Cases from Nordic Energy Way Arena

– RESEARCH TO PAVE THE WAY TOWARDS CARBON-NEUTRALITY IN 2050

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Nordic Energy Research

The Nordic Energy Way Arena
TOWARDS CARBON NEUTRALITY IN 2050

Contents

The burning question: Where are the unique Nordic R&D cooperation solutions that benefit industry, research and society?

From scenarios to research action

From scenarios to research action. This is what Nordic Energy Research aimed to bring about at the Nordic Energy Way Arena in Copenhagen in June 2013. The Arena brought together more than 50 experts on energy-related issues from research, policy and industry, for a unique two-day energy camp.

Nordic Energy Research's mission is to fund and promote Nordic cooperation within energy research. The Arena served as a matchmaking arena to develop ideas for future Nordic energy research cooperation, not necessarily funded by NER, but as an open source for inspiration for all stakeholders. The backdrop for the Arena was the first ever edition of Nordic Energy Technology Perspectives (NETP) published in early 2013 by the International Energy Agency (IEA) and Nordic Energy Research. The NETP involved top researchers from the Nordic countries and describes scenarios and measures to achieve a carbon-neutral Nordic Region by 2050.

The NETP points to Nordic research cooperation as an important tool in achieving the scenarios, and the Nordic Energy Way Arena looked to facilitate this cooperation. Based on the challenges highlighted in the NETP, the thematic working groups at the Arena presented a number of project proposals that would bring us one step closer to achieving the scenarios.

Over a two-day period, the participants identified the most significant issues within their fields, and the research opportunities with the highest potential of adding value. These opportunities are highlighted in the set of concrete Nordic R&D research ideas within this magazine, covering the fields of Bioenergy, Buildings, Industry, Transport, Smartgrids and Carbon Capture & Storage (CCS).

According to NETP, we cannot achieve a carbon-neutral future by changes in industrial usage and energy-reducing measures alone; it is dependent on a change in consumer behavior. This was supported by professor Per Espen Stoknes, from the Norwegian Business School BI, who highlighted the need to consider psychology and social behavior in climate change.

Nordic Energy Research are happy to present the results from the Nordic Energy Way Arena in this magazine, and encourage research institutes, industry and policy makers to take the cases from the Nordic Energy Way Arena one step closer to becoming action and not only scenarios.

Anne Cathrine Gjærde,
Director, Nordic Energy Research

The Nordic Energy Way Arena based on NETP challenges

The NETP identified five central challenges facing the Nordic countries when it comes to achieving a carbon-neutral energy system:

- Energy efficiency improvement offers the greatest potential for energy saving and emissions reduction in the short term.
- Infrastructure development will set the stage for success – or be a stumbling block for decades to come.
- Carbon capture and storage (CCS) accounts for more than 25% of industry emissions reduction and is also applied in electricity generation.
- Bioenergy will be the single largest energy carrier in 2050, raising questions over its supply.
- Continued Nordic co-operation is vital to reducing the cost of achieving these scenarios.

Based on the abovementioned challenges, six focus areas were chosen for discussion at the Nordic Energy Way Arena. In order to narrow the scope for each group and ensure concrete solutions, the challenge regarding energy efficiency was split into two focus areas; industry and buildings. Further, infrastructure was divided into two areas; smartgrids and transport. The final two focus areas at the arena were CCS and bioenergy. The last challenge identified in NETP, Nordic cooperation, was integrated as a common challenge for all the focus areas, as each group was asked to identify the joint Nordic R&D solutions for their topic.

IEA: Carbon-neutral Nordic energy system possible

The International Energy Agency (IEA), together with leading Nordic researchers, has developed scenarios for a carbon-neutral Nordic energy system by 2050. They point to sector-wide changes, including a tenfold increase in wind generation, a ramp up in energy efficiency measures and a revolution of the transport sector.

Nordic Energy Technology Perspectives was released in January 2013 and is the first regional edition of the IEA's renowned global publication *Energy Technology Perspectives*. While based on the same global scenarios to limit average temperature increase to 2°C, the Nordic edition includes an even more ambitious Carbon-Neutral Scenario, exploring how the Nordic countries can achieve their national emission reduction targets for 2050.

Achieving the goal requires substantial efforts on all fronts. The analysis calls for a complete decarbonisation of Nordic electricity generation, with an increase in wind's share from 3% today to 25% in 2050. Improvements in grid infrastructure will be important in facilitating this, and with the right pricing, the Nordic region could become a significant supplier of clean electricity and balancing services to the European continent over the longer term.

Achieving the required 7% drop in energy demand between 2010 and 2050 relies on significant energy efficiency improvements in buildings, industry and transport. Average energy use per square metre in buildings must drop by 35%. The required reductions in industrial emissions rely on Carbon Capture and Storage (CCS), which must equip 50% of cement plants, and 30% of iron and steel and chemical industries in 2050.

Transport will require the greatest emission reductions of any sector, to just an eighth of its current level by 2050. To achieve this, sales of electric vehicles must double every year for the next decade, reaching 30% of total sales in 2030 and 90% in 2050. Biofuels will underpin freight transport, accounting for half of Nordic transport energy use in 2050. The region could become a net importer of biomass, highlighting the need to secure a sustainable supply and the potential for Nordic technology development in the area.

Nordic Energy Technology Perspectives (NETP) was a cooperation between the IEA, leading research institutes from Denmark, Finland, Iceland, Norway and Sweden, and Nordic Energy Research - the intergovernmental organisation supporting sustainable energy research under the Nordic Council of Ministers. Find out more at www.nordicetp.org. ■

How it all played out

According to the International Energy Agency's and Nordic Energy Research's joint publication, Nordic Energy Technology Perspectives (NETP), Nordic cooperation will play an important role in meeting energy and climate targets for 2050. From 12–13 June 2013, 50 leading experts gathered at the Nordic Energy Way Arena in Copenhagen to discuss how Nordic collaboration may help pave the way for a carbon neutral future.

Day 1 - Key topics in energy collaboration

Researchers, business representatives and policy makers from the Nordic region attended the Arena. They were organised into six groups, one for each key topic in energy collaboration based on the central challenges in NETP. The six topics were: Bioenergy, Smartgrids, Buildings, Industry, Transport and Carbon Capture & Storage.

After presenting the speakers at the Arena, participants were welcomed and the programme introduced by Anne Cathrine Gjærde, Director of Nordic Energy Research. Markus Wråke, Head of Unit in Energy Supply Technology at the International Energy Agency, presented the NETP and the six key topics. Per Espen Stoknes, psychologist and Professor at the BI Norwegian Business School, gave a presentation focusing on how people transform energy and climate information into behavioural change efforts and stressed human behaviour in R&D issues.

After lunch, the six groups were asked to prioritise R&D activities for their subject, before presenting their findings to a panel of experts: Anders Eldrup, Jørgen Henningsen and Claus Bindslev. The panel provided constructive feedback and guidance for each group, emphasizing HOW to refine priorities, WHAT to be aware of and HOW solutions could develop and be implemented further.

Participants were faced with the following question; "What are the main challenges regarding joint Nordic Energy R&D cooperation?" To answer this question participants had to point to pathways of Nordic collaboration promoting low-carbon energy technologies. In other words the participants faced the challenge of illustrating the transition from scenarios to action.

Day 2 - From priorities to action plans

Day two was kicked off by Professor Benjamin Sovacool, who gave a presentation on how to form effective sustainable energy policies. Following the presentation, all participants started working on an action plan and establishing a list of stakeholders for their proposals. The outcome was presented as a set of recommendations on research opportunities. Following the six group presentations, Anne Cathrine Gjærde closed the conference with final comments from Nordic Energy Research. She elaborated on the next steps, and stressed the importance of maintaining contact within the groups to achieve concrete action.

Results of the Arena

The intensive group work resulted in a number of suggestions for solutions, including proposals for highly innovative and targeted Nordic R&D cooperation initiatives. ■

The strong brand

Extend and structure cooperation between the Nordic countries and there will be huge potential to gain, says **Connie Hedegaard**, European Commissioner for Climate Action. Her dream as a citizen and a professional is that we move faster in the right direction. So how do we do it?

Where are the unique Nordic research and development cooperation opportunities?

"From 2005 to 2007 I was Danish Minister for Nordic Cooperation, and with my fellow Nordic counter parts we discussed how to strengthen cooperation on climate and green solutions. Outside the Nordic countries people don't distinguish that much between whether something is from Norway, Denmark or Sweden. The Nordic countries are a really strong brand. At that time we decided to try and brand ourselves even more together and to join forces in various research and development cooperation. Even today there are many areas where the Nordic countries are frontrunners. But it is here, as it is in so many other places, that some times you don't know in one country what your neighbouring country already has a lot of experience with. I think that's an area where we can gain a lot if we have structured cooperation so we can share smart solutions and inspire each other to work faster in the right direction."

What areas should the Nordic countries prioritise?

"Our greatest challenge in the years to come is in the building and transport sectors. Because of the climate conditions that we share in the Nordic countries it makes very good sense working together developing new solutions in the building sector. With both public and private research and development funds. Transport is one of a few areas where emissions keep increasing in Europe, but everyone agrees that we have to break that trend. That's an area were we could cooperate in the Nordic countries. We have a tradition for efficient public transportation systems and we're good at building infrastructure. For example regarding electric vehicles there are possibilities. Norway has made a very deliberate effort, Denmark has to a certain extent been a test area, and Sweden has a history of developing car technology. In Denmark there is also second and third generation of biofuel with strong industry involved. Transport is an area where the world is crying out for solutions. The Nordic countries have some experience in this area and an even stronger cooperation could help solve one of the really big problems we face."

What will it take to realise the joint Nordic solutions?

"That the Nordic Council wants it and that it's backed by the governments in the Nordic countries. Maybe also that they make some more research and development funding available specifically for the Nordic area. And make an effort in bringing the relevant sectors together. We're good at it on a national scale, but there is a tendency to think either national or perhaps European. We can get better at cooperating between the Nordic countries if we strengthen cooperation between the sectors. The building sector has a huge potential, but it hasn't made the progress on the global markets that it could have with more innovation. There are some frontrunners, but there's also a large core of companies where innovation hasn't been strong for a long time. I think a united political and sectorial push in this area could be very useful."

Who is it necessary to involve?

"Both business and research. And a consistent political focus would help. The Nordic countries share an environmental history over the past 40 years. In my opinion it's a common Nordic experience that if we set clear political goals, then we can trigger innovation in the industry, join forces and connect the private and the public sectors on many levels."

What is the significance of public support to these issues?

"It really means a lot. It's obvious that in the countries where there's a lack of public support it's extremely difficult for politicians to be heard. When politicians plan long-term – and that's an important part of a politician's job – in a democratic society public support is imperative. It's important that citizens expect politicians to think and plan long-term. We've just made a campaign called 'A World you like with a climate you like'. We try to show the positive vision and the positive solutions. I believe it'll contribute to mobilise people. And here we have a good story in the Nordic countries. 30 to 40 years ago we struggled with a lot of the problems they now struggle with in southern Europe regarding garbage dumps or in China regarding air pollution and waste water. In the Nordic countries we solved the problems in interaction between citizens who understood the importance of the problem, and politicians who were given an opportunity to makes the proper policies. That sent a signal that made business and research cooperate and develop the solutions. That's why this understanding is important. Especially in a time of crisis where the usual tendency to think short-term becomes even more dominant among politicians."

What is your opinion of the perspectives of Nordic cooperation in an international context?

"It's not something that is talked about much but if you're negotiating climate issues in an international context or meeting with the 17 largest economies in the world, the Nordic countries are always among the nations pushing in the most ambitious direction. That's indisputable. It's not necessarily coordinated, but that's how it is even though not all of the Nordic countries are members of the European Union."

What is your dream as a citizen in this climate and energy context?

"My dream as a citizen and a professional is that we move faster in the right direction. That we don't have to use so much energy discussing whether at all it can cost anything. Because it'll cost something to make the green transition. I wish people will understand the high price it'll have not to take these challenges very seriously. There are so many good things happening out there, but there is a tendency that it's going on a little scattered. Let's get things connected so we can be inspired by each other's good examples and have them scaled up to what we need." ■

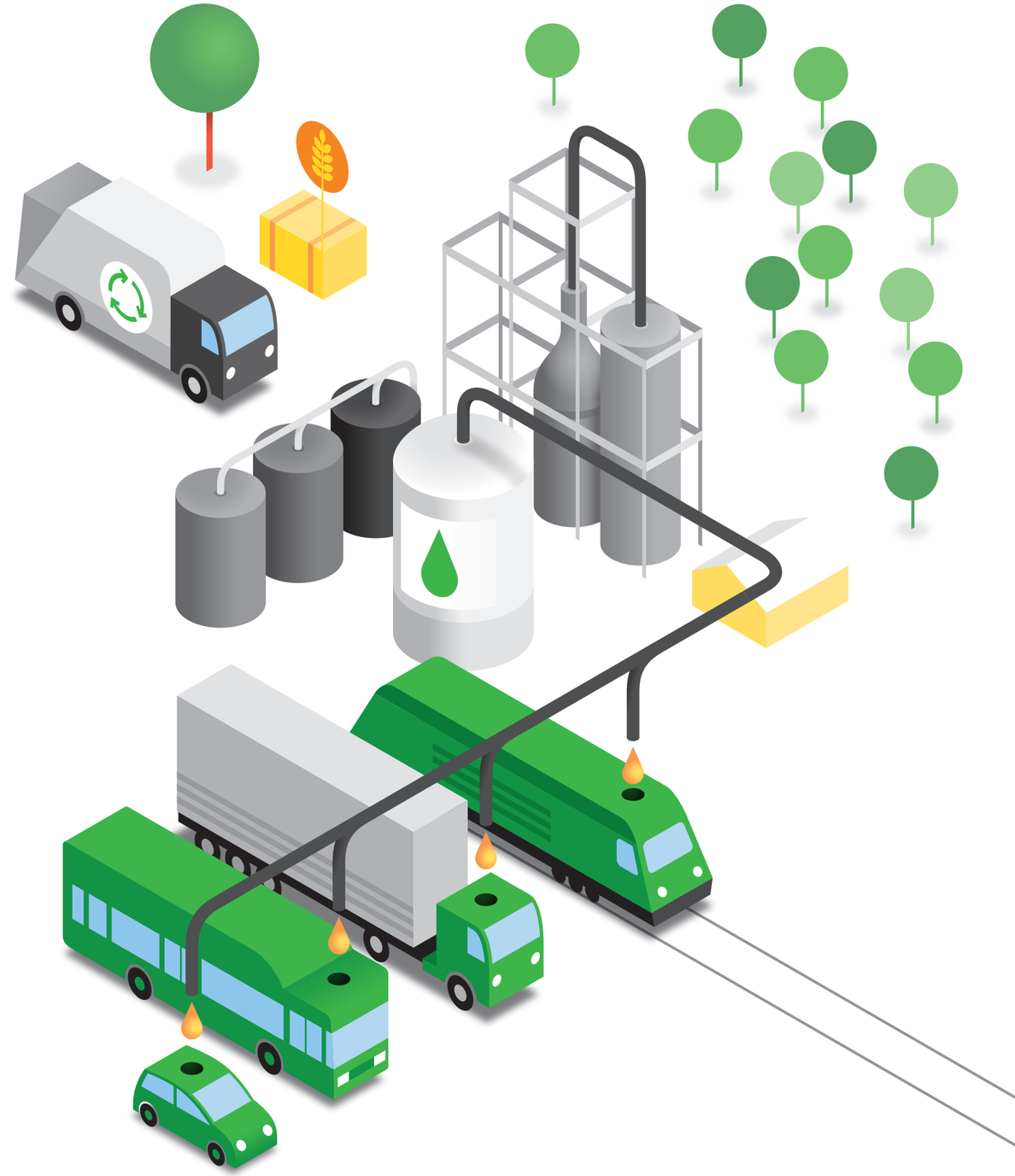
Connie Hedegaard

European Commissioner for Climate Action since February 2010. Danish Minister for Climate and Energy 2007–2009. Danish Minister for Nordic Cooperation 2005–2007. Danish Minister for the Environment 2004–2007. Prepared and hosted the United Nations Climate Change Conference 2009 in Copenhagen.

Bioenergy

How can the Nordic region accelerate Nordic technology development within advanced biofuel production?

The potential of Nordic biofuel production is significant but extensive investment in technology would be required for deployment – NETP, page 93

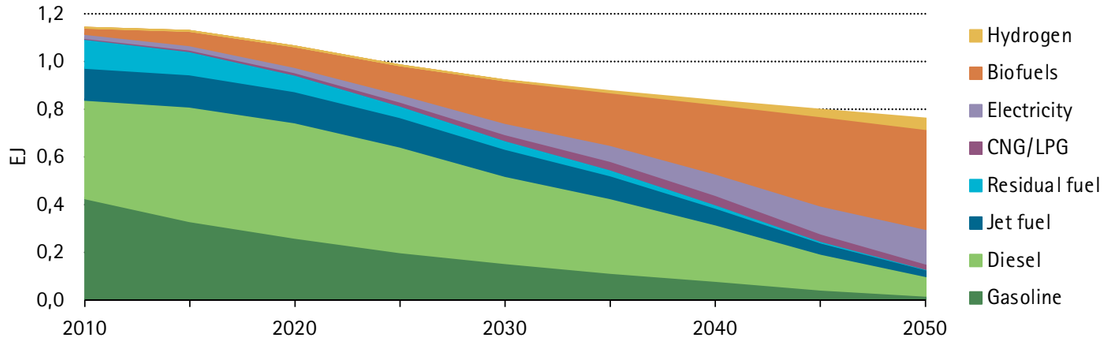


Biomass and municipal waste are the largest sources of renewable energy in the Nordic region, due to available natural resources and policy measures. They are closely linked to industrial activities, with the largest energy-intensive industry sector in the region – pulp and paper – using a significant share of biomass for its energy supply.

