

event report

ZERO11, incorporating HyNor
Oslo, Norway

6 DECEMBER 2011



Introduction

The Zero Emission Conference is an annual event organised by the Norwegian Zero Emission Resource Organization (ZERO). The environmental foundation was formed to tackle the threat of climate change and promotes the view that emission-free alternatives exist for all forms of energy use. Its focus areas are:

- Carbon capture and storage;
- Electric power for the offshore sector;
- Biofuels for road transport, ships and heating;
- Wind energy;
- Hydrogen;
- Electric vehicles;
- Other renewable energy.

The conference itself is the largest of its kind in Scandinavia and attracts high-profile speakers and attendees from around the world. As in previous events in the series, the first day offered a broader perspective on climate change and addressed how the global economy can be geared towards reducing greenhouse gas emissions. The second day focused on the specific solutions being applied to this issue in Norway and the rest of the world, including the HyNor project, fuel cell electric vehicles (FCEV) and fuel cells in aircraft.

Many of the presentations on the first day were in English and simultaneous translation into Norwegian was available for the Norwegian content. A number of the parallel sessions on the second day were held entirely in English, making it very easy for non-Norwegian delegates to participate in this stimulating event.

Perspectives on Climate Change

This report will not attempt to cover in detail the presentations made by the speakers on the first day of the conference, but a brief summary of some of the most interesting points is given below (all speaker photos from ZERO). Videos of each presentation can be viewed in full on YouTube or via ZERO's website at: www.zerokonferansen.no/alle-foredragene-fra-dag-1

Einar Håndlykken, Executive Director of ZERO



Håndlykken opened the conference by addressing how Norway might meet its obligation to cut carbon dioxide emissions. He challenged the view that developed countries such as Norway can most easily and cheaply reduce emissions through investing in renewable energy projects in emerging countries. This view rests on two assumptions: the first that cutting domestic carbon emissions necessarily harms GDP; the second, less explicit assumption is that newly industrialised nations will not or cannot act on emissions unless funded and incentivised by fully developed nations.

In reality, Håndlykken said, the scale of cuts needed means that Norway, like other developed nations, has no choice but to act on carbon dioxide internally as well as externally. But it is possible to enact an intelligent climate policy that will benefit its economy – among other advantages, Norwegian capability in clean energy technology will position the country to exploit a profitable export market in the near future. He regards this as preferable to offsetting, which could equate to investment in foreign development at the expense of domestic industry.

As to the second assumption, China, for instance, is often held up as the archetypal emerging polluter, particularly since it overtook the USA to become the world's largest carbon emitter. But, Håndlykken pointed out, it is also the world-leading investor in renewable energy technology and is setting (and meeting) its own targets for emissions reduction. China has clearly recognised the economic dividends that result from creating a strong domestic clean energy sector.

Erna Solberg, Leader of the Norwegian Conservative Party



Solberg underscored the need for a steady focus on long-term objectives: to meet the target of a maximum average emission of two tons of carbon dioxide per person per year by 2050, the rate of innovation must accelerate. Solberg said that industries at the vanguard need consistency and a solid framework for development before they invest, which is where farsighted Government policy is necessary. In addition, there is no point to simply displacing emissions: emission cuts in non-quota sectors will also have to be made.

Heidi Sørensen, State Secretary, Norwegian Ministry of the Environment

There is consensus on the threat of climate change across the political spectrum in Norway, but Sørensen wants this to go further: agreed climate policies should be on the agenda of every party and must not change if the government changes. She also stated that Norway, due to its fossil fuel derived wealth, has a 'moral obligation' to develop clean technology and lead the way in reducing carbon dioxide emissions.



Anthony Giddens, Author of “The Politics of Climate Change”



Little time at the conference was wasted on whether anthropogenic climate change is ‘real’ or not. As Lord Giddens said, there is now about a 5% chance that the skeptics are right – worse odds than Russian roulette. With informed consensus on this issue, the discussion can more usefully move on to defining the threat it poses and considering how it can be countered.

