure an accurate and relevant evaluation of sustainability.

The aim is to identify which sustainability criteria should be incorporated into road infrastructure design; through the study, evaluation, comparative and discussion of the current assessment methods, such as CBA, MCDA, environmental impact scores, LCA, standards and codes. Finally, we will provide recommendations for decision-makers for assessing the environmental sustainability of future road projects in Norway.

### **Potentials and challenges of using crowdsourcing for urban environmental sustainability**

Selamawit Molla Fossum, Department of Informatics, University of Oslo  
selamawm@ifi.uio.no

#### *Track D – Business models for sustainability*

Crowdsourcing is widely defined as an open call mobilization of individuals to participate in an online task by contributing data, knowledge, opinions or skills. The underlying assumption in crowdsourcing initiatives is that new ideas, possibilities and ways of solving complex problems can be found in the crowd outside organizational boundaries. Using the Internet as infrastructure, crowdsourcing platforms provide a means to gather non-expert knowledge in a given field. In the field of urban environment sustainability, crowdsourcing has been applied for obtaining better knowledge regarding air pollution,

in species studies, disaster management, urban planning, and in climate change monitoring activities.

Crowdsourcing is seen as a cost-effective business model for collecting vast amounts of environmental research data. It is acknowledged as an effective way of gathering citizens' opinions and suggestions regarding their urban environment. Simply, it provides another means of participating citizens for tackling urban environmental challenges. However, our thematic analysis of research published during the past decade (2006-2016) shows that the use of crowdsourcing for such purposes has been fraught by various challenges. Using Scopus (Elsevier) and IST web of science (Thomas Reuters), the synthesis of peer reviewed articles maps out four main components that the challenges are associated with. These are: **participants, data, crowdsourcing platforms and task**. Alternative strategies for managing the challenges are also provided.

The primary challenge of crowdsourcing emanates from participants; meaning how one can best recruit, manage, motivate and sustain contributors throughout the entire process. In other words, the key challenge is how to kick-start the crowd that will be responsible for generating needed solutions. The studies suggest the use of both extrinsic means, such as money, and intrinsic, such as creating moral obligation motivation mechanisms as ways to engage participants. Keeping continuous contact through feedback and use of gamification have been found effective in sustaining the participants through time.

The second major challenge for using crowdsourcing in environmental research is the concern regarding the quality of contributed data as contributors may lack expert knowledge of the given task. Various measures such as proper instruction, training and controlled variables have been suggested, based on case studies, to address this concern. The nature and design of crowdsourcing platforms has also been outlined as a challenge for engaging participants. This is particularly associated with privacy issues. For instance, some mobile apps may reveal the location of participants while performing the online task. Lastly, the nature of the outsourced task; if it is complex or simple is reported to determine the interest of people to participate in online tasks.

In conclusion, previous studies show the potential of crowdsourcing in environmental research and decision-making. It can be a viable business model for addressing issues of environmental sustainability. We identified around 90 platforms and mobile apps applied in this area successfully. Most users in these platforms are volunteers that are engaged for intrinsic motivation factors. We identified lack of studies that explicitly focus on how to design crowdsourcing tools. This study was conducted as part of the iResponse project: <http://iresponse-rri.com/>.

### **Marketing approaches in pursuit of a circular economy: how do fashion providers address consumer concerns through digital communications?**

Lucy Chamberlin, NTNU  
lucy.chamberlin@ntnu.no

Ida Nilstad Pettersen, NTNU  
ida.nilstad.pettersen@ntnu.no

Casper Boks, NTNU  
casper.boks@ntnu.no

#### *Track D – Business models for sustainability*

The Circular Economy has been posited as a solution to the rise of environmental decimation with growing global economic prosperity, by introducing new systems of production, consumption and disposal. Rather than creating products for one life and then releasing the waste into earth, sea or air, it is suggested that products should be intentionally designed for longevity, re-use, repair, refurbishment or at the very least recycling, and that the outright ownership of products can be replaced by Product-Service Systems (PSS), which create value and customer utility whilst significantly reducing the throughput of materials.