According to the Carbon-Neutral Scenario in NETP, biomass will come to play a much larger role in the future. This is due to the importance of biofuels in decarbonising the transport sector, where it is the most feasible technology for long-distance applications such as shipping and aviation. Participants at the Arena were presented with the following key points from NETP:

- Bioenergy will be the single most important energy source in the Nordic region, particularly in transport where it accounts for half of energy use.
- Energy consumption from biomass and waste will increase from close to 1100PJ today to almost 1700PJ in 2050 – a third of the total primary energy supply. This results in 13% of demand being imported to the region, meaning that ensuring a sustainable supply will be a central challenge.
- Development of advanced biofuel technologies is a key priority, presenting an opportunity for RD&D investment. ■

Nordic energy use in transport in the Carbon-Neutral Scenario



Bioenergy comes to underpin transport energy use in the Carbon-Neutral Scenario, needing to be doubled already by 2015 and multiplied twelvefold by 2050. Over the same period, oil use for transport will need to decrease by 90%. The figure indicates that the phase-out of fossil fuels would increase in pace from around 2020, as energy efficiency improvements contribute a significant share of short-term emission reductions.

Cases from the Nordic Energy Way Arena on Bioenergy

The Challenge

According to Nordic Energy Technology Perspectives, bioenergy will be the single most important energy source in the Nordic region in 2050. According to the Carbon-Neutral Scenario, by 2050 biomass and waste shares will have almost doubled in terms of the total primary energy supply. The scenario also predicts that the Nordic region will become a net importer of bioenergy, importing 13% of its supply in 2050. The group discussed the opportunity for Nordic research and development in advanced biofuel technologies, which could potentially strengthen domestic production of second-generation biofuels. Another key challenge is to ensure sustainable bioenergy production. This shows the importance of international co-operation and standards, such as the sustainability criteria laid out in the EU Renewable Energy Directive (European Commission, 2009).

The bioenergy group identified three main Nordic challenges to be addressed:

- Ensure self-sufficiency through increased production
- Achieve credible political commitments from decision-makers
- A total sustainability approach; correct cost calculations for alternative energy sources

Based on these challenges the group came up with two solutions: *Proforest/ Sustainable Forestry Supply by 2050* and *Clean Bioenergy for Society*.

Solutions

ProForest – Sustainable Forestry Supply by 2050

Goal: The goal is to find to solutions to increase and optimise production of Nordic forest biomass.

ProForest aims to achieve a 20% increase of woody biomass production by 2050. In order to reach ambitious levels in bioenergy use without imports, sustainable forest bioenergy utilisation will have to be increased significantly. The concept includes engaging forest managers and owners across the Nordic countries through R&D to increase sustainable production to maximise climate mitigation and forest adaptation.

The group suggests establishing 30 Nordic business cases related to different local conditions by 2017. Then, by 2020, the project outcome will be a long-term road map for Nordic forestry supply, including 30 implemented local cases.

On a societal level, ProForest will provide benefits such as more job opportunities, improved rural economy and public participation. The relevant stakeholders identified by the group are local NGOs and municipalities, forest owners and industries within forestry, energy and conservation. The industry sector could gain large-scale access to biomass and see a boost in conversion technologies. Further, companies may gain opportunities to export both high-productive solutions for forest restoration as well as competitive technologies. By developing local Nordic participation models in forest restoration, research institutions and the Nordic branding of research alliances could also improve international competitiveness.

Clean Bioenergy for Society

Goal: The goal is to secure sufficient sustainability criteria for Nordic forestry.

The bioenergy group discussed the fact that the mandatory EU sustainability criteria for biofuels are insufficient from many perspectives. The criteria mainly consider Greenhouse Gas (GHG) emissions related to biofuels, without taking into account the other environmental, economic and social aspects. Furthermore, the criteria have been developed from an agro-bioenergy point of view, and they are not very suitable for forest bioenergy. Clean Bioenergy for Society provides a possibility for the Nordic countries to join forces in developing better sustainability criteria for forest bioenergy.

The concept includes verifying the sustainability of using Nordic wood as bioenergy feedstock. An implementation of Clean Bioenergy for Society could ensure sustainable biomass consumption and improve Nordic forestry and forest management. Furthermore, the development of a domestic and local sustainable market could be very beneficial for Nordic industries.

According to the group, the stakeholders that should be involved are Nordic researchers, the forest industry, end-users, committed politicians and NGOs. While researchers would contribute with facts, evidence and methodology, the industry could provide data and funding. The desired outcome is to verify the sustainability of using Nordic forests in the short and long term. ■

What should we prioritise?

Two experts in the field of energy, **Anders Eldrup** and **Jørgen Henningsen**, participated in The Nordic Energy Way Arena. We asked them for their opinion on where the Nordic research and development cooperation opportunities are. Both mentioned two areas they consider the most important and valuable priorities.

Anders Eldrup

Number one: Biomass
"I would point out two areas where there are special reasons for the Nordic countries to cooperate. One is biomass. We have a strong and unique bio-industry in the Nordic countries. We have some of the best research in the world in this area. It is an area where we have comparative advantages and where it would be obvious for the Nordic countries to play a leading role."

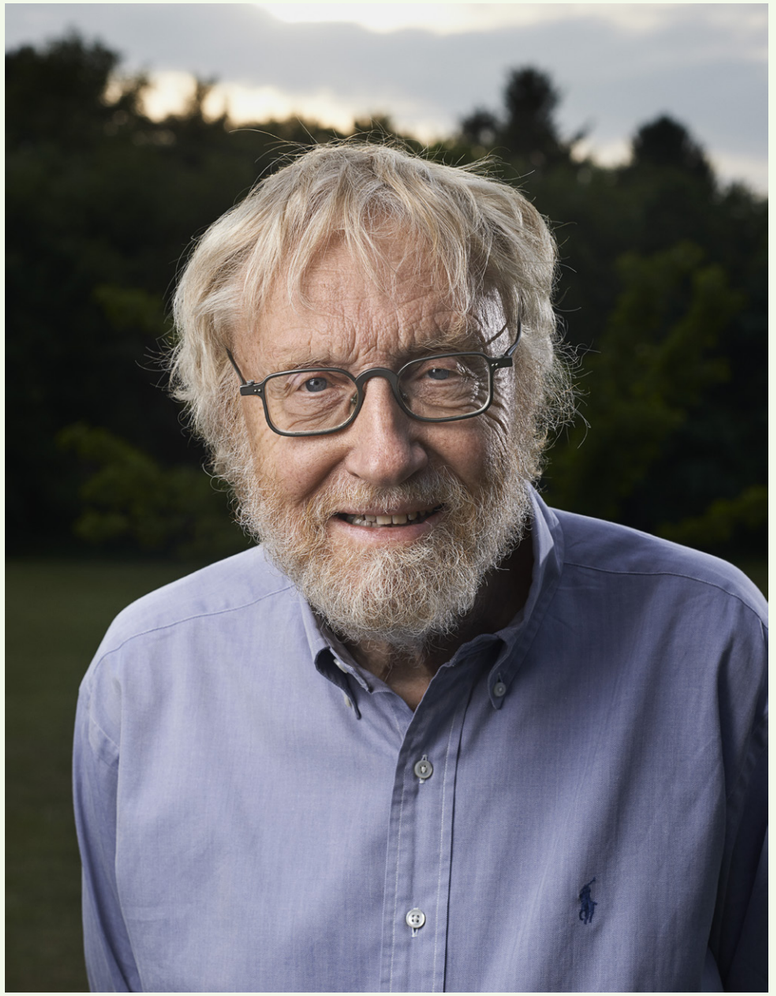
Number two: Buildings
"The second area is buildings. We live in a part of the world where it is relatively cold for parts of the year. It is natural for us to find out how to make our houses energy neutral. We also have skilled industries in this area, such as insulation industry, thermal control industry and so on. We must set very ambitious targets for new buildings that do not emit CO_2. And tough targets for existing buildings. And it should be targets that are significantly tougher than we see in the rest of Europe. This will have a number of advantages. We need it because of the climate. We are well placed with the companies we already have in this area. And it is an area, like bioenergy, that creates a lot of jobs, and therefore helps not only the climate but also to remedy general economic and employment issues that we have."

Anders Eldrup

Danish business leader, formerly Permanent Secretary of State at the Ministry of Finance. Since 2001, Eldrup has worked as a CEO, first for the Danish oil and gas company DONG (Danish Oil and Natural Gas), and from 2006 to 2012 for DONG Energy – the result of one of Denmark's largest mergers in history between DONG and five other Danish energy companies.

Jørgen Henningsen

Number one: Transport
"The Nordic countries have to prioritise transport. The difficulty is that a large part of transport is European or global, so there are limits to how far you can get with Nordic initiatives. For example, if the auto industry doesn't want to cooperate, we will not succeed. But we face a common challenge, and 25 million people have more weight than five million. Sweden has a trucking industry, Denmark and Norway have shipping, so there are some areas that are obvious to start with. The Danish shipping industry has tried to influence the International Maritime Organization (IMO) when it comes to shipbuilding standards, fuel economy and so on. So transport is one area I would mention."



Number two: Structural transformation
"The second major challenge is the structural transformation of the energy sector to enable it to use far more electricity in the end use of energy consumption. And because renewable energy is mostly based on electricity, we will have to produce a lot of windpower. There's not enough biomass in the Nordic countries to solve this problem and we cannot import enough of it for this purpose. Therefore it will quickly become apparent that we will have to make the structural transformation to more electricity using windpower, hydro (as in Norway, Sweden and Finland) and perhaps some nuclear energy. We have to look at how we transform the energy sector to being based more on electricity in the end use of energy consumption. This is especially important in three areas: transport, buildings and industry. How can we get heating for buildings transformed to electricity? And how can we switch from traditional forms of energy to electricity in the industry?"

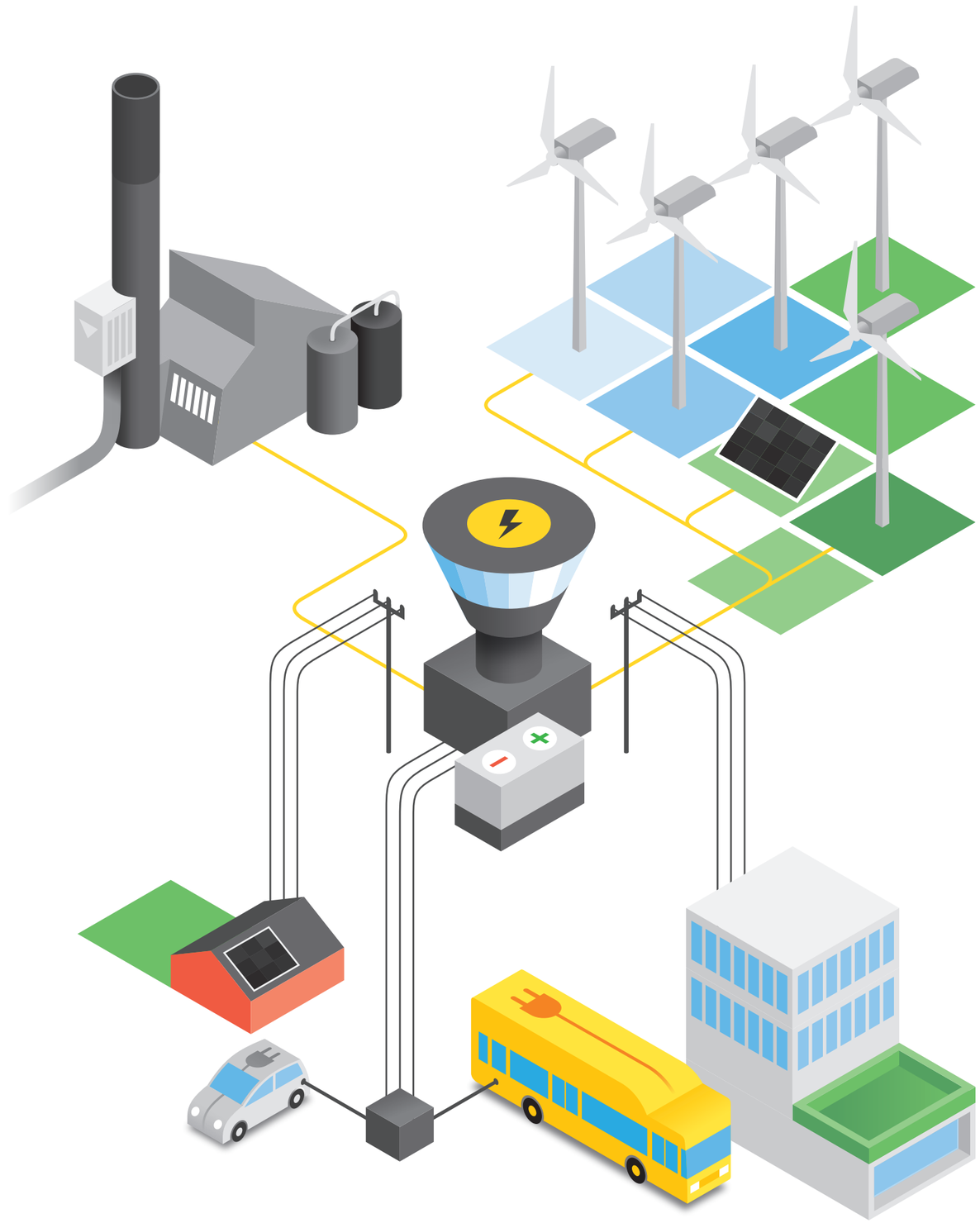
Jørgen Henningsen

Danish senior consultant for the European Policy Centre think tank. Has worked as part of the European Commission for almost 20 years, first as director in DG Environment and from 2001 as principal advisor in DG Energy and Transport. He headed the commission's negotiations on the UN Climate Convention and the subsequent Kyoto Protocol.

Smartgrids

How can the Nordic Region facilitate early infrastructure development to unlock renewable power generation and energy efficient demand-side technologies? And can the region address financing barriers and public acceptance issues?

Nordic electricity generation needs to be fully decarbonised by 2050. This will increase the need for flexible generation capacity, grid interconnections, demand response and electricity storage. – NETP, page 9

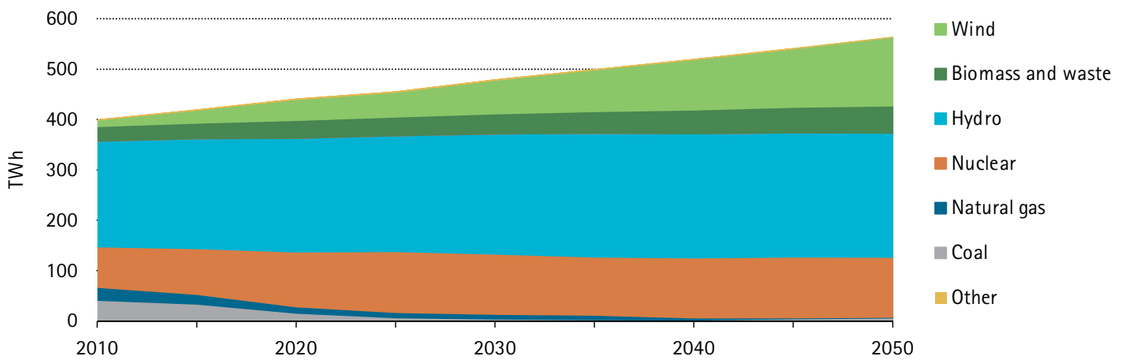


The Carbon-Neutral Scenario in NETP describes a build-out of Nordic power generation capacity to meet increased demand from the electrification of transport, buildings and industry, but also to supply continental Europe with clean electricity. In the scenario, wind generation increases tenfold from 3% of the total generation in 2010 to 25% in 2050. These changes require a strengthening of the grid, more interconnections and smart solutions for demand response and storage.

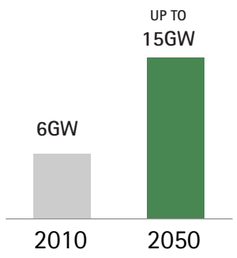
Participants at the Arena were presented with the following key points from NETP:

- A build-out of renewable power generation and a strengthening of grids will result in a more visible energy system, raising public acceptance issues.
- Europe's demand for clean electricity could make it profitable for the Nordic region to become a net exporter of electricity to the continent. This would require a significant expansion of transmission capacity to facilitate net Nordic exports of up to 80TWh in 2050.
- A low-carbon and flexible Nordic electricity system could benefit other European regions by providing balancing capacity.

Nordic electricity generation in the Carbon-Neutral Scenario



Extra nordic transmission



The Carbon-Neutral Scenario envisages a tenfold increase in wind generation, and an increase in nuclear generation in Finland. This would likely raise significant public acceptance issues. To facilitate the export of electricity to continental Europe, extra-Nordic transmission capacity would need to increase to up to 15GW by 2050.

Jan-Ove Gjerde, SVP at Statnett

Smart grids are something the Nordic countries are good at. Now it's time for a pilot project, to make it real and use our competitive edge, says Jan-Ove Gjerde.

From your point of view, where are the Nordic research and development cooperation opportunities?

"Smartgrids. We have already created a system together. We are four countries who have worked together on developing the energy sector for several decades. We have the same cultural background, the same needs and we have almost the same economic capacity. Smartgrids is an area we are good at, where we can teach others. Universities in the Nordic countries are also very strong in this area. We have been good at power system thinking. Smartgrids are about having a holistic overview of production, transmission, distribution and users."