There are, however, no easy answers here either. In his presentation, Giddens pointed out that carbon emissions are accelerating, showing no evidence of the effectiveness of current emissions reduction strategies. He has little confidence that the current political leadership of the big emitters can or will act effectively on this issue and cautions that reliance cannot be placed solely on the United Nations Framework Convention on Climate Change (UNFCCC) negotiations, which have become largely paralysed. In his view, bilateral and regional agreements are likely to prove more important than international discussions when it comes to reducing emissions – and it is possible that the BRIC emerging economies and other developing nations may lead the way.

Giddens also called for the development of a holistic model of a green economy: what exactly does ‘green growth’ mean in the real world? His view is that a low-carbon economy will be structurally different and that a fundamental social and political transformation is necessary. This is because in an orthodox economy climate is an externality and environmental toll is not accounted for. He is wary of emissions trading schemes, which in a conventional economy are apt to displace emissions rather than eliminate them.

Connie Hedegaard, European Commissioner for Climate Action



Hedegaard was emphatic that action on climate change cannot wait while the world deals with the current economic crisis. She pointed out the logical fallacy in assuming that cutting carbon emissions will exact a net cost compared to ‘business as usual’. The latter will result in far greater costs for the global economy as it suffers the knock-on effects of climate change; for instance, damage from extreme weather events related to climate change was estimated to have cost Europe around €11 billion in 2010 alone.

Hedegaard defended the European Union Emissions Trading Scheme (EU ETS) and said that targets are necessary to create certainty for investors, deliver cuts and boost innovation. She does not underestimate the value of a domestic clean technology industry and believes, in contrast to Giddens’ view, that the EU is exhibiting true green growth: over the last twenty years or so, it increased GDP by ~40% and manufacturing output by ~36%, while at the same time reducing emissions by 17%. However, Hedegaard also referred to China’s massive investment in clean energy and said that Europe risks being outcompeted.

Depressingly, when questioned it was clear that Hedegaard shared Lord Giddens’ total lack of optimism on the outcome of the latest round of UNFCCC talks (COP17) in Durban. She acknowledged the weaknesses in the process and her frustration with its slow progress, but made the point that we do not have anything to replace it with at the international level. The EU will, however, continue to act on carbon dioxide in the absence of an international deal being reached. A common view that regional action on emissions will prove most effective thus emerged during the course of the conference.

Arnold Schwarzenegger, Former Governor of California



California could be described as a poster child for regional green growth, and its former governor remains optimistic that a unified vision for a sustainable world can be achieved. However, much relies on the way that this 'green vision' is communicated, and it is here that Schwarzenegger feels he can make a valid contribution.

He was adamant that any sort of 'lecturing' of the developing world must be avoided at all costs, as must a strategy that relies on provoking guilt in the developed nations. He advocates selling action on climate change in a positively framed, four-part package: a higher standard of living by replacing fossil fuels with clean energy; job creation; national security and energy independence; and improved health through reduced pollution. These are the things that matter directly to people and hence, Schwarzenegger believes, will elicit the most positive response.

Martha Delgado, Secretary of Environment for Mexico City

The Global Cities Covenant on Climate, aka the Mexico City Pact, is an inspiring example of effective regional action, but which is taking place in a new kind of international agreement. On the 21st November 2010, mayors from 135 cities around the world met in Mexico City and entered a voluntary agreement to measure and report emissions and monitor effectiveness of mitigating strategies (a further 70 cities have since joined).



Delgado stressed how important urban action is: ~50% of the global population is urbanised and this proportion is expected to increase to 70% by 2050. Cities also account for ~80% of global greenhouse gas (GHG) emissions and many are very vulnerable to rising sea levels. The signatory cities are aiming to reduce GHG emissions from public transport, promote sustainable buildings, increase recycling and change energy use patterns. 51 cities have reported back so far, and it has emerged that one of the largest concerns is the management of solid waste. 26 cities have already implemented landfill gas schemes – a development that a number of fuel cell system suppliers may be able to capitalise on.