Current literature has explored circular economy business models, including PSSs, and has also identified some difficulties of implementing consumer behaviour change (for instance due to lack of awareness, perception of risks, fear of 'contamination' or reduced ownership). However, there are few studies

which incorporate a marketing and communications perspective or which focus on the ways in which organisations communicate and market their circular economy product or service offerings to consumers in real life.

This paper aims to make practical examples available to scientific literature by analysing some ways in which 'circular economy' products or services in the fashion industry are marketed to consumers through digital communications. Four different business examples are chosen according to four design models of circular economy: longevity, re-use, rental or leasing, and recovery. Rhetorical analysis and qualitative methods are used to evaluate the different marketing approaches, common themes drawn out and enabling models taken from behavioural psychology, marketing and design for sustainable behaviour (DfSB) used to structure the analysis (e.g. identifying language or content that attempts to inform, encourage, steer etc).

Through categorisation and analysis of practical examples, with reference to existing literature, the paper builds a new model for circular business communication and makes examples grounded in real life available for further scientific research. This provides a useful basis for further research into the effectiveness of communication and marketing approaches in encouraging consumer uptake of circular economy behaviours.

### **Primary versus secondary mineral materials – Can recycling replace mining?**

Mark U. Simoni, Industrial Ecology Program (IndEcol), NTNU  
mark.u.simoni@ntnu.no

Daniel Beat Müller, Industrial Ecology Program (IndEcol), NTNU

#### *Track D – Business models for sustainability*

Mining extracts minerals from the ground and transfers them to the built environment, the 'anthroposphere' or 'technosphere'. Due to their many functional uses the non-energy mineral commodities provide a wide range of essential services to society. In terms of mass, the natural mineral construction materials such as sand, gravel, stone and crushed hard rock aggregates constitute the biggest solid material flow into the anthroposphere.

They are used for instance in concrete and asphalt, and thus buildings, bridges, dams and transportation networks such as roads and airport runways, as well as the utilities sector all require substantial amounts. Metals and industrial minerals are used in lesser quantities and often fulfil more specialized functions due to their physical and chemical properties.

Their multiple applications make minerals so fundamental to society, that understanding the dynamic change of the material stocks in the anthroposphere – as well as when and where resources will become available for recovery – becomes critical for long-term sustainable development. Moreover, understanding the material system is also needed for financial planning in the extractive and recycling industries dealing with primary and secondary resources, as well as for government policy making.

Current primary production and waste flows can be measured with relative certainty. Future material flows can only be forecasted, based on an understanding of the material value chain as well as reasonable assumptions about the factors that influence the material stocks and the demand-supply situation. Our work brings together Material Flow Analysis (MFA), an established method for quantifying the metabolism of industrial ecosystems, and Mineral Resource Classification procedures. Primary resource classification has a long history in the mining industry and its main objective is to define resources and reserves (potentially recoverable quantities that exist in the ground) for capital acquisition and resource accounting purposes. It builds on agreed standards and definitions that prescribe how to collect, structure, interpret and aggregate information on the quality and quantity of the recoverable materials. However, when it comes to anthropogenic stocks, there is no comparable instrument for estimating the material quantities recoverable from the anthroposphere. We present a new standardised classification scheme for anthropogenic (secondary) materials that adapts and translates the existing geogenic (primary) mineral resource classification standards to anthropogenic resources. By integrating this concept with MFA, we demonstrate how a system-perspective provides the context that is – in our view – absolutely indispensable for robust quantitative assessment of the recoverability of primary and secondary minerals.

A comprehensive resource classification system that integrates both the mining and the recycling industry is the cornerstone for building compatible

digital data inventories and services for primary and secondary resources. A systemic approach facilitates the development of dynamic resource management capabilities for knowledge-driven long-term regional and national policymaking, and helps to answer the question whether, and to what degree, secondary materials can compete with primary materials in the trade markets.