What do we need to move forward?

"We've come very far, so what's missing is a pilot project where we can show what we can do. A Smart Grid with balance, integrating renewable energy, finding other ways to ensure the reliability and involvement of customers. We need to show the value of smartgrids. We have talked about it for ten years, but we have not shown how it works in practice."

Are there any other areas you want to highlight?

"Another area where the Nordic countries have great potential is big data. In Statnett we have installed a technology called Phasor Measurement Unit (PMU) which is able to obtain information from the power system 50 times per second. We get huge amounts of data that can give much more accurate information about the state of the power grid. We can use this information to plan the operation online. Instantly. It will change the market. And we are going to use PMUs not only at the transmission level, they will be key building blocks all the way, maybe down to the you-and-me-level. But only if we can handle the huge amount of data. In Statnett we are also working on a system that constantly checks the state of the power grid. It makes 30,000 checks a year, but with today's operating system, we only have capacity to go through 500 of the incidents. So what is all this information hiding? What added value can we get from checking all these incidents? We can build a much better monitoring system that can display weaknesses, prevent failure of all different kinds and enhance the security of the power grid."

What are the Nordic countries' strengths in the energy sector?

"The main strength is our common culture and common understanding. We have worked together for a long time with these issues. The political situation is very stabile in the Nordic countries regarding the energy sector. The competitive edge in Scandinavia and Europe versus Asia is our systems thinking. We have a holistic view."

Jan Ove Gjerde

Jan Ove Gjerde is the Senior Vice President of the Research and Development division at Statnett. He has 25 years of experience as a senior R&D Scientist at SINTEF Energy Research (Trondheim) and Senior Research Manager in ABB Corporate Research (Oslo). He has also had a global responsibility for the power systems R&D areas in the ABB Group. Statnett SF is Norway's national main grid owner and operator, and is responsible for all high-voltage electricity transmission and distribution in Norway.

Cases from the Nordic Energy Way Arena on Smartgrids

The challenge

To optimise the benefits of Smartgrid R&D, facilitating Nordic cooperation is paramount. Smartgrids encompass technologies that span the entire power system from producer, system operator to end-user, and can induce changes needed for an efficient and flexible power system in the future. Without an automated and complex grid infrastructure, other smart solutions are hindered from being sufficiently integrated and utilised, hampering increased development and efficient operation of the power system.

The group discussed the challenge that lies within the lack of one strong common Nordic platform to motivate cooperation, which leads to fragmented research activities. There also seems to be a lack of a general understanding of the benefits of Smartgrids, preventing the necessary investments from being made.

Based on this, the group identified two main challenges to be addressed:

- *How can we ensure that multiple stakeholders accept Smartgrids in the Nordic power system?*
- *What are the Nordic countries' competitive advantages in developing market and technical solutions for power system balancing?*

In order to answer these questions, the group came up with two solutions: "Smartgrid Strategies" and "Smartgrid Balancing".

Solutions

Smartgrid strategies

Goal: The establishment of a top-level Nordic R&D strategy that identifies the technical, economic, and social benefits of Smartgrids to increase the motivation for further investments and development opportunities. Nordic cooperation on Smartgrids R&D will help avoid fragmentation of research activities and establish a common Nordic knowledge platform.

Investments are spurred by focusing on researching, implementing and developing Smartgrids infrastructure. The societal, technical and economic benefits of Smartgrids need to be identified, which will ensure that further investments are accepted.

Smartgrid strategies mean increased support for public investments in affiliated projects, a more cost-effective power system and increased flexibility for prosumers. Within a Smartgrid system, prosumers are electricity consumers that can also produce electricity and store energy. For industries, developing and investing in Smartgrid solutions might provide competitive advantages and pave the way for an increased system flexibility. Nordic-based research institutions are geared to cooperate with the Nordic power industry and policy makers, and could therefore receive more funding for knowledge-base creation.

Smartgrid Balancing

Goal: The goal is to develop and evaluate new solutions for utilising Smartgrids and automated demand response. Coordinating Nordic solutions is important in order to be proactive within European decision-making.

Through the up-scaling of Smartgrids research from a national to a Nordic level, certain advantages that will facilitate the maximisation of technical penetration as well as implementation, development and economic and societal benefits will be identified. Balancing opportunities for varying power in a future carbon-neutral society will secure an efficient power system and potentially increase the Nordic region's export of power to continental Europe. The main challenge is to balance variable renewable power and interconnections by securing reserves and controlling power. One main driver behind Smartgrids balancing is the increased flexibility in handling higher loads from variable power production, which can have a positive impact on the integrated Nordic electricity market.

Smartgrid Balancing will contribute to a power system free of carbon emissions, and secure power supply. To provide the necessary technology there will be a need for new IT and technology industries. Smartgrids can contribute to increased energy efficiency in industries, and provide opportunities for end users (prosumers). Altogether, a more effective and efficient grid can be provided. There are both research opportunities and challenges linked to Smartgrid balancing, which ultimately will lead to increased knowledge and competence in the research sector. ■

Katherine Elkington, PHD, Electrical Engineer in Svenska Kraftnät

The Nordic countries share many of the same goals and joint solutions are already often the only way forward. For example cooperation regarding renewables and balancing the power system.

Where are the unique nordic R&D cooperation opportunities?

"The Nordic countries have many of the same conditions, which make many of their goals overlap. The European Commission has set out the so-called 20-20-20 climate goals. For the electrical and other utilities industries, this means installing and interconnecting renewable energy sources. Also, the power system must be in balance."

What will it take to realise the joint Nordic solutions?

"The Nordic countries have a unique position in that their power systems are so closely interlinked that they have many common goals. Joint Nordic solutions are already often the only way forward, and the countries already cooperate closely regarding issues in power systems. For example, the Nordic Analysis Group works closely on studying Nordic power system issues."

Katherine Elkington

PHD, Electrical Engineer, works in Svenska Kraftnät, the Swedish national grid, a state-owned public utility. The important tasks are to transmit electricity from the major power stations to regional electrical grids via the national electrical grid; ensure balance between consumption and production; contribute to ensuring an electricity market where the players can purchase electricity in free competition; responsibility for electricity preparedness; and working to reinforce Swedens electricity supply system to ensure it is able to withstand critical situations.

The Climate Paradox
If it's so important, why doesn't it sink in?

There are lots of facts and statistics about climate change. Science has provided ever more reliable data over the last 20-30 years, and thus ever more gloomy forecasts for the coming centuries. But nonetheless public concern about climate change and support for climate policies has been declining over the last decades. What is the psychology of this climate paradox? And what can we do about it?

By Psychologist and Professor Per Espen Stoknes

The paradox is so obvious that everyone can see it: never have we had a more accurate understanding and so many facts about how serious climate change is, but still public concern is declining. For example, Norway is more often affected by floods, avalanche danger increases, roads are washed away, it rains much more than before and the tree line is moving upwards to higher altitudes. Internationally, we know that the Arctic sea ice is disappearing at a dramatic rate, and many other examples and facts are well known. But how do people relate, cognitively and emotionally, to climate issues and facts? And can we suggest better ways to communicate with them?

Climate scientists say that we might be on the way towards a world that is four degrees celsius warmer at the end of this century than in pre-industrial times, possibly five or six degrees. These figures may not sound like much. But these are global averages where each degree means major changes in landscape and soil. A plus four-degree world is a very different world than the one we know in recorded history. Vast deserts, Amazonas scorched, agricultural land lost, melting permafrost, perhaps massive migration with people moving north and to the coasts to locations that still have water and predictable rainfall.

The scientific debate about whether climate change is happening or not is over. 97 out of 100 climate scientists are reasonably confident that climate change is caused by emissions from human activities in the energy and land use. But since this is so serious – and the consensus is so great among scientists that we are heading in that direction – then why aren't people marching in the streets and demonstrating?

Instead, Norwegian polls from 1989 to 2012 show a declining interest among the population.

Per Espen Stoknes

Organisational psychologist, doctoral degree in Green Economics
CEO, Stoknes Futures AS
Lecturer, BI Norwegian Business School
Co-founder of two new clean-tech companies, GasPlas and AgroPlas
Author of several books

The question posed was "How concerned are you about the greenhouse effect and climate change." In 1989, 69% were somewhat or very concerned. Since then the figures have gone a bit up and down, but mostly down. In 2011, only 41% were somewhat or very concerned.

Why is the loud protesting limited to environmentalists, extremists and alarmists? Why are most people calm about it? According to the international communications agency Nielsen, Norwegians are the second least concerned in the world, much like Americans, surpassed only by Estonians. Why has this climate paradox occurred?

Partly it is a side effect of scientists and environmental bureaucrats' own model for climate communication. They often start from a false premise: that most people are like an "empty bucket", that they lack information and training. The task is rationally to fill it up, to inform people adequately about research results with facts and graphs and references. With repetition if they don't get it. Those who do not change perception based on the new facts are ignorant or stupid. This empty-bucket approach to climate information is known as the "deficit-model" of science communication.

There are many reasons why information campaigns are insufficient to convince people about basic conditions. First and most important is the recognition that people's heads are not empty buckets. They are already full – of attitudes, filters and prejudice. This ensures that information contrary to what we already know – or think we know – is filtered away, perceived as excessively biased or wrong. We prefer to hear confirmations of what we already know and believe. Information that is disturbing or repulsive is almost automatically deselected.

This is called "confirmation bias" within cognitive psychology. In other words, those who are already concerned and have sympathy and interest in climate matters typically read more articles with facts that confirm what they already believe, while those with the opposite attitude avoid, distrust or explain away new unsettling climate facts. Similarly, most people seek information from sources that they already agree with.

Another problem is that environmental and climate activists may have used up their emotional capacity to respond to the apocalypse and doom. Already in 1987, the Brundtland Commission stated that "It is urgent ... and the time for action is now!" This story says that unless we act now, it will go terribly wrong in the future. We have heard that every year since. It may well be objectively correct, but such fear and doom stories have less and less effect in people's minds.

A third important issue is that the climate message has become politicised. Those who prioritise climate issues highly, are also typically supporters of higher taxes on energy and CO_2, and strong regulation of greenhouse gases. That means stronger government with more regulations and requirements, and more focus on the environment and green values. Others have political beliefs and values that prioritise the market, freedom and less government intervention higher. Still others prioritise jobs and local industry.

It turns out that such politically coloured world views have great significance for how different people read the same climate facts. The higher your level of education, the more you rely on your own interpretation and political worldview, rather than relying on climate scientists' interpretation. Our thinking is culturally and politically constructed, and easily overrides purely scientific reasoning. This surprises and frustrates apolitical climate scientists, who primarily are in search of the truth, however complex it may be.

The last factor regarding the climate message is helplessness. Climate change is a global problem, and it is measured in gigaton CO_2. These are huge numbers hard to comprehend and many will easily get a feeling of helplessness: there is nothing I can do about it anyway

The psychological barriers

To explain the climate paradox, it's not sufficient to blame one-way information campaigns or poor communication models such as the empty-bucket model. There are additional and deeper psychological barriers that impair our reaction to the unsettling facts of climate change.

Let's take a look at four barriers in the human – and especially western – psyche, that prevent facts about climate change from being recognised and changing our behaviour patterns.

First, there is something about the climate change issue itself that makes it distant: climate change is distant in *time*. A lot of changes are expected to take place nearer to 2050 and beyond towards the next century. This feels very far away from our daily life. Climate issues in the news are often distant in *space* as well. Generally, the effects are strongest in the Arctic, in Greenland, Antarctica, the Pacific island states and Bangladesh, port cities like New York and New Orleans, or high up among the Himalayan glaciers, etc. It is also invisible, *remote from the senses*. The gases are rare, described very abstractly in "ppm" numbers.

Whatever climate change is, it is not something we can see or feel. Researchers talk about long-term or time-lag effects. All this strengthens the feeling of being helpless. And even if we stopped emitting now, the delayed effects – including from the coal our grandfathers burned last century – will continue to plague future generations for centuries to come. Finally, we (living in the western countries) are all implicated.This means everybody has to change for the benefit of all. That is the politicians' responsibility, and these powerful international decision makers are terribly far away from me. Climate

> "Every time the climate issue is framed in terms of the 'this is expensive' or the 'you have to make sacrifices' frames, the climate communicators are shooting themselves in the foot."

change is almost like a ghost, invisible, half-real, an evil omen with a whiff of death and disaster – perhaps something very superstitious people would care about.

In case of an immediate threat, however, like a speeding truck coming towards you or a basketball thrown at your face, your whole body reacts. You can feel the fight-or-flight response and the adrenaline rushing. This is a bodily response pattern that has developed over millions of years. The human body is very good at responding to threats that are close and visible, have happened before, have an immediate effect and a clear purpose, are performed by a clear enemy, and have serious consequences for me and my family. By contrast, evolutionary psychology states that threats perceived as distant arouse far less concern and response. The climate problem doesn't fit any of these criteria.

Attitudes

Attitudes to climate issues are not changed by information alone. Attitudes are half-automated predispositions of the organism to react to people or things in a positive or negative way. They have three components: emotion, action and thinking. In psychology this is called the ABC-model: Affect, Behaviour and Cognition.

The problem with climate information is that it almost exclusively targets the cognitive component. We have all by now understood cognitively that CO_2 causes global warming, but what is the link to the other two components, emotion and action? Journalists have used a lot of pictures of polar bears to try to supplement information with some emotional appeal. For a while the images of single polar bears on sinking ice with sad faces, served an emotional function in our unconscious. However, after prolonged overuse of polar bears as emotional triggers, we are now habituated and they no longer work.

Today, the dominant emotional component has probably become a mixture of fear and guilt, created by a climate message which constantly repeats that we should drive and fly less, eat less meat and generally not consume so much. Perhaps even more important than the emotional component is the action component of climate attitudes: if it doesn't match the other components, then cognitive dissonance will occur.

I fly a lot myself. Many colleagues and friends do too, especially in connection with "necessary" work. Everyone flies. There is a social dimension in our attitudes: we easily adjust our own attitudes to those that our significant others have. Imitating the significant others lies deep in our evolutionary psyche. When others believe this, it becomes difficult to maintain a strong personal attitude and motivation. The action component gradually wins back ground from thinking (we still know how serious the climate issue is), and even emotion.

We know, that if authorities come out with a strong public message ("Use dental floss!"), but does not provide sufficient opportunities for action (impossible to get dental floss), the lack of possibilities for action will soon weaken the message and the corresponding attitude. That is perhaps an important part of the explanation of the backlash seen in climate attitudes, for example since the wave of climate attitudes that occurred in 2007. That was the year when IPCC released its fourth report, Al Gore became a movie star with An Inconvenient Truth, the two shared the Nobel Peace Prize and the EU's emissions trading system seemed to become strong and comprehensive and headed towards a global climate agreement.

But international negotiations in Copenhagen in 2009 failed, and there was a national lack of pressure in many countries. At the same time, we have very few opportunities to do something on a personal level – and be acknowledged by others for doing it. In that situation the daily dissonance and guilt will gradually grind down the attitude: it is difficult to maintain a strong belief and motivation over time. It's easier to explain away dissonance and perhaps even deny it, which is the third psychological barrier:

Denial

Persistent cognitive dissonance strengthens denial. When you fail to change the pattern of actions, you can always change how you interpret the action. Aesop's fable about the fox that covets the inaccessible grapes are perhaps the first description of this pattern: "Those grapes surely must be sour."

> “The climate issue is easily perceived as distant. We need to give people simple opportunities for action that are consistent with the climate message.”

This is best known from social psychological research on smoking. Many smokers know (thinking) that smoking is harmful. But they still continue to smoke (action). This evokes an inner discomfort, as one’s self-image is threatened if there is too much distance between what we think and what we do.

But it is certainly not always easy to change our pattern of behaviour in line with what we know to be best or most rational. Our modern society is built around driving, eating meat and air travel. The inner tension and perhaps even contempt grows – and this is what is called dissonance. To get rid of this dissonance, our brain will come up with more or less fancy unconscious coping strategies. Four such strategies to reduce dissonance are well identified: 1) modifying one or both of the components; 2) changing the meaning of a component; 3) adding of an additional component; or 4) simply denying the problematic component.

In this way it is easier to reduce dissonance between knowledge and action through self-justification than to actually change behavior. Cognitive dissonance – especially in the field of smoking – is one of the best researched areas of social psychology. This theory has a very solid empirical foundation. Now we are starting to see studies confirming that the same patterns we see in smoking are also taking place in climate attitudes:

1) My emissions are so small, it is the Americans or the Chinese who have to cut theirs; 2) It’s far from certain that CO_2 causes global warming. This winter was freezing cold! I have heard that the Nobel Prize winner Ivar Giæver for example believes that global warming simply is not happening; 3) I have installed a new A-class heat pump in my house, so now we deserve a trip to Thailand: and 4) There is no evidence for the theory that CO_2 emissions leads to global warming. The whole climate thing is a hoax that left-wing alarmists have come up with in order to get more money for research and higher taxes.

The point is that dissonance creates a demand side for messages of doubt about the climate message. It’s much more comfortable to explain away climate as a non-issue than to change attitudes and corresponding actions. A psychological explanation of the climate paradox is that dissonance has created a need to not believe in the climate change. It’s this demand that anti-climate deniers have addressed by supplying contrarian ideas.

Climate scientists create discomfort and dissonance with their message about climate changes. According to cognitive dissonance theory, it is quite predictable that this leads to self-justification by denying – and shooting the messenger – as a natural and comfortable next step.