Ole Enger, CEO of Renewable Energy Corporation



REC is engaged in the whole solar value chain from production of polysilicon and wafers to installation of panels. Enger reviewed the state of the solar power industry today, stating that it has reached the point where its carbon footprint is becoming competitive. As to cost, he said that grid parity is being approached in places at around 2,000 sunshine hours per year. In Germany between 2008 and 2011, the cost per kWh dropped by 55%.

Solar PV is now the fastest growing industry in the world: Enger quoted a figure of 64% growth over the last five years. He expects to still see major growth in India and China, especially as costs continue to come down. However, in 2012 supply will outstrip demand due to the Eurozone financial crisis and a consequent lack of funding. This overcapacity will have an impact on profitability but is not expected to last.

The most important point to be made about solar power, as Enger put it, is that renewable energy technology to combat climate change exists and is viable – it just needs to be grasped.

Bunker Roy, Founder of the Barefoot College



The next speaker then proceeded to demonstrate this point in a spectacular way. Among other skills, the Barefoot College in India trains women and men from poor, rural villages – who are often illiterate – to be solar power engineers. Using hand signals to overcome illiteracy and language barriers, the college can produce a ‘Barefoot Solar Engineer’ in six months. The college generally chooses to train women, particularly matriarchs, rather than men as they are less likely to leave the village to find work in a city once they have acquired marketable skills, and these women then go on to train more Barefoot engineers in turn.

This approach is remarkably successful: the college’s alumni have solar electrified over a thousand villages in India, Africa, Afghanistan and elsewhere, bringing light and power and freedom from kerosene lamps. Roy stressed the importance of the fact that the electrification is not done for free – each villager must agree to a monthly stipend to cover the cost of training the engineer, her salary and system maintenance. Part of the point is to reduce dependence on outside experts (Roy estimates, somewhat trenchantly, that the cost of bringing solar electricity to five villages is roughly equivalent to the cost of keeping one UN consultant in Kabul for a year).

The Powerhouse Alliance

Buildings account for a massive 40% of global energy consumption. The Norwegian Powerhouse alliance aims to turn this on its head, by creating buildings that produce more energy than they consume – what they call ‘plushus’ (plushouses). The alliance was created early this year when state-owned real estate agency Entra Eiendom, construction company Skanska, architects Snøhetta, ZERO, and the aluminium company Hydro entered into an agreement to build Norway’s first energy-positive office building.



The design of these buildings is a work in progress, with every parameter being evaluated to maximise efficiency. The first plushouse will be built in Trondheim and with it Powerhouse is hoping to establish best practice in the construction industry and thus raise the average.

Johan Rockström, Executive Director of the Stockholm Resilience Centre



Any lingering doubt about the importance of combating climate change was firmly dispelled by the final speaker of the day. As of 2011, Rockström told us, the concentration of all greenhouse gases in the atmosphere has reached the point at which the IPCC considers we have a 60% chance of avoiding ‘disastrous’ climate change. With the carbon dioxide we have emitted so far and the emissions still in the pipeline (often literally) we appear to be all but committed to a 2°C rise in average global temperature – short of disastrous, but not by much. We thus have a very narrow window of opportunity: the longer we wait to act, the sooner we will have to completely eliminate carbon dioxide emissions to stay on the ‘safe’ side of warming.

Even here we face challenges: the probable effects of moderate warming are well documented. Rockström said that it is now becoming possible to conclusively link extreme weather events with climate change and that we are beginning to see the interaction of these with the economy (in rising food prices) and politics (as the spike in food prices contributed to the Arab Spring) – and this with only 0.8°C warming to date.

HyNor: Hydrogen in Norway

HyNor is a project established to coordinate the creation of hydrogen infrastructure in Norway. The secretariat is run by ZERO and this year the HyNor conference was integrated into the ZERO conference for the first time. The session included updates on the H2moves Lighthouse Hydrogen Demonstration Project from Björn Aronsson of Hydrogen Sweden, and the HyNor Oslo Buss Project from Ruter's Chief Executive Bernt Reitan Jenssen. More information on these projects can be found in the [FCT report](#) on the recent Nordic fuel cell and hydrogen conference.