### **Who Dares? Corporate Venture Capital Investment in Cleantech Start-ups**

Puck Hegeman, NTNU  
puck.hegeman@ntnu.no

Roger Sørheim, NTNU  
roger.sorheim@ntnu.no

#### *Track D – Business models for sustainability*

The challenges brought by climate change and a growing world population have resulted in a call for the greening of our economy. The Paris Agreement in 2015 underlines the importance of the cleantech industry in this regard. Most cleantech gets commercialized via start-ups. However, literature on the finance of cleantech start-ups is limited and tends to focus on venture capital fund (VCF) investments from and in the US.

Cleantech start-ups have specific characteristics which make one wonder why any type of investor is inclined to commit capital. They are characterized by high technology risk, high government involvement, and long development times, are capital intensive, are difficult to exit and have an unfavorable track record. One of the benefits of clean technologies, reduced environmental degradation, does furthermore not lead to financial return to investors in cleantech start-ups (Cumming et al., 2016). Based on these features it is not surprising that research on VCFs has been published with titles including “Venture Capital and Cleantech: The wrong model for energy innovation” (Gaddy et al., 2017) and “The Promise and Pitfalls of Venture Capital as an Asset Class for Clean Energy Investment” (Marcus et al., 2013).

However, VCFs are not the only type of investor providing venture funding to cleantech start-ups. The Cleantech Group, tracking larger cleantech venture capital deals, reports that the share of corporate investments in European cleantech deals in terms of amount invested has steadily increased from over 12% in 2008 to over 22% in 2014. Corporate venture capital (CVC) investment in cleantech start-ups has, however, not been covered in the literature and as such there is no knowledge on who these investors are and why they invest in cleantech start-ups. Identifying relevant investor segments in renewable energy investments along the different stages of the innovation chain, including early-stage technology firms can facilitate increasing the efficiency and effectiveness of public policy aimed towards attracting private investments.

This exploratory study will therefore focus on corporates that have provided equity to cleantech startups and will answer the following research questions:

*Who are the corporate investors investing in cleantech start-ups?*

*What are the drivers of corporates investing in cleantech start-ups?*

*How do these drivers influence the investment management process?*

In order to answer the research questions we will build on a unique sample of cleantech start-ups founded in an academic setting in Norway. These companies were founded between 1995 and 2012 and their development is being followed to date. There have been 31 incidences of corporate investments by 26 different established corporates in 17 cleantech start-ups. In addition to the rich data provided by the dataset, interviews will be held with CVC investors and entrepreneurs in the cleantech start-ups.

### **Italian experience supporting the transition towards circular and collaborative Business models**

Francesca Cappellaro, ENEA Territorial and Production Systems Sustainability Department  
francesca.cappellaro@enea.it

Grazia Barberio, ENEA Territorial and Production Systems Sustainability Department  
grazia.barberio@enea.it

Rovena Preka, ENEA Territorial and Production Systems Sustainability Department  
rovena.preka@enea.it

Paola Sposato, ENEA Territorial and Production Systems Sustainability Department  
paola.sposato@enea.it

Laura Cutaia, ENEA Territorial and Production Systems Sustainability Department  
laura.cutaia@enea.it

Claudia Brunori, ENEA Territorial and Production Systems Sustainability Department  
claudia.brunori@enea.it

Track D – Business Models for sustainability

### **Introduction**

Supporting the transition towards Circular Economy (CE) means using resources more efficiently, and particularly dissociating the economic growth from resources and energy consumption and from the relative environmental impacts, whilst reducing GHGs and increasing competitiveness, efficiency and innovation. In 2015, the European Commission adopted the ambitious Circular Economy Package, establishing a number of actions and practical measures to promote circular business models (CBM) and cultural change in the whole society that have to be adopted from the institutional to the industrial side and also from the consumer side. This type of economy is not linear and represents a challenge at global level in order to achieve an inclusive sustainable growth.