Framing effects

The fourth psychological barrier is the framing effects. Cognitive framing is the unseen, often subconscious frame around concepts and discussions that affect how an issue is perceived. Different words and concepts evoke different frames through the metaphors that are used. For example, there is a huge difference between an ”illegal immigrant” and a ”humanitarian refugees”, and the expression ”incest survivor “ comes with a different frame than an ”incest victim”. If you are told not to think of a pink elephant, it still brings up a cognitive image that will be related to a conversation situation, even if you actually manage not to think about pink elephants. The background image, the frame, is there even if you agree or not.

In climate discourse and climate policy the costs of different measures have become the dominant framing. We’ve heard for years from economists and politicians how expensive the different measures are. According to this framing, the things we ought to do are not cost-effective: electric cars and charging points are expensive, and it’s much more cost-effective to implement measures abroad.

The cost per tonne of CO_2 reduction has become the major scale: $/t$CO_2$. But with this framing it is not surprising, that many in society believe that we really can’t afford to implement a consistent climate policy. The framing has already declared it too expensive.

Partly overlapping with this cost framing is also a kind of puritan framing of sacrifice and life-denying moralism: ”Thou shalt not fly. Thou should not eat meat. Thou should not consume” – at least don’t let anyone see your consumption. Stop eating beef and meatballs. Eat carrots and broccoli. Give money to environmental organisations and vote green. Buy organic and so on.

Every time the climate issue is somehow framed in the “this is expensive” or the ”you have to make sacrifices” frame, the climate communicators are shooting themselves in the foot.

To summarise the barriers: the climate issue is easily perceived as distant, a lack of social action opportunities weakens attitudes over time, dissonance increases the need for denial, and messages framed by cost and sacrifice weaken the appetite for solutions. But the interesting thing is that the barriers can also be seen as success criteria: communication about climate change must in the future be made in such a way that it feels near and urgent. We need to give people simple opportunities for action that are consistent with the climate message. Dissonance can be reduced in other ways than denial. And we need new framings when we talk about climate issues and solutions. These success criteria are the basis of new strategies for climate policy:

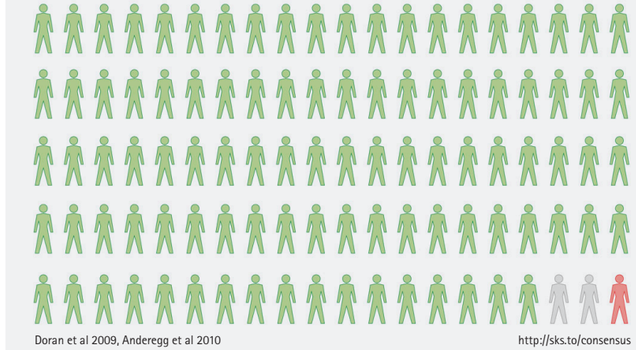
New psychological solutions and strategies

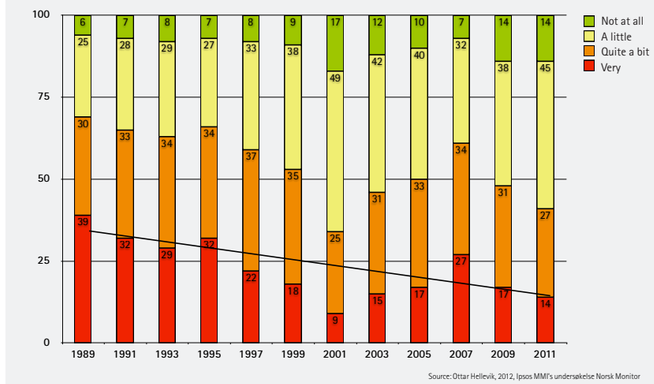
If factual communication, information campaigns or cost-effectiveness are not sufficient for effective climate communication, then what is? Fortunately, there is a wide range of well-founded and tested options. But they require a certain willingness to think differently and innovatively, lots of determination and perseverance to experiment, and trial and error. The direction and the new strategies, however, are very clear.

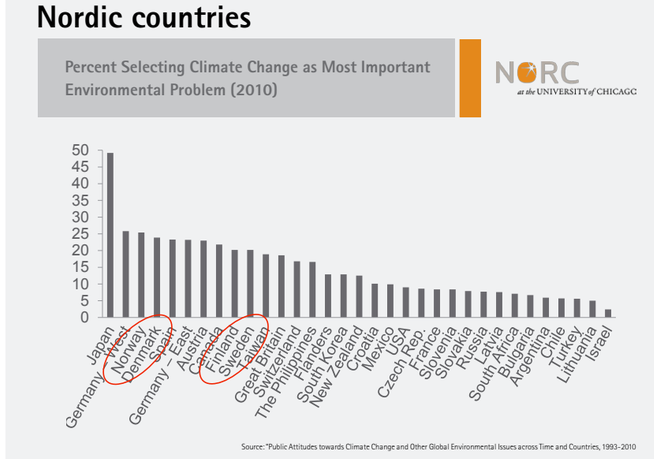
At least four are worth mentioning: 1) Use the strength of social networks; 2) Make it simple to act in a climate-friendly manner; 3) Use the power of storytelling; and 4) Use new framings for the messages.

Use the power of social networks

In conventional economics it’s primarily price incentives that work: consumers will be rational and do what is cheapest. But with recent psychological-economic research the importance of social norms and peer pressure has become much more prominent. Studies from the research environment around the marketing research psychologist Robert Cialdini illustrate this. In order to look at reduction of power consumption a study was made comparing four groups of households. Each group was given different reasons for saving power: Group 1: because it’s better for







the earth (sustainability). Group 2: for the sake of future generations (your grandchildren). Group 3: because it pays (more money). Group 4: because your neighbours do it (how much do your neighbours use compared to you?).

Which group had the greatest reduction in power consumption? No, not the first idealistic group. And care for our grandchildren did not last long as motivator in group two. Not even the third group, who had learned how much money they would save. The most committed people, and those with the greatest reductions, were those who could compare their own efforts with their neighbours. Social status and peer review is a very strong motivator. Comparison with peers is an emotional driver that is in many situations stronger than isolated self-interest. It's no real fun just saving power or money. But being recognised by others makes it so.

The company OPower has developed an app for facebook where you can access your own power consumption measurements, and compare your energy-saving performance with your friends. If you feel competitive, you can invite more friends to join the app. I cannot wait to see these apps – connected directly to real-time measurements by energy suppliers – set in motion in Norway. Social norms connected with two-way real-time readout of consumption will mean a very different awareness of our own energy-consumption.

The popularity of social networks can also be used to tap into local patriotism, to get Bergen to compete with Oslo, Gothenburg against Stockholm, Copenhagen against Helsinki etc. Other ways to use this strength is to engage unions, clubs and sports teams, as has been done with skiing. In that situation you can get the message out through the wire via senders who are much closer to the target groups than climate scientists are, senders whom they already identify themselves with.

Make it easy to choose eco-friendly

To avoid dissonance and maintain a climate-friendly attitude, it is important that as many daily actions as possible are consistent with climate knowledge, while not demanding too much extra effort. Many of the choices that consumers make have major and long-lasting consequences for energy consumption and therefore emissions. This is particularly true in relation to purchases of houses, cars, household appliances, clothing and food, especially red meats.

Can we add situations of choice to make it easier for people to shop in a more environmentally friendly way? This is called nudging (Thaler & Sunstein).Some countries have instituted automatic – or presumed consent for – donation of organs from the recently deceased for medical purposes, unless you register against it. It's easy to do, but many don't.

The organisation GreeNudge, together with Elkjøp, a retailer of electrical products, has succeed in getting people to buy energy-efficient dryers by providing life-cycle costs on large signs next to the purchase price. It helps people see the benefits of investing in the most efficient appliances. The nudging simply consists of reorganising the price information in decision-making moments.

If this nudging were used broadly in purchasing situations to favour the most energy-efficient of all types of electrical appliances, it could lower energy consumption by up to 5%.

At least as important – from a psychological perspective – is that this would help reduce the cognitive dissonance, at least in theory, because it's made easier to act consistently with what we know. And thereby it would strengthen the whole climate attitude.

Use the power of storytelling

As humans we create meaning through stories and storytelling, ever since we were hunter-gatherers and sat around the fire outside the cave at night 50,000 years ago. Climate change is also one such story or narrative, although scientists easily loose sight of this when we are immersed in our research and facts. Any presentation, graph or article, no matter how factual or objective they look, also has story features. The question is which kind of story to tell when communicating to non-scientists in order for them to understand the extent, urgency and need for action.

The story that has been used most often and without reflection is the apocalyptic story. That's not surprising, because it's a core story in our Christian culture: the last book in the New Testament, about the last times, with environmental and climate disasters described in exquisite detail as a form of punishment for sin and decay. The climate message too easily falls into this well-worn story track, often without the intention of the senders – the climate experts. You might say that the apocalyptic story comes sneaking in uninvited and spreads like a fog around graphs, figures and calculations: if we do not change now, doom will soon come to us all. What is described is increased storms, drought, floods, a rise in sea levels, damaged ecosystems and self-reinforcing feedback mechanisms that increase greenhouse gases in the atmosphere. It's the end of our world as we know it, it is coming soon, and it's all due to your sins.

It is not impossible that the future will in fact be something of a climate hell. But that is just one story, just one type of scenario. And it also generates fear, guilt, anger, despair and helplessness as its shadow side.

What we need are more positive environment stories that describe and help us imagine a renewal of wildlife and ecosystems. We can tell stories describing a new form of contract or relationship between economic activities and nature. Damaged or unproductive land can return to being forests and wetlands, and nature can demonstrate its often marvellous ability to restore vital ecological relationships. Many wild species can settle surprisingly close to rural areas, as long as humans do not destroy them. Stories like this would stretch the horizon further than just working to stop the destruction of pristine nature, and also describe an ecologically richer, rrewilded and better world that you and I can look forward to living in.

Technological and lifestyle changes promoting a green economy are also occurring at a furious pace. Creativity and capacity for change appears in small-scale solutions, such as bottle-sunlight, solar cookers, electric bicycles, passive houses, bioenergy systems and reuse of waste to create high-value products. There is no shortage of ingenious solutions that can be told inspiring stories about. There is, however, a shortage of good storytellers who give hope and inspiration as well as attractive images of the future.

Reframing the climate messages

"Reframing" refers to the invisible rooms of thought around our concepts and conversations that gives meaning and guidance to our understanding of something. They are typically formed in our brains using metaphors and mental images. So rather than continuing the climate discourse within the "it's too expensive" framing, we could employ other metaphors and put them to work. For instance the insurance framing.

Rather than going on and on about the cost-effectiveness of climate measures today compared to future costs of global warming, we could see the field within another frame. This field needs a different logic than the one given by cost.

We don't have a national defence because it is profitable or cheap. We don't pay fire insurance bills because it is cost-effective. We don't believe anymore that we will be invaded by the Soviet Union or that our house will burn down. Yet we spend a lot of money to ensure against such risks. Because it *could* happen. As a society we pay to protect the values we believe in. The same should be the case with climate action: we have to pay insurance against the climate system falling over the edge with large, irreversible consequences. Within the insurance framing the discussion will change to the size of the insurance payments: how much is it worth to pay today to avoid climate chaos in the future? What about Norway's contribution to the problem as an oil nation? Is it more important today to insure against climate change than against military invasions?

This brings us to another related framing: how we, in case it happens, should defend ourselves or handle mass migrations of climate refugees from areas that are uninhabitable due to heat and drought or a rise in sea levels. It is significant that even the CIA has conducted extensive research and set up a centre for climate security.

Another important framing of the climate issue is health and quality of life. Global warming would cause changes in our natural environment, and a part of our identity would disappear. A lot of invasive insects, more floods, storms and landslides, roads that fail, homes destroyed, lives and health put at risk. At the same time it can be excellent for both health and climate to eat less meat and more vegetables. Good for both body and climate with more biking and less driving. The two causes have much in common.

Conclusion

Today we already have the technological solutions, best practices and resources to solve the climate problem. The challenge now is to get a majority of us to decide on and support the wider implementation of existing solutions, especially in western democracies. Politicians seem reluctant due to the costs and prefer to wait for stronger demands from citizens, just as citizens are waiting for stronger action from politicians. How do we break this deadlock?

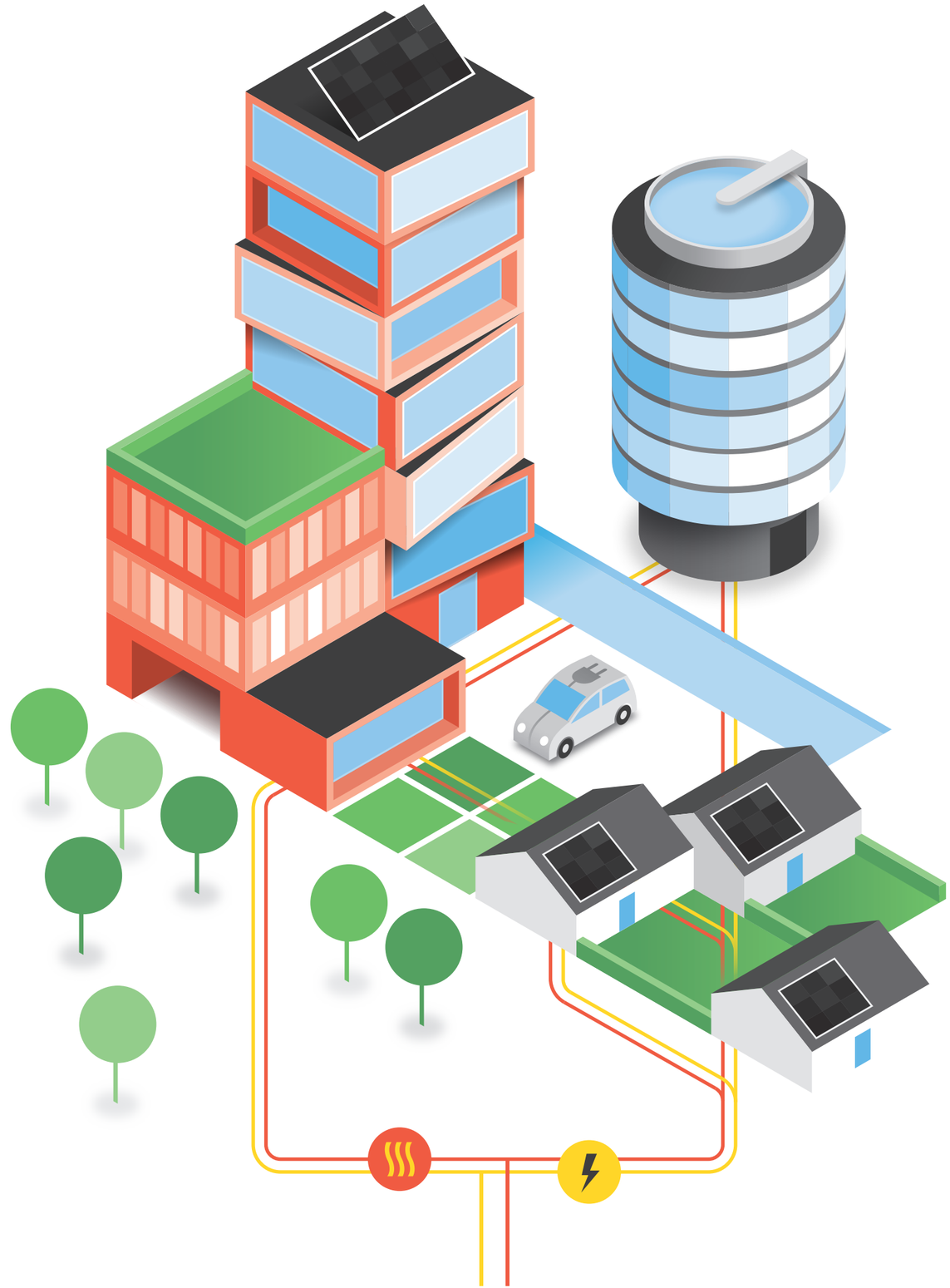
Psychology and behavioural economics by no means have all the answers, but in a multidisciplinary approach climate scientists and people dealing with energy and climate information can avoid pitfalls in their communication efforts. With a multidisciplinary approach we can develop a new range of practical communication solutions for overcoming the psychological climate paradox. The new climate communication must actively address the psychological barriers in a way that makes the climate issue felt as more personal (less distant), develop nudge actions that reduce cognitive dissonance and denial, tell new stories and, finally, push us towards a more constructive framing of the debate. ■

> "Politicians seem reluctant due to the costs and prefer to wait for stronger demands from citizens, just as citizens are waiting for stronger action from politicians. How do we break this deadlock?"

Energy Efficiency in Buildings

How can the Nordic Region accelerate the energy efficient renovation of the Nordic building stock? Can the building sector integrate with other sectors and contribute to smarter Nordic cities with lower emissions?