### **Methods**

In order to identify most promising solution to unlock the CE potential, some new CBM and new consumption models are investigated. Significant opportunities for a radical transformation of business models are provided by collaborative models (PwC, 2015). According to “European agenda for the collaborative economy”, the “collaborative approach can contribute to the

EU's sustainability agenda and to the transition to the circular economy". Also EU Communication "Towards a circular economy: A zero waste programme for Europe" highlights the role of collaborative BM based on sharing economy (e.g. lending, swapping, bartering and renting products) "to get more value out of underutilized assets or resources". A powerful CBM that promotes the resource efficiency clustering traditionally separate industries and other organisations in a network is Industrial Symbiosis (IS). This new CBM represents a collaborative model that acts at territorial level with multi-stakeholders involvement for a better resource management, in order to maintain richness onto the territory with materials loop closure by means of residues valorization, jobs creation and overall satisfaction. The following table presents some Italian experiences for the implementation of circular and collaborative business models which can provide strategies for unlocking the Circular Economy potential.

### Results

Several Italian experiences have already been strongly developed around circular economy models, adopting collaborative approach. Especially, collaborative circular BM are based on collaborative platforms that create an open marketplace for the temporary usage of goods or services often provided by private individuals. Actually, Italy is one of the main countries where collaborative business models are growing fast. According to a recent survey (collaboriamo.org), sharing economy and peer-to-peer initiatives have been known by the 38% of Italian consumers and from 2011 to 2015 the number of Italian sharing economy platforms is increased till about 250, the 77% of them located in Italy. Furthermore, activities have also been carried out collaborating and working with companies for finding industrial symbiosis opportunities. Especially, ENEA has implemented the first industrial symbiosis platform in Italy and developed some pilot cases of industrial symbiosis at European and Italian level, in different Italian Regions. In this free web platform, data are georeferred and allow the identification of potential matches and symbiosis pathways. This pathways are often strongly influenced by specific regulations on waste and by-products management.

### Discussion and conclusion

From the preview experiences, it emerges that strategies for unlocking the Circular Economy potential include either bottom-up and top-down actions. Both these approaches need robust, clear and transparent information

based on technical and scientific studies (evaluations, innovations and tools/models). An essential part of collaborative BM is the creation of digital platforms, as they link all the main actors of a collaborative system. Collaborative platforms offer the potential for environmental benefits by providing the possibility to share resources more widely than in the past. The development of these circular business models can allow companies to get through the constraints of linear zero-sum thinking and to gain a circular advantage fostering new consumption models to be adopted by consumers.

### Sustainability in local clusters - the case of the Rørвик salmon industry

John Ellis, NTNU  
John.ellis@ntnu.no

Siri Granum Carson, NTNU  
Siri.granum.carson@ntnu.no

#### *Track D – Business models for sustainability*

Literature suggests that Scandinavian countries implicitly practice CSR, and in this paper we explore the concept of a Scandinavian context of CSR through a case study of the cluster of salmon related businesses in Rørvik, Norway. (CSR and sustainability have similar definitions in this abstract and will be further defined and differentiated in the paper). My research objective is to illustrate how the Norwegian salmon industry must be viewed from two perspectives: MNCs and the local cluster. MNCs create sustainability through resource allocation, such as the ability to invest in sustainable business practices, economies of scale, and centralized corporate structure. On the other hand, local clusters create sustainability for their communities through direct and indirect jobs, and keeping money local. If the objective is to create a sustainable salmon industry to compete in the global market, then protecting the social and environmental resources of Norway must be a priority. Local clusters create economic, social, and environmental sustainability.

Farmed Atlantic salmon started as a cottage industry in Norway as a way for individuals living near coastal communities to supplement their income.

The Norwegian coast and extensive fjord systems are ideal for salmon aquaculture due to sheltered locations, consistent water temperature, and strong currents. As the salmon farming industry began to emerge in the 1970s in Norway, Chile, US, Scotland and Canada, and the Norwegian government saw the potential to stabilize struggling rural coastal communities, which were losing jobs and population.

The Norwegian salmon industry experienced steady growth for over two decades and became the world's largest producer, based in part on a strict organizational and institutional framework created by the government (Aarset and Jakobsen 2009). However the framework was too rigid and the system eventually collapsed in the early 1990s due to over production, global competition and falling market prices (see Aarset and Jokobsen 2009 for further information). The new institutional framework removed rural priorities that protected coastal communities and liberalized ownership, which caused a consolidation of the economically strongest firms. Today in Norway, 5 MNCs represent 58% of all salmon production, and the rest is produced by over 100 SMEs (Fiskeridirektoratet 2015, Marine Harvest 2016).