Widespread retrofits of older building stock will be needed to achieve the necessary energy efficiency improvements – NETP, page 9

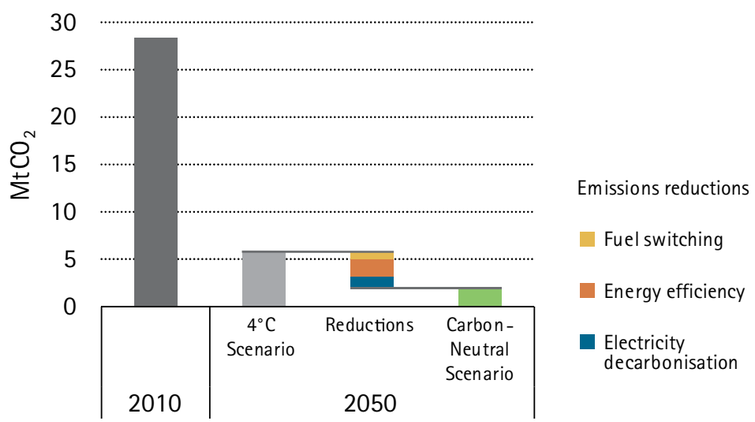


According to the Carbon-Neutral Scenario in NETP, emissions from energy use in buildings need to be reduced from 50 $MtCO_2$ in 2010 to approximately 5 $MtCO_2$ in 2050. Participants at the Arena were presented with the following key points from NETP:

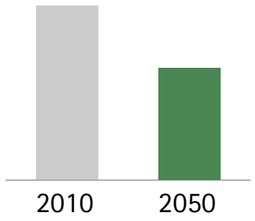
- A significant portion of the emissions reductions from the sector are achieved through decarbonising heat and power upstream.
- As direct CO_2 emissions in the building sector are relatively low, the central challenge is addressing energy use in buildings. The scenario projects a 35% drop in residential energy use per m^2, requiring substantial investments in retrofitting the building shell.
- Energy efficiency retrofitting is a no-regret measure that must be incentivised through targeted policies addressing both economic and non-economic barriers to investments.
- In the longer term, there will be a need to prioritise advanced building technologies, urban planning, and intelligent systems that empower consumers and encourage behaviour change.

Nordic CO_2 emissions from residential buildings

In the Carbon-Neutral Scenario, a significant 35% drop in residential energy use per square metre is required. Most emission reductions in the sector come from upstream decarbonisation of the heat and power supply. However, moving from the 4°C Baseline Scenario to the Carbon-Neutral Scenario requires substantial energy efficiency improvements.



Energy use per m2 in residential buildings in the Carbon-Neutral Scenario



Lars J. Nilsson, Professor, Lund University

The Nordic countries need long-term, use-inspired, and relatively basic research, says Lars J. Nilsson.

Where are the Nordic R&D cooperation opportunities in the building area?

"Much of the R&D in the building sector is national, as is the building sector in itself. The Nordic countries have similar climatic conditions and the construction industry, as well as energy service companies (ESCOs) and other stakeholders, would benefit from greater harmonisation across the Nordic markets. Greater Nordic R&D cooperation would be valuable in itself and could, in addition further such a development."

And in general?

"The Nordic countries are endowed with energy, minerals and other natural resources. A hitherto neglected but important area is to develop technologies and strategies for decarbonising heavy industry and becoming an international supplier of sustainably produced, or green if you like, basic materials as well as higher value added products."

What will it take to realise the joint Nordic solutions?

"It requires cooperation at all levels: governments, agencies, industry and academia. Good research is driven by curiosity and interest. Fruitful research cooperation also requires trust, openness and mutual respect. But most of all, research needs to be funded."

Who is it necessary to involve?

"The relevant stakeholders to be involved vary depending on sector and research topic. But we need to take care to ensure that the agenda is not taken over by the incumbent firms and other actors. Most of all, we need to look out for the stakeholders of tomorrow. Thirty years ago, the wind industry was not yet a stakeholder. Today it is an important one."

What is needed?

"I would like to stress the importance of long-term, use-inspired, and relatively basic research. It is important to include industry interests, but they are far too influential and gear the research priorities to their own and often very short-term development needs."

Do you know of any existing examples or best cases of Nordic cooperation?

"I think several of the Nordic Energy Research initiatives fall into this category, but unfortunately they are relatively limited in scale compared to national and EU funding streams. Thus, future Nordic cooperation should be geared towards complementing rather than duplicating this through identifying uniquely Nordic focus areas."

Are you aware of national differences in the Nordic countries?

"Some examples: Denmark, Norway and Iceland are strong in electric vehicles, smartgrids and hydrogen. But Sweden, for example, has a strong automotive industry. Sweden and Finland are strong in forestry and bioenergy. But Denmark and Norway has Novozymes and Borregaard, respectively – two important industrial biotech companies. Different national structures and contexts have produced different priorities in R&D, resulting in complementing expertise in different knowledge areas. This could be better exploited."

Lars J. Nilsson

Professor at Lund University. His topical focus has been on renewable energy and energy efficiency in the context of evolving energy systems. Main research focus at present is how the transition to low-carbon energy and transport systems can be governed.

Cases from the Nordic Energy Way Arena on Buildings

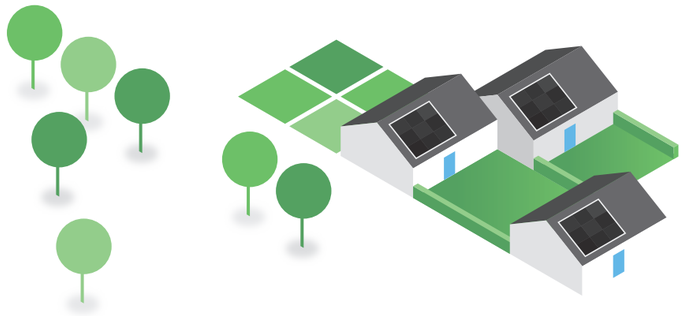
The challenge

Energy efficiency in buildings has significant potential to contribute to emission reductions, with many energy efficiency investments paying back so quickly that their marginal abatement costs are negative. However, the group discussed the fact that non-economic barriers and other factors have hindered consumers and businesses from making investments in energy efficiency and realising this potential.

Energy efficiency improvements are vital for both new and existing buildings, and in both the residential and commercial sectors. The group identified existing residential buildings as the most critical for accelerating energy efficiency improvements. Residential buildings use two-thirds of the total energy consumption in buildings, and 73% of the existing Nordic building stock will still be in use in 2050. The group members agreed that the renovation of existing residential buildings is the area where information gaps and other non-economic barriers to energy efficiency improvements are most prevalent. One example that was discussed is the owner-renter dilemma, where the short-term renter has little incentive to invest in an improvement with a long payback period.

The group identified three barriers to energy efficiency improvements in today's residential building sector:

- Incomplete information and unwillingness of private home owners to invest, leading to slow renovation rates
- Unutilised potential to integrate energy consumption with distributed production and transport in urban areas
- Unutilised potential to harness energy efficient behaviour changes in urban areas



Based on these issues, the group identified the following challenge that needed answering:

- *How to unlock the inter-linkage of technical and behavioural energy efficiency potential in existing Nordic residential buildings?*

Solutions

Nordic Neighbourhood Symbiosis Programme

The Neighbourhood Symbiosis concept is a holistic energy efficiency renovation programme for neighbourhoods. More specifically, the programme will consist of scalable, flexible packages and prefabricated solutions, including financing, incentive structures and other aspects, to roll out renovation programmes at the neighbourhood or larger scales.

In practice, city planners, developers and local residents will be able to cooperate using this programme to achieve the optimal energy efficiency renovation for the neighbourhood in question. The renovation activities will be carried out over an entire neighbourhood over a short period. By implementing on a neighbourhood scale, the cost of implementation is reduced, early renovation is incentivised, the resident is provided with adequate information, energy and material symbioses can be realised through reusing waste energy and materials in the neighbourhood, and finally, new energy efficient behavioural norms can be established amongst the residents.

Neighbourhood symbiosis will result in improved energy efficiency through renovation, and improved well-being though better energy services and community development amongst residents. It will result in a more integrated neighbourhood energy system where waste heat and electricity are better utilised from industrial and commercial installations, or from variable distributed renewable generation in the neighbourhood – such as rooftop solar power. Space in the neighbourhood most suited to distributed generation will be utilised, while electric vehicles will integrate with the system to provide balancing storage, and smart meters will facilitate demand-side management and smart appliances. Lastly, it will result in a more socially integrated neighbourhood, where consumers are empowered to save energy though better visualisation and feedback of their consumption, and through energy efficient behavioural norms developed within the neighbourhood. These neighbourhoods can then function as demonstration projects to encourage energy efficiency renovations elsewhere.

Concretely, the programme will offer three core deliverables:

- A **set of criteria** defining a Nordic Neighbourhood Symbiosis. This will detail levels of energy savings needed, as well as other criteria with regard to system integration and behaviour change.
- A **catalogue of solutions** compiled from leading neighbourhoods across the Nordic region.
- An **interactive planning tool** to be used by urban planners, developers and residents, which assists in calculating the optimal technical solution for a given neighbourhood, and interactively visualises cost and savings to facilitate engagement of the end user. ■

ACTION PLAN

- Develop the project description
- Involve research-funding institutions
- Map existing programmes in the field
- Structure and funding of R&D programme
- Begin parallel research tracks in all countries
- Initiate the first pilot neighbourhood implementation
- Scale up to commercial implementation of the programme

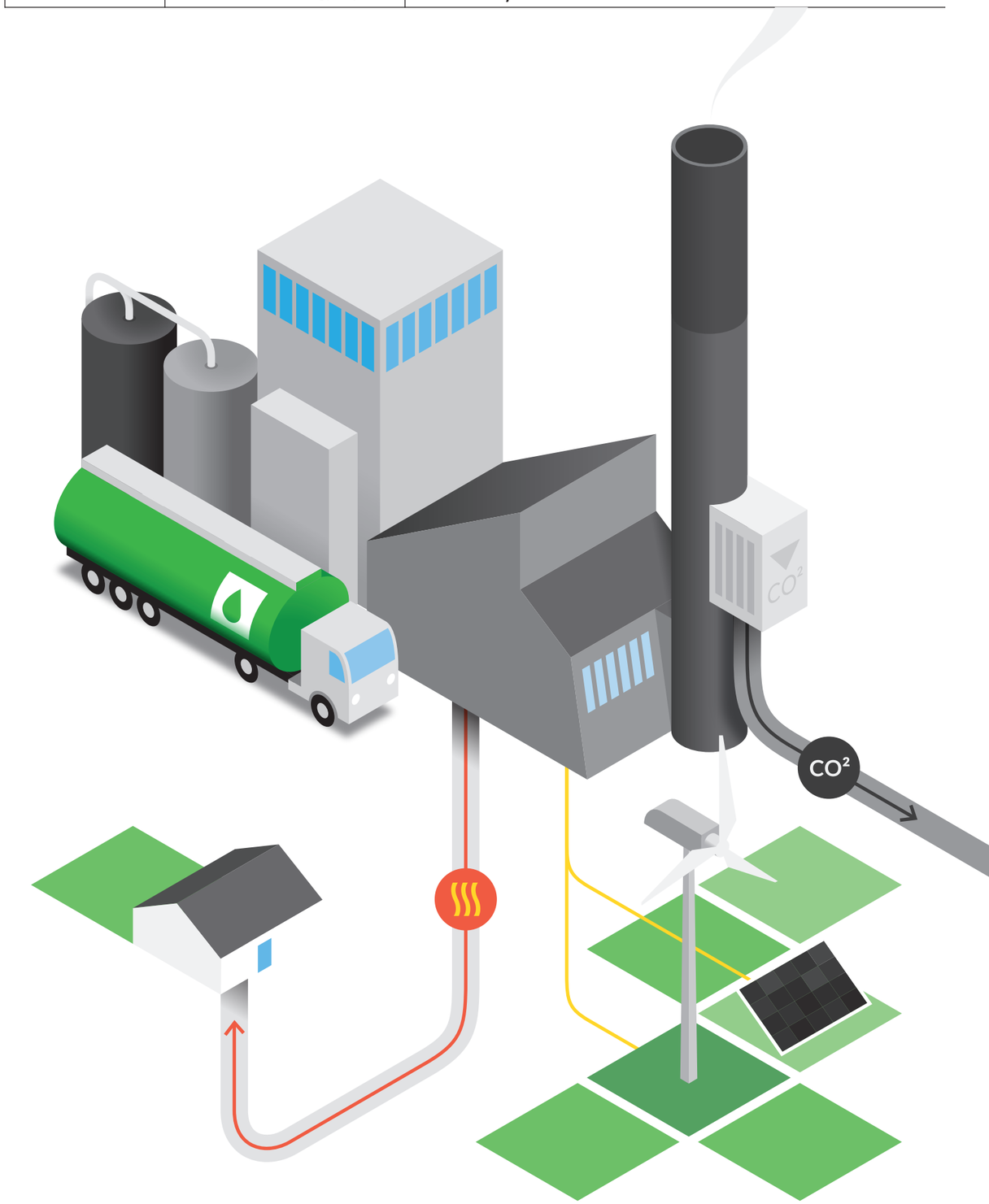
Research topics

Cross-cutting	**Mapping existing initiatives** in behaviour change, neighbour-scale renovations, system-based renovations, and other relevant topics. **Model the impact** of the programme on the wider energy system if it is rolled out in different scales and timelines. Modelling would show the additional effect of neighbourhoods symbiosis, and building-grid-transport integration over single-building energy efficiency measures.
Technology	**Prefabrication for renovation technologies** Research into energy efficient prefabricated elements applicable for Nordic renovation projects, as well as system-integration technologies. **Advanced materials and system integration** Research into new materials and system-integration technologies can further tie together neighbourhood energy supply, production and storage.
Social	**Behaviour change** Research into how consumers can be empowered to become more energy efficient. For example by making energy consumption more transparent through better information feedback and control. Further research will look at the effects of social norms in neighbourhoods, and how they can incentivise sustainable behaviour – for example where consumers are motivated to change their behaviour based on what their neighbours are doing.
Economic/ Legal	**Legal structure** Research into how the legal and financial barriers of the implementation could be overcome. **New scales** Research into the wider applicability of the model, into larger and smaller scales, different population densities, and markets outside the Nordic region.

Energy Efficiency in Industry

How can the Nordic Region accelerate energy efficiency improvements in industry? Can industrial energy use be better integrated both within the industrial sector and with other energy-using sectors?

To achieve significant reductions in CO_2 emissions in Nordic industry by 2050, all industrial sectors need to contribute and all emissions reduction measures should be utilised - NETP, page 96

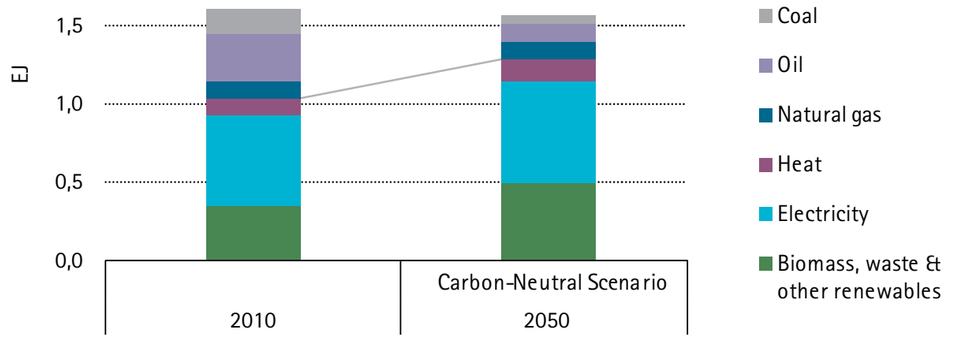


At present, Nordic economies are characterised by a high share of energy intensive industries, with industry accounting for a third of energy consumption on average, compared to a fifth in other industrialised countries. All countries except Denmark use more energy per unit of GDP than the OECD average.

The Carbon-Neutral scenario in NETP projects a 60% reduction in direct industry emissions from 2010. Participants at the Arena were presented with the following key points from NETP:

- Collectively, industrial sectors will need to cut the share of fossil fuel in its energy use in half, to below 20%, while increasing the use of biomass, electricity and heat.
- Despite increased output, total energy use must drop through energy efficiency measures. Energy efficiency offers the greatest potential for energy saving and emissions reduction in the short term, and policies must incentivise investments in these technologies.
- Carbon Capture and Storage must be implemented to reduce industrial process emissions that require fossil fuels, such as in cement, chemical and steel production. These emissions cannot be avoided using renewable energy or energy efficiency.

Final energy consumption in Nordic industry



Industrial energy consumption in the Carbon-Neutral Scenario sees an increase in renewables and the decarbonised Nordic heat and electricity supply. Remaining fossil-based sources are largely process-related and cannot easily be replaced by renewables, instead requiring Carbon Capture and Storage. The black line indicates the reduction in energy consumption from the baseline 4°C scenario.

Lars Guldbrand, Senior Adviser, Swedish Ministry of Enterprise, Energy and Communications

The Nordic countries have an advantage when it comes to sustainable development, but increased coordination and harmonisations is needed, according to Lars Guldbrand. And when it comes to research and development cooperation, commitment and personal relations should not be underestimated.

Where are the unique Nordic research and development cooperation opportunities?

"There is already a lot of cooperation within research, and there are good opportunities to increase it. It's important to look at sustainable development, climate issues and questions concerning the transition to a sustainable energy system. I think the Nordic countries will benefit from increased coordination, because right now we are going in somewhat different directions. When we look at solutions within the transport area, fuel, and energy efficiency in buildings, the Nordic countries are different markets. So market players, which in many cases are companies that operate in many countries, are a bit frustrated that there are different rules and systems. They need long-term investment conditions. So I think we need to work with harmonisation. I also think we would have a stronger voice in Europe if we were a little better coordinated. Another area is to increase cooperation within the forest industry between Sweden, Finland and partly Norway. This is an area where we have something of a unique position in a European context. Europe does not consist of forest countries. In Brussels nobody really knows what a forest is."

The Nordic countries are known for long-term strategies in the energy sector – what is the importance of this?

"The Nordic countries are a little special in this respect, in that we are fairly stable. If the Nordic countries can't make the transition, then which countries can? We already have a common Nordic electricity network. We've also shown how to cooperate with interconnectors and a lot of wind power in Denmark interacts with the systems in both Norway and Sweden. This is a good example of a common electricity market, and something of a role model for the rest of the EU.

Denmark is probably the most visible example at the moment in its ambition to build a sustainable energy system with wind power and electrification of transport. But of course it has something to do with the fact that Denmark is under a little more pressure, coming from a starting point with quite a lot of fossil fuel in their energy mix. Norway, for example, already has 100% clean electricity and Iceland is also doing well."

What is it important for the Nordic countries to start doing now?

"Everything. But we have to start somewhere, so we could begin by electrifying transport, in particular freight and city logistics. We have an advantage with our existing industrial structure, production of heavy vehicles, competence in power grids and electrical machinery, and a tradition in the area which goes way back. And we can link it to other areas we are good at, such as mobile communication and wind power."

So we better start networking now?

"Yes. And we have to remember that when it comes to cooperation within research and development with several partners, the human factor is essential. It is my own experience that commitment and personal relations mean a lot. You have to invest time and energy in it, because it's necessary to be on the same wavelength."

Lars Guldbrand

Senior Adviser at the Swedish Ministry of Enterprise, Energy and Communications Chairman of the board of Nordic Energy Research. Lars Guldbrand has worked with energy research and innovation, energy- and climate-political issues, evaluation of policies, etc.

Cases from the Nordic Energy Way Arena on Industry

The challenge

To achieve the scenario results from Nordic Energy Technology perspectives, the industry project group discussed the need for heavy industries to switch to more sustainable fuels, invest in CCS, and introduce new production processes and alternative products. Currently, the lack of knowledge concerning benefits from integrated industry processes is delaying development. It is also necessary to increase energy efficiency, not only by implementing the best available technologies, but also through substantive research into the areas identified by the group: "Social Energy Branding" and "Smart Heavy Industry". To facilitate the shift towards a renewable and efficient industry sector, the following challenge needed to be addressed:

How can the Nordic region unlock the potential for energy efficiency in the energy-intensive industries through joint Nordic RD&D?

Solutions

Smart Heavy Industry

Goal: The goal is to gain added value from Nordic industrial symbioses by integrating industries into clean energy systems and facilitating a better use of materials and increased energy efficiency.
Concept: "Smart heavy industry" through industrial symbioses in a new Nordic environment.

Smart heavy industry is a concept that, through complementary industrial activities, aims to achieve synergies in energy and materials use. Reaching industrial symbiosis requires that we identify the benefits from integrating industries into a clean energy system. The potential cases could vary country by country due to differences in both industrial structures and energy systems, and therefore the group emphasised that creating a Nordic R&D programme would need pre-studies of the most important cases in each country. The pre-study would map the needs for new technology and services, and where possible introduce demonstration projects.

On a societal level, increased industrial symbiosis will not only provide environmental benefits, but may also reduce socioeconomic costs. Industrial benefits could be higher profits and the creation of "green" Nordic industries. In addition, new services could be offered by the industrial sector for the common Nordic power system, e.g. by providing flexible capacity for power-balancing purposes. This would also generate new sources of income for industry players. Research institutions could experience integration of research competences of different research fields in collaboration with industries.

Social Energy Branding

Goal: The goal is, instead of using command-and-control measures, to set positive incentives for the industry to improve energy efficiency and to reduce carbon intensity in production processes.
Concept: "Social energy branding" by bringing industry products of heavy Nordic industries closer to the end consumer.

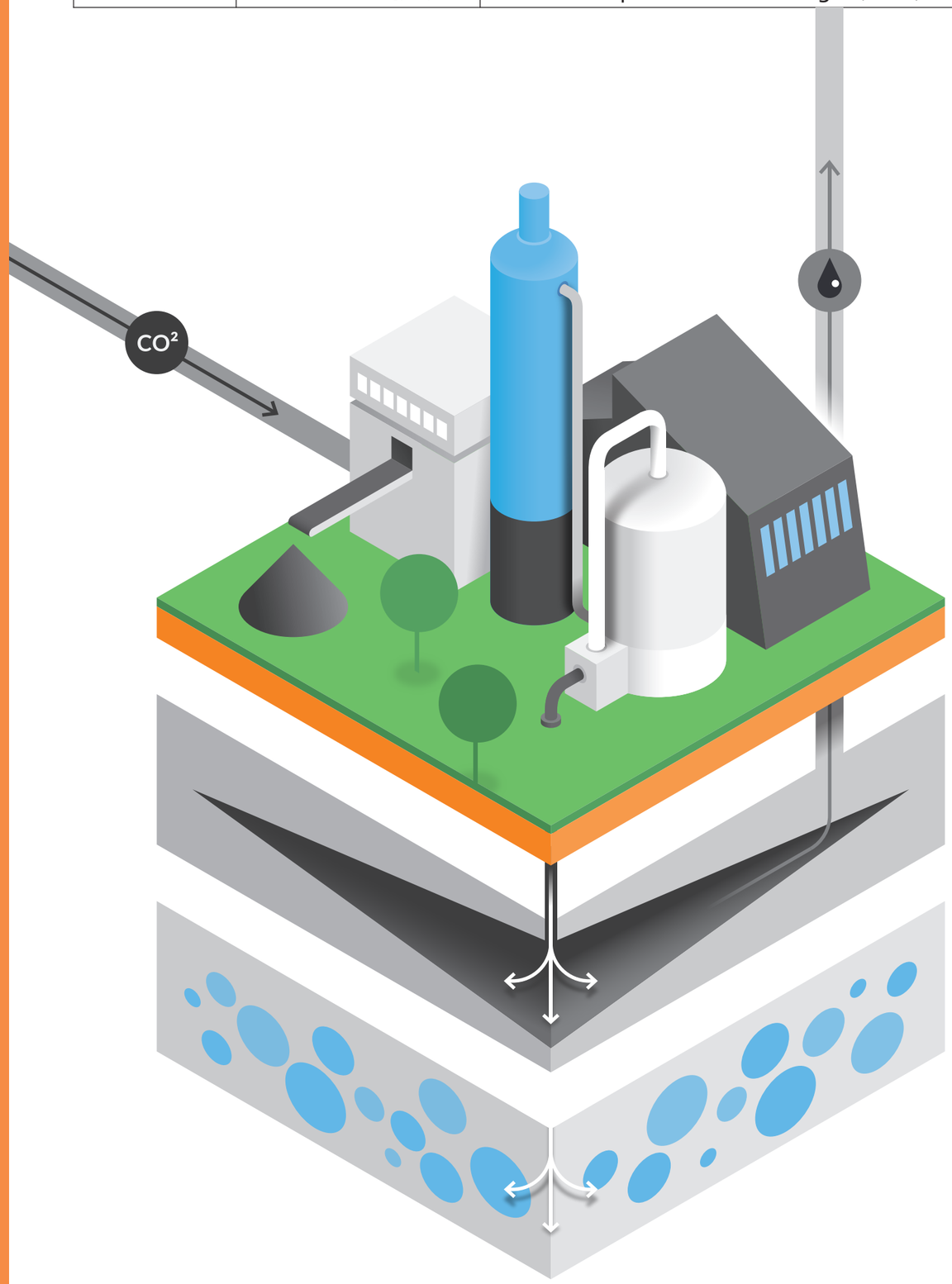
The goal behind Social Energy Branding is to create an eco-label for consumer products that use commodities from heavy industry, such as steel, aluminium, paper or cement. Branded products, showing that Nordic industries already deploy high shares of clean energy (e.g. hydro, geothermal and wind power), facilitate environmentally conscious choices by the consumer. Bringing heavy industry's products closer to end-consumers would level the playing field for energy efficiency in the Nordic region. Assuming that consumers choose the less polluting products, this would also trigger competition and further increase the level of investment of industrial players in more environmental friendly production processes. To provide the necessary information on Nordic industries and consumers an inventory mapping, stakeholder workshops and a pre-study to collect data could be conducted (a pre-study could be done in collaboration with smart heavy industry project). Equally important is the development of an evaluation system to monitor progress. The envisioned end result would not only improve energy efficiency but also provide positive incentives for the industry to reduce the carbon intensity of their production processes voluntary rather than through legal obligation.

This project may also provide societal and environmental benefits, e.g. improved levels of health through less pollution. Industrial benefits include recognition, increased societal acceptance and reduced production costs. Nordic industrial products may stand to increase their competitive advantage in an expanding global market for green products. The benefits would also reach research institutions by creating new interdisciplinary research areas, bringing together for instance behavioural economists, neuroscientists, marketing experts and energy engineers to develop a well-functioning labelling system. "Social energy branding" can give an impetus to researching new solutions and identifying radical innovations to improve energy efficiency by bringing together different actors. ■

Carbon Capture and Storage

How can the Nordic Region support technology development and increase collaboration between countries? Where are the Nordic R&D cooperation opportunities?

Carbon capture and storage represents the most important option among new technologies for reducing industrial CO_2 emissions after 2030 – NETP, page 81.

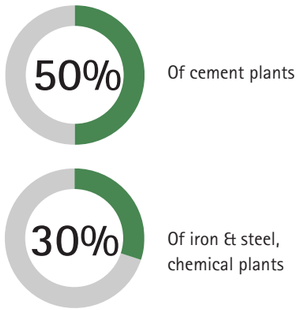


Carbon Capture and Storage (CCS) technologies could play a significant role in enabling the Nordic countries to decarbonise industrial emissions, as well as heat and power. One central challenge is that the countries where capture is needed are in many cases different from those where the storage would need to take place, highlighting the potential for Nordic cooperation.

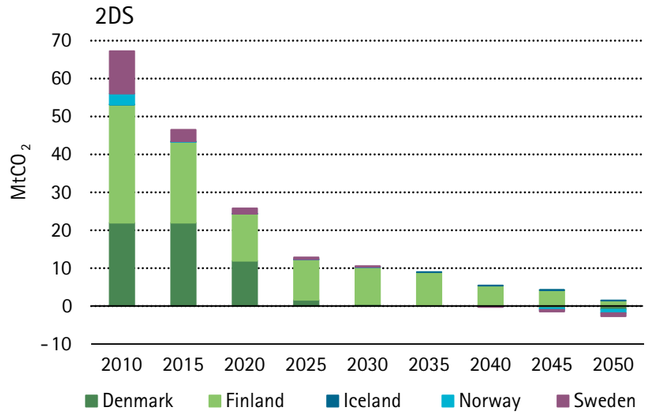
According to the Carbon-Neutral Scenario in NETP, CCS would capture up to 40 million tonnes of CO_2 by 2050, in industry, heat and power. Through installation on biomass-fired co-generation plants, CCS could contribute to negative CO_2 emissions from heat and power. While the full decarbonisation of heat and power could be achieved thorough renewables, reductions in process emissions from industry rely on CCS implementation. Participants at the Arena were presented with the following key points from NETP:

- CCS is to be introduced as early as 2025 in the Carbon-Neutral Scenario, a development that requires decisive and immediate support for CCS technology development.
- CSS is essential in cutting industrial process emissions. By 2050, 50% of all cement and ammonia plants must be equipped with CCS. Furthermore, the technology must be used in 30% of all ethylene and iron and steel plants.
- Deploying CCS at the level projected in the Carbon-Neutral Scenario requires broad policies to address technological development, infrastructure, public acceptance and risk governance.

CCS utilisation in industry in 2050 generation in the Carbon-Neutral Scenario



CO_2 emissions from electricity generation in the Carbon-Neutral Scenario



In order to reduce process emissions from industry, Carbon Capture and Storage (CCS) must be installed in 50% of all cement and ammonia plants and used in 30% of all chemical and iron and steel plants by 2050. Much of the CO_2 captured would take place in Finland and Denmark, where storage potential may be scarce. From 2035, CCS in biomass-fired plants can contribute to negative emissions from heat and power.

Cases from the Nordic Energy Way Arena on CCS

The challenge

The general public may perceive carbon capture and storage (CCS) as an immature technology. However, CCS may provide between 20-30% of the industrial sector's emissions reductions by 2050, according to Nordic Energy Technology Perspectives. The group addressing CCS considered Nordic RD&D as important to reach these targets, but also identified the need to support and encourage more collaboration between research and industries. Furthermore, reducing public resistance against carbon storage in rural and urban areas is key, and may be achieved by working with public perception.

According to the group, CCS should be integrated into industrial production processes. It will be important to enable implementation of Enhanced Oil Recovery (EOR) projects that will create a market for CO_2 and help defray the costs of doing CCS in all industries. Cross-sector cooperation within CCS is

Sigurdur Björnsson, Head of Science and Innovation, Rannis

Iceland is in a unique situation isolated in the Atlantic, but the challenges are best met by sharing, says Sigurdur Björnsson.

Where are the Nordic research and development cooperation opportunities?

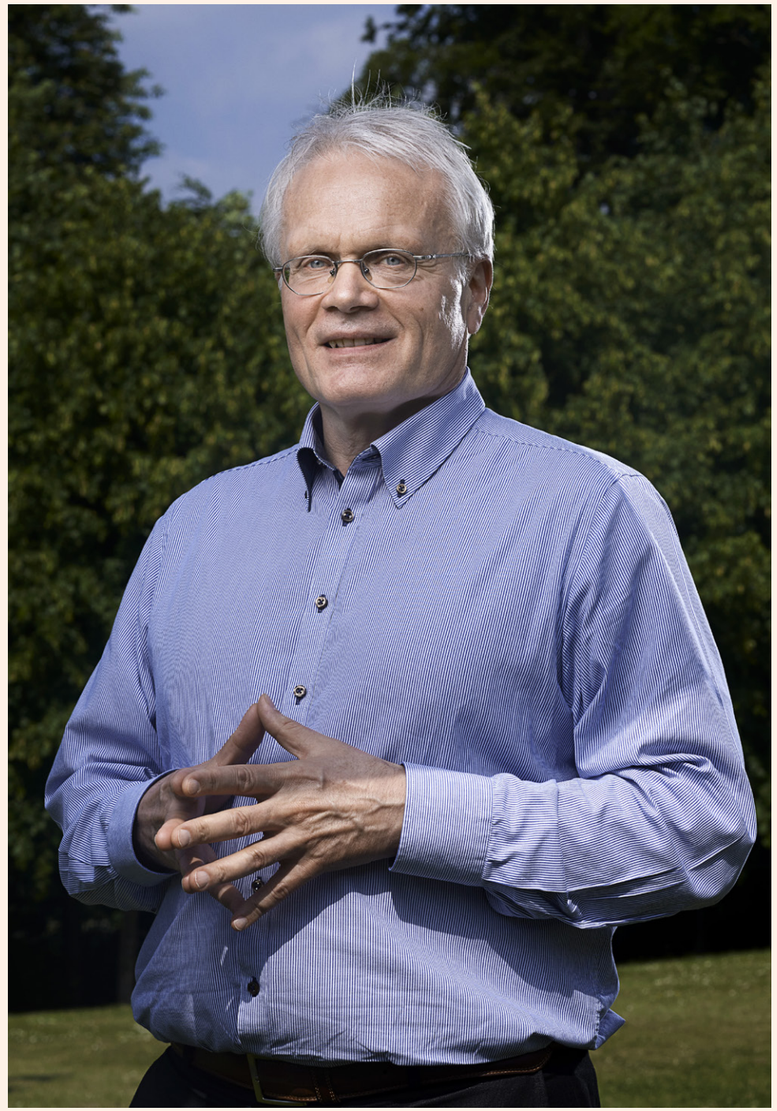
"In Iceland we have a unique situation. We are not connected to the continental grid. We are isolated in the Atlantic: 80% of our energy is produced by renewables – geothermal and hydro. The only fossil fuels we use are for transport. We can cut CO_2 emmisions a little. We have aluminium smelters, but aluminium production is a fact, and when produced in other countries, for example driven by coal, the emission is double. CO_2 capturing is a field were we should cooperate, and not only with carbon capture and storage. We also need solutions for what to do with carbon once we've captured it. We can make fuel out of it, and there may be other uses for it. That's a field for research and development. Carbon capture and storage is a known process. It certainly needs fine-tuning, but let's do it. It's more about getting the policies right. In terms of social acceptance we need research."

Are there other fields with cooperation opportunities within R&D?

"We have cooperation opportunities in terms of analysing the grid. How we distribute energy. Iceland is a big country, we have a network with different issues to resolve. That's something we have in common with the other Nordic countries. But decisions need to be taken on a very high level."

What is the best case result?

"The whole idea of Nordic cooperation is added value: it is better to cooperate than to work in each country. We will definitely get more value for the research money that we have available if we can share more."



Sigurdur Björnsson

Head of Science and Innovation, Rannis. Rannis is the Icelandic Centre for Research. It supports research, research studies, technical development and innovation in Iceland. It also cooperates closely with the Icelandic Science and Technology Policy Council and provides professional assistance in the preparation and implementation of science and technology policy in Iceland.

needed to create synergies. For example, captured CO_2 can be used in the production of synthetic fuels, positively affecting the transport sector.

Framework conditions must be improved in order to make CCS projects viable in the Nordic countries. Nordic politicians should jointly take steps to help implement CCS. Potential tools to consider are initial government support for main infrastructure for the first projects, CCS Certificates for power producers, feed-in tarrifs or a carbon tax.