Rørвик, Norway is a coastal fishing community of 3000 people located in Nord-Trøndelag, and the SMEs have a long history of collaboration. What makes Rørвик unique to the salmon industry is the cluster of SME salmon companies that often work together as one large company, and additionally co-own companies that provide all of the services to support salmon production. For salmon companies in Rørвик it's not just growing the industry, it is growing the community.

Are clusters of SMEs the way forward for the sustainable development of the salmon industry in Norway? In Rørвик, SMEs rely on a network of synergistic firms to produce salmon while also creating stability in their rural community. Together, the SMEs in Rørвик are the 4th largest producer of salmon in Norway, on par with the global production of 3 MNCs (Fiskeridirektoratet 2015, Marine Harvest 2016).

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#### **Organisational LCA (O-LCA) for activities in the Norwegian Defence sector**

Magnus Sparrevik, Norwegian University of Science and Technology (NTNU) and Norwegian Defence Estate Agency (NDEA)  
Magnus.sparrevik@ntnu.no

Håvard Jacobsen, Norwegian University of Science and Technology (NTNU)

Simon Utstøl, Norwegian Defence Research Institute (FFI)

*Track D – Business models for sustainability*

#### **Introduction**

The Norwegian Defence sector has annual revenues of approximately 5 billion US\$ and employs over 20.000 people. The activity of the sector is diverse and the organization may affect the environment in several ways; i) indirectly through purchasing of good and services, ii) directly by using resources and creating emissions to the environment and, iii) through waste handling and end of life activities.

To adequately map the environmental impacts in the entire value chain, NTNU have conducted an organisational life cycle assessment (LCA) of the sector.

#### **Methods**

Organisational LCA (O-LCA) is a compilation and evaluation of the inputs, outputs and potential environmental impacts of the activities associated with the organisation adopting a life cycle perspective. The O-LCA was in this case, delineated to assess the carbon footprint (CF).

The O-LCA was conducted through a hybrid LCA approach, using both process and economic data. The process data were collected from the environmental



report of 2016 prepared by the Norwegian Defence Research Institute (FFI), while the economic data was collected from the official economic account, publicly available at the Norwegian Government Agency for Financial Management. Both generic and process specific emission factors were used in the study.

### **Results and discussion**

The emissions from process data were calculated to 420 000 tonnes CO<sub>2</sub>-eq, and the emissions from economic data accumulated to 560 000 tonnes CO<sub>2</sub>-eq. The total CF was estimated to be 800 000 tonnes CO<sub>2</sub>-eq with adjusted economic values to avoid double accounting. The largest contribution (44 % of the total CF) originates from transport related activities, while building and construction is the second largest contributor (25 % of the total CF).

The results showed that when only the direct emissions were included, the greenhouse gas emissions were dominated by fossil fuel use and particularly the use of fossil fuel in aircrafts and in naval operations. However, the overall results showed 60% contribution from indirect emissions originating from producing goods and services for the sector. Most important was the emissions relating to building and construction activities.

### **Conclusion**

The study showed that O-LCA might be a valuable contribution to assess the life cycle impacts for a diverse organisation. By using a hybrid approach with both process and economic data, the O-LCA becomes more comprehensive. The limitation may be increased uncertainties due to use of generic emission factors for the economic data.

The findings confirm the present focus on reduced use of fossil fuel and energy savings as effective means of reducing the environmental impact. Interestingly, the study in addition finds that impacts from indirect emissions upstream in the value chain heavily influences the CF.

The results may call for an increased attention on stringent environmental procurement criteria to effectively reduce the total life cycle greenhouse gas emissions in the sector.

“...the risk of doing the same old thing is far higher than the cost of change”,  
Bill Clinton, The President’s Radio Address, February 13th, 200





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