Members of the group formulated the main research question on the background of several challenges which the group felt needed addressing:

- Negative public perception of CO_2 storage in Europe
- Mapping potential storage sites and long-term monitoring of actual storage projects to address public concerns
- High costs for capture technology have to come down
- Low funding budgets for research, development and demonstration of CCS in most of the Nordic countries, with the exception of Norway (but also declining here). Joint Nordic funding could spur new projects
- Nordic research institutions need more and stable funding opportunities to engage in this field and to build up and maintain research groups, which include technological studies, case studies, and innovation studies
- Need for many demonstration facilities to learn from the experiences and to implement these learning results in full scale facilities. Here Nordic interaction could provide synergies and economies of scale and scope
- Need to have a broader view on CCS than just for fossil power plants: as a technology which can allow us to go carbon negative in bio power plants, and a technology which is absolutely needed for cement and steel production this is actually needed for all Nordic countries
- Possibilities to exploit the captured CO_2 for establishing new industries in the future, e.g. the production of synthetic fuels

After discussing the above-mentioned issues and challenges, the group identified and formulated the following research question:

To what extent is CCS/CCUS a preferred technology in the light of policy uncertainty?

In order to spur the introduction of CCS, the following three research proposals for Nordic implementation were identified:

Solutions

Benchmark Analysis

The benchmarking exercise is to determine to what extent CCS or CCUS represents a value proposition for society, in that such technology may deliver a cheaper route to reach the nationally agreed CO_2 reduction targets than would be the case if alternative CO_2 mitigation measures are favoured instead.

The Nordic countries all have various programmes and schedules for implementing CCS, with Norway being at the forefront of the development. However, a better understanding of the potential for CCS may require a benchmark study, which could report on the status for the Nordic Region. The goal of the benchmark analysis is to determine whether CCS/CCUS is cost-competitive in a Nordic context and how it compares to other measures in terms of reducing greenhouse gas emissions. The findings could be used to form research-based policymaking and investment decisions.

The societal benefit of a benchmark analysis lies in its potential to inform policymakers and enlighten investment decisions. For the industry, benchmarks can identify low-hanging fruits and identify business opportunities. The analysis may also benefit research institutions by providing clarity on the portfolio of mitigation options and subsequent funding opportunities.

Societal Business Modelling

Discussions on using CCS in the Nordic countries highlighted the need for several business cases to illustrate the various scenarios. The backdrop of the business cases should be an analysis of both how carbon could be captures and stored, and how much this will cost. The envisioned outcome is knowledge-based advice for policymakers. Furthermore, the analysis could pinpoint market regulations and incentives that are required to make CCS a preferred solution for the industry.

The societal benefit of the business case modelling is that it will provide new knowledge to inform policymakers and support investment decisions. The modelling would also enable industries to identify business opportunities and clarify stakeholder participation. Finally, benefits for research institutions include funding opportunities for case and innovation studies.

Managing Public Perception

Introducing storage facilities relies heavily on financial support, which again pillars on public acceptance. To boost public acceptance, the group proposed an information campaign which would highlight the benefits of CCS and how risks are mitigated. The information campaign should inform the public of the overall challenge of global warming, and how CCS fits into the greater picture. Overall, improved public perception of CCS facilities the steady investment in joint Nordic Carbon Capture and Storage. ■

Ståle Aakenes, Chief Economist, Gassnova

The development of CCS is highly relevant and not for free, says Ståle Aakeness. But it might be more expensive not to take the cost now.

Where are we in the Nordic countries when it comes to carbon capture and storage?

"We are in a phase of development, ready for demonstration. We know the storage potentials, and have proved that storage is safe. We have tested capture on a large scale at the test centre at Mongstad. We know we can do it. CCS is highly relevant in areas where we are dependent on fossil fuels and are not able to transition to renewables fast enough. Cement and steel are examples. But it is not free, we have to pay the cost of deploying it. The climate waits for no man and we need to reduce our emissions. It might be more expensive not to."

From your point of view, where are the Nordic research and development cooperation opportunities in the area of carbon capture and storage?

"CCS is very well studied and the technology has been tested and evaluated in all Nordic countries. Norway is a frontrunner on CCS globally. The world's most advanced test centre on carbon capture is the TCM test centre at Mongstad, on the west coast of Norway. Two out of eight full-scale operational CCS facilities in the world are Norwegian. These real-life opportunities are an important basis for further research. The Nordic countries may therefore lead the way. Gassnova funds world-class research and development of CCS technology and we have supported major projects in cooperation with companies in other Nordic countries with international potential. CO_2 reduction is needed on a global basis, and Sweden, Denmark and Finland should contribute with their share of the development of CCS."

Who is it necessary to involve?

"To move forward, the industry must be more involved. CCS must be integrated into industrial production."

Ståle Aakenes

Chief Economist, Gassnova.
Gassnova, established in 2005, is the Norwegian state enterprise that manages the government's strategy on carbon capture and storage (CCS). Gassnova stimulates technology research, development and demonstration. Gassnova represents the state's interests in CCS projects funded by the government and provides advice to the authorities in matters related to CCS.

Transport

How can the Nordic Region ensure the improvement of transport infrastructure for different fuels and upgrading of existing railways? Can we ensure better coordination of transport and energy priorities?

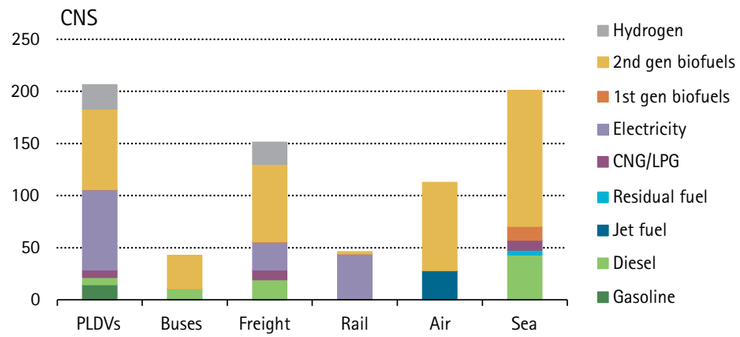
Transport requires the most dramatic emissions slash, from 80 million tonnes of carbon dioxide ($MtCO_2$) in 2010 to just 10 $MtCO_2$ in 2050 – NETP, page 9

Despite efforts to roll out electric vehicles and biofuels, transport in the Nordic region is still underpinned by oil. According to the Carbon-Neutral Scenario in NETP, it is the sector requiring the largest emission cuts. Participants at the Arena were presented with the following key points from NETP:

- In the short term, improved fuel economy in conventional vehicles provides the highest impact as the rollout of new technologies gather speed.
- Biofuels are critical in long-distance road transport, maritime transport and aviation, coming to represent over half transport energy demand in 2050.
- To achieve the penetration rates in the Carbon-Neutral Scenario, electric vehicles sales must double every year for the next decade, reaching 30% of all sales in 2030 and 90% in 2050.
- Necessary changes in modes of transport include a shift from private to public transport of 20% in 2050, from freight by road to rail of 50% in 2050, as well as avoidance of 4% of transport demand in 2050 through urban planning.
- Practically all growth in freight transport must be on rail, which will require upgrading existing rail systems and investing in new rail infrastructure.

Nordic energy use in transport in the Carbon-Neutral Scenario in 2050

Under the Carbon-Neutral Scenario, second generation biofuels underpin long-haul road freight, aviation and shipping, while electricity is a major factor in Personal Light Duty Vehicles (PLDVs) such as cars and motorbikes. Electricity accounts for a greater share of transport work than is evident in the figure showing energy use above, due to the greater efficiency of electric motors over internal combustion engines.



Cases from the Nordic Energy Way Arena on Transport

The challenge

The transport sector, which has the largest growth in emissions, consequently requires the greatest emissions cut according to Nordic Energy Technology Perspectives. This entails a near complete transition in road transport, from fossil fuels to biofuels and electricity. This transition will require the development of an infrastructure for multiple fuels. Improved fuel economy will provide the majority of transport emissions reduction through 2030, with biofuels and electric vehicles becoming more important in the longer term. It`s vital that sales of electric vehicles double in the next decade, to account for 30% of all sales in 2030 and 90% in 2050. Emissions in shipping and aviation must also be reduced, and will rely on Nordic collaboration.

In order to reach these goals, the transport group discussed the following challenge: *How can the Nordic region integrate efforts to achieve a more efficient, electrified and bio-based transport system in order to reach the carbon-neutral scenario?*

Solutions

Bulk green innovative procurement of electric vehicles

Goal: The goal is to achieve a critical mass of electric vehicles (EV) on the roads by 2015.

Concept: Involve relevant stakeholders who should contribute by agreeing on the principles of procurement, and by committing to acquiring a certain number of electric vehicles.

Martin Porsgaard, Director at SAS

SAS has a target to reduce CO_2 emissions by 50%, and that's why the company is involved in initiatives and projects that will make it possible to use biofuels in aviation.

From your point of view, where are the Nordic research and development cooperation opportunities?

"The most important thing is that we find a way to work together towards reducing CO_2 emissions. Transport is one of the most important areas we should prioritise. The Nordic countries have many common concerns, where the countries are similar, for example in terms of culture, knowledge, technology and employment. So there are good opportunities for the development of common platforms across the Nordic countries."

Why exactly the Nordic countries?

"We have to start somewhere, where there is a common interest, and where you can move it forward. We have these opportunities in the Nordic countries. In Europe it's harder and takes longer. We have to think in terms of regions. Nordic countries are not as large as for example Germany or England, so it's only natural that we look a little across borders. In that way we can be a role model for others. We've been at the forefront in terms of supply and energy development, we must continue that. It's an advantage regarding both technology development and creating jobs."

Who is it necessary to involve?

"Many of the things we deal with involve decision-makers. I wish we could implement it on a private market basis, but it's hardly possible, because it interferes with the regulatory framework, and these issues are not harmonised between countries. Anyway you have to start somewhere, and it could be in the transport sector, to harmonise standards and requirements, establish cooperation between universities, businesses and organisations. I think we can – in addition to efforts internationally. On the international level it will take much, much longer, and in certain areas there are larger gaps between stakeholders."

Martin Porsgaard

Director of Sustainability, Environment and CSR at Scandinavian Airlines, SAS Group. SAS was the first airline in world to be certified according to both the ISO 14001 and EMAS environmental standards. SAS has a target to reduce CO_2 emissions with 50% by 2020 compared to 2005, and use of biofuels plays an important role in achieving this goal.

The main goal of this proposal is to establish a bulk green innovative procurement of EVs to create Nordic markets for electric vehicles and an environment that the future development of utilising electric vehicles can be based upon. Besides improvements in the energy efficiency of vehicles with combustion engines, reaching the carbon-neutral scenario by 2050 will also require biofuels and at some point also electric vehicles with zero emissions in usage. The potential for electric vehicles is strongest in urban environments, and a successful implementation of a bulk procurement programme could be a way to kick-start sales of electric vehicles and achieve a critical mass on Nordic roads.

The action plan developed by the group suggests that the concept will be approved in 2013 and that procurements will be carried out during 2014. The desired result is a critical mass of EVs on Nordic roads by 2015. As a first step a pre-study should be done to identify the needs: thereafter the idea should be pitched to relevant stakeholders such as municipalities, public companies, private companies and research institutes. The group also recommends that stakeholders should contribute by agreeing on the principles of procurement, and by committing to a certain number of EVs.

Common Nordic demonstration projects on electrifying heavy-duty transport

Goal: The goal is to demonstrate the effectiveness of electrification of heavy-duty transport and showcase new market opportunities for Nordic companies.

The main goal of the proposal is to establish common Nordic demonstration projects on heavy-duty electrification. Freight transport by road is growing, and even if the scenarios in NETP take place, where much of this is moved to rail, there is still a significant need to deal with emissions from freight transport by truck. Batteries are not seen as an option for electrifying heavy duty vehicles because of the heavy weight of batteries needed to carry the required amount of energy. Biomass is the most likely candidate because of the long distances involved, but electricity could also play a role if the range issue can be solved with new solutions, for example by charging while driving along busy highways. Such new solutions need to be researched, and because of a strong Nordic position globally in heavy-duty

vehicles, e.g. from Volvo and Scania, developing new technology and solutions for electrified heavy duty transport could provide new market opportunities for Nordic companies.

The group suggests conducting a pre-study, followed by conceptualising demonstration projects including identification of sites and technology. The aim is to complete construction of demonstration sites by 2015. The desired outcome would be demonstrating how efficient electrified heavy-duty transport is and what types of solutions prove to be sensible.

According to the group the main stakeholder should be the Swedish Transport Administration (Trafikverket), which plans to implement a test site in Sweden. Other relevant stakeholders include research institutes, companies such as transport/logistics companies and vehicle manufacturers, public authorities, and national road administrations. The different stakeholders could contribute by conceptualising the study and providing vehicles.

A Nordic platform on sustainable innovative fuels

To encourage collaboration, tap into synergies and develop a roadmap towards sustainable fuels, the group proposed to develop a Nordic platform on sustainable fuels. The Nordic platform would particularly address sustainable fuels for maritime, aviation and heavy-duty trucks, improving the understanding of sustainable fuel development. Currently fuels are developed in several companies and for several types of use. Both the companies developing the fuels and the companies using the fuels in the maritime, aviation and road transport could benefit from cooperation. The Nordic countries have a strong position that could help to bring biomass and its processed products into use in different forms as fuels for transport.

The group recommends that the platform should be implemented as soon as possible to facilitate the commercialisation of sustainable fuels. It is important to focus on basic assumptions and cooperation opportunities for launching demo and pilot projects – and later a full-scale production experience. To start up, a design proposal should be prepared, a "model roadmap" that stakeholders should comment on and adjust. Once this roadmap is developed, the next step could be to organise a Nordic workshop for major stakeholders

The group identified stakeholders such as private companies, fuel producers, research institutes and the public sector. In addition, the whole supply chain could participate, and the different stakeholders can contribute by producing, testing and utilising the fuels as well as facilitating common standards. ■

Tom Warras, Senior Technology Adviser, Tekes

There are several areas where the Nordic countries are good at cooperating, and where it is possible to go further. But we have to build up understanding, says Tom Warras, who works at Tekes, the Finnish Funding Agency for Technology and Innovation.

What areas do you think the Nordic countries should prioritise?

"I think there's a great potential for an innovative approach – that companies or private actors can turn innovation into business. Their markets are naturally Nordic. Researchers and the public sectors of the Nordic countries should support this by having very tight networks. Cooperation between the public, private and research sectors will help the markets."

Are there any areas they should prioritise?

"An area were the cooperation is good is the building sector. We have the same climate and conditions, the same view of society and of communities as being green, we don't build very densely, so our vision of daily life is similar. The Nordic Built Programme is an initiative to accelerate the development of sustainable building concepts, a concrete physical building project with model building for energy efficiency. In the transport area there's also a huge potential. In particular, the conditions for the larger countries – Sweden, Finland and Norway – are very much the same. We should find each other now."

Could you mention other examples of stellar Nordic cooperation projects apart from Nordic Built?

"A good example of cooperation between Sweden and Finland is Tekes' Witty City programme where research investments focus on how the city can become more energy efficient using smart technology to improve the daily lives of people. And the Nordic Energy Transport Programme is testing electric mobility within the Copenhagen-Gothenburg-Oslo corridor. This is a project for electric cars involving building pilot charging so people can travel along this route."

Is there a dilemma you've come across?

"The challenge in this cooperation is to activate our networks at home. When we go home after this inspiring Arena, we will have new contacts in the other countries and will have identified common challenges. Now we want to solve them. So we have to involve staff and colleagues at home, and that is the hard part, because the everyday pace is fast and demanding. But we have to incorporate these thoughts into our domestic strategies. And we need help building domestic networks. In Finland we need more knowledge about what's going on in the other countries, for example from the good people from Nordic Energy Research. We need to build up understanding."

Tom Warras

Tom Warras is Senior Technology Adviser at Tekes, the Finnish Funding Agency for Technology and Innovation. Tekes is the most important publicly funded expert organisation for financing research, development and innovation in Finland. Tekes boosts wide-ranging innovation activities in research communities, industry and service sectors.

Joining forces

Markus Wråke led the work on Nordic Energy Technology Perspectives and participated in The Nordic Energy Way Arena. He has a long list of areas where the Nordic countries could cooperate. He shares the most important ones here.

What role can the Nordic countries play on environment and energy issues?

”The Nordic countries can play an important role by being a strong voice in the world when it comes to putting this issue at the top of the agenda. The past few years the climate issue has slipped down the agenda ranking. The Nordic countries can play a big role by joining forces, and perhaps build alliances with other countries such as Germany. It would be valuable. Right now it is energy security that is talked about, rather than climate.”

But is the Nordic voice really that strong?

”The Nordic region is perceived in many places as a role model because it has welfare combined with economic growth. The Nordic brand is still strong, and this includes energy and environment. It should not be underestimated. The ability of the Nordic countries to combine economic growth with limited energy and environmental impact – called ‘decoupling’ – is a very compelling argument.”

Is there a difference between the Nordic countries as a region and other regions?

”The Nordic countries have done relatively well during the crisis due to proactive and progressive environmental policies and energy policies. This shows that it’s possible to achieve strong economic growth while reducing energy intensity. That is a very important argument, and for this reason the Nordic countries are a good example to follow.”

Are there other “best cases” in the Nordic countries?

”The Nordic electricity market is often highlighted. We have succeeded in cooperating in a complex, often controversial area, and in managing it across borders. Environmental policies and CO_2 taxes is another example. Not least taxes on petrol, which has proven effective. The long-term and consensus-based energy policy you find in the Nordic region provides a stable situation for agreements. Here things have been implemented that apparently are not possible in Europe, despite many years of trying. So the Nordic cooperation is already a good example of how regional cooperation can help solve common problems. It’s something to build on.”

Where are the unique Nordic research and development cooperation opportunities?

”There are many. The area of market design is one. There’s a good basis to continue work on designing the Nordic electricity market, so it also works in a Carbon-Neutral Scenario. Then there is energy efficiency. Just to be able to pool resources by working together can produce results. Within the transport sector, it will also be wise to coordinate. Infrastructure must function across borders. And should cars run on electricity, biofuel or both? It can be a simple question of using the same plug or batteries for electric vehicles. Then there’s carbon capture and storage. Only Norway has been really active in this area. To establish a convincing demonstration plant and make progress, it will be an advantage if the other Nordic countries participate.”

What will it take to realise Nordic cooperation?

”Willingness to cooperate. The realisation that there’s a lot to gain by cooperation. There should also be coordination at high levels, e.g. initiatives such as the Nordic Energy Arena and at even higher levels, where decisions about what the Nordic countries must prioritise and focus on are made. Cooperation between national research agencies is also necessary to elevate research efforts and find synergies.”

What areas should be prioritised?

”The list is long. Market design to begin with. If it’s possible to agree on working with this area, it would prove very important. Regarding the transport sector, it is above all the electrification of personal transport. And in the field of bioenergy in particular, the Nordic countries have a special expertise to build on. But the list is long.” ■

Markus Wråke

Markus Wråke is Head of the Energy Supply Technology unit at the International Energy Agency (IEA). He leads the work on Energy Technology Perspectives, the flagship publication on energy technology at the IEA. Wråke holds a PhD. in Environmental Management and Economics from the University of Gothenburg and an M.Sc in Environmental Engineering from Uppsala University.

Energy security and areas of promise

How do we find the optimal policies for promoting low-carbon energy technologies? What kind of research programmes have worked best? And what does energy security mean today? **Benjamin Sovacool**, one of the most quoted scientists in the energy policy and research area, has some of the answers.

What is energy security?

Prime ministers, presidents and the European Commission talk about energy security, but what is it? The traditional definition was just access to fuel – mostly coal, oil or gas. Winston Churchill once stated that energy security meant having enough oil for the navy. President Jimmy Carter was occupied with Middle Eastern oil security, and that was why the United States had military presence in the Persian Gulf. But today that definition no longer applies, because there are many other dimensions in energy security. 1: Price and affordability. How much does it cost, and how stable and equitable is the cost? 2: Efficiency. How efficiently does a country use energy? 3: The environmental dimension. Is climate change taken into consideration, or air and water pollution? 4: The governance dimension. Does a country have institutions, skilled energy professionals, appropriate consumer behaviour, accountability, transparency and competition?

With this definition of energy security, a working group led by Benjamin Sovacool created what they called an energy security index. They

Benjamin K. Sovacool

Benjamin K. Sovacool has worked at the Institute for Energy and the Environment at Vermont Law School, and is now Professor of Business and Social Sciences and Director of the Centre for Energy Technologies (CET) at Aarhus University (AU)-Herning. CET is working together on these research issues with NCoE NORD-STAR at AU-Herning.
Some of his work has involved three separate projects described in this article:

1. The results of an energy security index.
2. Optimal policies for promoting low-carbon energy technologies.
3. Optimising energy research development and demonstration.

> “All walks of life are responsible for this problem, so all walks of life have to be included in the solution.”

took ten different metrics that were matched with each of the four dimensions. For example oil import dependency, energy intensity, CO2-emissions, energy efficiency, electricity or petrol prices and so on. These were put in an index, and then 22 countries in the OECD were tracked for performance from 1970 up until 2010.

The first question was who had the biggest improvement in energy security in the tracked period, and who had the worst. The second question was which of the countries is today the most energy secure. In both cases the country was the same: Denmark. The other best performing countries were Belgium, UK, Japan, Canada, Finland and France. The worst performing countries were Spain, Portugal, Greece and USA.

”One would think that USA and Japan would score high on energy security, because they are the biggest energy users and have a lot of energy security risks, but they didn’t. Norway did not do well either, surprisingly, but scored below average. Norway didn’t score well in efficiency and scored low on prices and emissions. In all those indicators Denmark improved,” states Benjamin Sovacool.

To explain why, the working group compared top performance with bottom performance, Denmark with Spain. The conclusion was that in Denmark there’s a lot of commitment towards energy research and development, a push for wind combined with heat, power and efficiency, and relatively high energy prices, which helps fund energy taxes. And in Denmark there has also been consistency in policymaking, especially up until 2001-02.

But in Spain it was the opposite. ”Spain did a nuclear power push that was abandoned. Billions of dollars were used, but reactors were never built. Spain has to import all its energy, it has a very low renewable penetration, and policymaking was very inconsistent from year to year. In Spain there is not a strong consumer advocacy or civil society network. Another fact is that in Denmark, many of the energy companies are cooperatives, whereas in Spain most of them are just companies. These elements are part of the explanation why Spain did not do well and Denmark did,” says Benjamin Sovacool.

What are the optimal policies for promoting low-carbon energy technologies?

REN21 is a global renewable energy policy network that makes a global status report every year. The report has a catalogue of policies for promoting renewables. For example, in its 2012 issue, it listed more than 90 policies, different types of policies used to promote renewables: subsidies, renewable portfolio standards, net metering, public procurement, research and development tax credits and so on. The question is, in this sea of policies, which ones work best?

A working group led by Benjamin Sovacool conducted more than 180 interviews in 13 countries with experts, CEOs and directors of companies, organisations, energy authorities, consumer groups, efficiency groups, both pro- and anti-nuclear, to answer the question: what is the best policy for promoting renewable energy?

”131 out of 180 said the same thing, and to us that was very surprising, given they were from all different sectors. Their answer was that the single best policy change is to eliminate subsidies for fossil fuels,” says Benjamin Sovacool. The second best policy change in their opinion would be to create accurate electricity prices and encourage feedback. The third thing was to pass national feed-in tariffs. And the fourth was demand-side management (DSM). According to the various experts, these four things were what works the best.

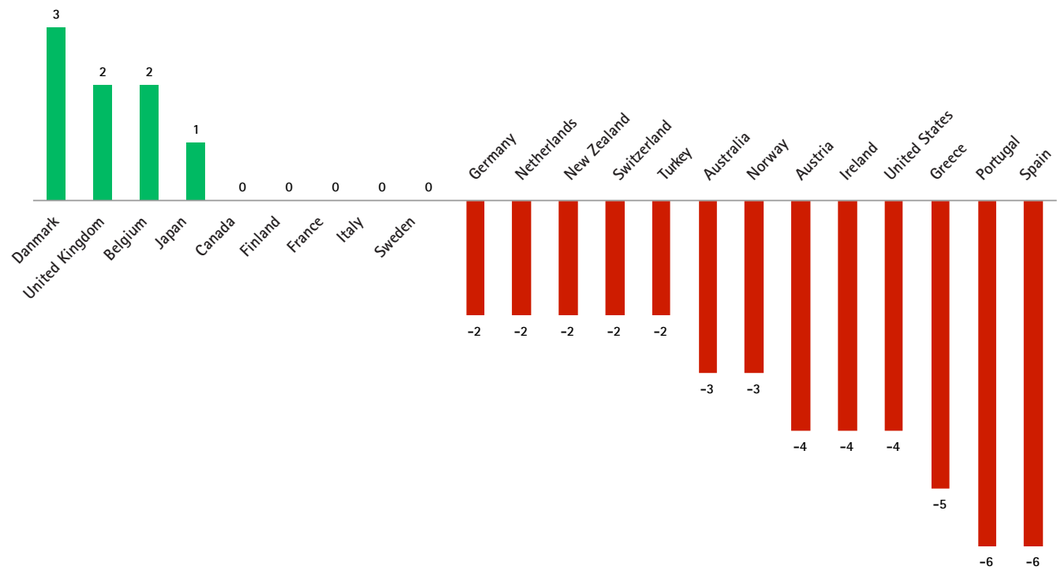
”What is interesting about the first two policies – removing subsidies and changing how we price electricity – is that they don’t cost anything. Feed-in tariffs cost, and demand-side management sometimes cost money up front, although they make money later on. But the first two put money back into government revenue. Changing electricity prices is how you change the tariff, it doesn’t actually cost money. If it’s done right with energy efficiency, the increased tariffs still mean an overall lower cost, because we use less energy. It raises prices, but lowers the usage,” states Benjamin Sovacool.

One would think that it would be good news for politicians that the first two things they can do won’t cost society anything. ”But if that’s the case, it raises the question, why do we have so many subsidies? But that’s a completely different question because of the political economy of industries, and how they become attached to subsidies,” says Benjamin Sovacool.

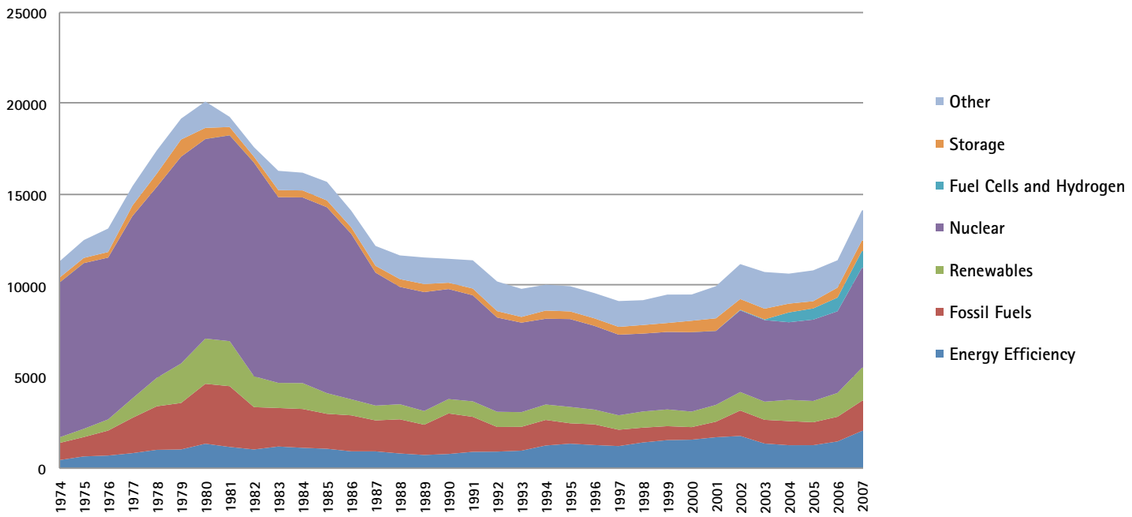
How do you optimise energy research and development?

When companies and organisations decide they want to do research and development, and they

Energy-security performance score for 22 OECD countries, 1970 to 2007.



Research expenditures in the OECD.



Spikes are after the oil crises in the 70s, and a small spike after 9/11 in 2001. After 2007 it starts to increase as the momentum of climate change increases. Despite how serious climate change is, OECD countries are still investing less now than in 1980.

> “The Nordic countries have the necessary resources and structure to conduct really innovative research and development.”

want to start a new programme, how should they structure it? Benjamin Sovacool's team identified two different types of research styles that are almost opposite: an open style and a closed style. The open being inclusive and participatory, the closed being exclusive and proprietary. They compared these two styles in three different areas of research: wind energy, ethanol and hydrogen fuel research. And they compared two countries for each area. The open-style wind energy case was from Denmark, the closed-style wind energy case from USA; the open ethanol case was from Brazil, the closed from France; the open fuel cells case was from China, the closed from Norway. Benjamin Sovacool:

”In each case we found that the open styles accomplished their goals more quickly, cheaply and comprehensively than the closed styles. Yet the closed styles are how most countries and companies still do energy research. It's competitive, proprietary, focused on getting patents, making money for their shareholders and it sets very strict goals. It also puts almost all the money into technology. 95% of the US wind programme's money went into building the turbines. Only 5% went into areas like business-development, marketing, consumer relations or investment,” says Benjamin Sovacool.

The open style is different. It's inclusive, has many different actors, is open to multiple stakeholders, decentralised,

Three areas of promise

What are the most important areas for the Nordic areas to cooperate in? Benjamin Sovacool highlights three areas

The big question raised at the Nordic Energy Way Arena was: where are the unique Nordic research and development cooperation opportunities that benefit industry, research and society in the current situation? According to Benjamin Sovacool, the Nordic countries are leaders in three areas in which most of the world lags behind, and these areas have promise. These are renewables, carbon capture and storage and innovation in new types of policies and institutional structures.

Renewables

”I think one of the key lessons from the Nordic Energy Way Arena is, that renewables are not just about wind and solar. Those are the two renewables everyone pictures in their mind when they think about opportunities. I think it's also geothermal. Incredible things are going on in Iceland, to the point where they have so much geothermal energy that they can use it to make liquid fuel for automobiles. You have incredible amounts of biomass energy. Not just energy crops, and agricultural residues, but also waste. Waste to energy from poultry and pig farms is a huge opportunity. If you look at the IEA's projections for which sector has the most potential, there's more biomass potential in the Nordic region than wind energy potential, even including off-shore. They are projecting that bio energy will be a bigger sector than wind and hydro, which are two of the big ones.”

Carbon Capture and Storage

”Some are sceptical about this area, but the Nordic countries have unique opportunities here for several reasons. There's a technological advantage. Statoil has been doing research on it for decades, they almost started it. There are a number of depleted oil and gas fields that have the storage space to sink carbon into. That's unique. There are only a few other places like Russia and USA that have these depleted fields. And the Nordic countries have aggressive plans to be low-carbon in 2030 or 2050. What was clear from the Nordic Energy Way Arena is, if you're going to reach those plans, you cannot do it without CCS. It is impossible to continue to have economies in the Nordic region that still do the things they do, and at the same time reach those low carbon targets, unless you develop CCS. At least for industries like cement, steel and petrochemicals. It's an impossibility to reach those targets without CCS in strategic places. Maybe even for power plants. That was very mind-opening.”

Policy and structure

”The Nordic countries are known for good governance. They are strong, democratic, liberal regimes with educated energy users, very good infrastructures and information exchange, and they are relatively wealthy countries. Regarding possibilities of collaborations, the Nordic countries have the necessary resources and structure to conduct really innovative research and development. All that put together is a unique attribute.”

All walks of life

The Nordic countries don't need new technologies at this point, says **Benjamin Sovacool**. Even if there were no further technological breakthroughs at all, today's technology would still be good enough to realise joint solutions. What the Nordic countries need is cooperation and political will. And to include all walks of life

What will it take to realise the joint Nordic solutions?

"Cooperation and political will. The Nordic countries don't need new technologies at this point. Even if there where no further technological breakthroughs at all in wind, solar or hydrogen, you would still have technology that is good enough today. What you need is the political and social elements. A common mistake people make about energy is to invest all the money in new technology. But we don't necessarily need new technology. What this means is that it's necessary, politically, to get people to cooperate, and to educate consumers, investors and entrepreneurs. That's the key challenge. You have to get people who are committed to low-carbon lifestyles. Beyond policies, I guess, and towards lifestyles."

Who is it necessary to involve, who are the stakeholders here?

"If it's carbon lifestyles we're after, then we all are. And it's a mistake to think that you can limit your stakeholders just to the government or just to business leaders. They are pieces of the puzzle, but I think it's important for every single person to realise that everything we do, every day, contributes to the climate and energy problem. From what we choose to drive, what we choose to eat, where we choose to live, what we choose to buy. I remember my grandparents used to put patches on everything. I don't think I've seen a single patch for a very long time. This is the challenge, and this also means that you have to include consumers, consumer groups, teachers, insurers, military specialists and on and on … Everyone. All walks of life are responsible for this problem, so all walks of life have to be included in the solution."

flexible, and it adapts its standards. Rather than setting strict goals – like a five-megawatt turbine built by 1980 – the goal is set at the best wind turbine that it is possible to make. It's more bottom-up and focuses on cooperating, rather than about being competitive." And what's interesting, sticking with USA and Denmark, is that USA spent about 1.1 billion dollars to make bad wind turbines, which failed in large numbers. Denmark spent 100 million dollars to produce highly successful wind turbines, and establish Denmark as the world's leading wind-energy manufacturer," states Benjamin Sovacool.

It was the same case with China and Norway, and that might surprise some because China is known for being authoritarian. "But in China they had a very open hydrogen programme that involved automobile manufacturers, NGOs and environmental groups, and they were experimenting with different fuel sources like hydrogen from electricity or natural gas. Whereas in Norway, they spent almost twice as much, using only natural gas, being proprietary – and it didn't work," says Benjamin Sovacool. The conclusion is that R&D is not always a question about how much you spend. It's also about what type of programme you develop. And if you have an open programme, it might be more cost-effective than a closed programme.

Most energy research and development programmes aren't totally open or closed, Benjamin Sovacool explains. "In this study extreme cases were picked because they were typifying. Most research projects are going to fall in between these cases; they'll have elements of both. The open programme gives you more feedback, more information, better learning, more rapid advances in technological development – if you get feedback from a hundred different users instead of two," says Benjamin Sovacool. ■

Open and closed styles of energy research.

Open styles	Closed styles
Inclusive of actors at various scales and of differing types.	Exclusive to a few select firms at limited scales.
Participatory and open to multiple stakeholders.	Proprietary and focused on limiting access.
Cooperative and encouraging of information sharing.	Competitive and encouraging of information hoarding.
Decentralised and conducive to diversity and experimentation.	Centralised and predicated on consolidation and control.
Flexible and autonomous in letting researchers refine and adapt on their own.	Rigid in setting strict goals, methods, materials and/or targets.
Holistic in valuing technical and social considerations.	Narrow in focusing predominantly on technical development.

List of participants at The Nordic Energy Way Arena

Name, title, organisation, nationality

Bioenergy

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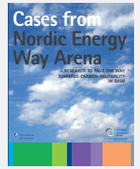

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The Nordic Energy Way Arena
TOWARDS CARBON NEUTRALITY IN 2050

norden
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The burning question:

Where are the unique Nordic R&D cooperation solutions that benefit industry, research and society?