Hydrogen in Oslo and Akershus

The county of Akershus and Oslo, its administrative centre, are the most densely populated parts of the country. Oslo itself gains over 10,000 people per year and it is estimated that by 2020 every fourth Norwegian will live in Akershus. It is thus a concentrated source of carbon dioxide emissions, which in some ways makes it easier to introduce effective countermeasures.

Oslo is working closely with the county administration to develop a sustainable public transport network and introduce zero emission vehicles. After the opening of the H2moves Scandinavia station in Gaustad (*right*), Oslo now has two hydrogen stations and two new stations will come online in Akershus next year (one under HyNor Lillestrøm and the other at Ruter's depot just outside Oslo for Oslo Buss). According to Ola Elvestuen, Vice Mayor for the Department of Environment and Transport, the aim is to have at least two to three more stations in Oslo by 2015 to maintain a steady pace in building up infrastructure. Incentives to purchase EVs (including FCEVs once they become available) are likely to remain in place for another ten years.



Mayor of Oslo Fabian Stang cutting the ribbon on the H2moves Scandinavia hydrogen refuelling station, 21st November 2011 (© H2moves Scandinavia)

Anette Solli of Akershus Municipality said that the county is backing this development of infrastructure, but that national government support is limited and significantly outweighed by EU funding. Statoil's recent reversal on hydrogen has also been a major setback: not only has the oil and gas producer halted development of new stations, it is also planning to abandon its existing hydrogen refuelling assets. These include one station in Oslo and two more in Akershus. Although Statoil maintains it is trying to find a solution so that these don't have to be shut down, its relationship with the county has soured somewhat and a deal is unlikely.

The Road Ahead

HyNor's chairman, Bjørn Simonsen, told us that HyNor remains motivated despite the loss of Statoil as a partner. As outlined above, a number of projects are underway and he made intriguing mention of a project at Oslo Airport in the pre-production phase. An EU concept that Norway could function as a 'green battery' for Europe is also being explored. For example, through the medium of hydrogen, Norway could absorb excess energy from Danish wind power and release it as electricity or transportation fuel to meet German demand. This would create another avenue for Norway to capitalise on early hydrogen infrastructure, which HyNor is intent on creating. By 2020, Simonsen suggested, Statoil could find it has been left behind.

Fuel Cells in Transportation

Daimler

During the HyNor session, Johnny Kristian Danielsen, Director, Mercedes Benz Passenger Cars for Norwegian importer Bertel O. Steen, said that the emphasis at Daimler is on the development of electric drivetrain technology and hydrogen internal combustion engines (HICE) are not being considered. Fuel cells are necessary to allow electric vehicles a suitable range, especially at colder temperatures where battery range halves. Daimler chose Norway for demonstration of its FCEV as the incentives for EVs are so good; although it is a relatively small market, Norway is an important pilot for much larger markets in the USA and Germany. The demonstration has proceeded well, with successful tests of hydrogen quality recently concluded, but has stalled in the last three months due to the closure of Statoil's Økern hydrogen station. Danielsen was adamant that the vehicles will not be returned to Germany and Daimler is working with various partners to ensure the continuation of hydrogen infrastructure and vehicle tests in Norway.

Toyota

Later, in the session on global transportation trends, we heard from Katsuhiko Hirose, Project General Manager, Fuel Cell System Engineering Division, Toyota. Hirose laid out not only Toyota's strategy but also why the development of FCEVs is so important to Japan, which is heavily dependent on imported oil, gas and coal and has seen its import bill soar. Where transportation is concerned, a fuel saving of at most 30% through efficiency improvements to ICE technology is just not enough to counter this. Biofuel is not seen as the answer either, not only due to the potential for conflict with food supply but also because the price could track oil.



The Toyota FCV-R hydrogen fuel cell concept car: Toyota aims to start marketing the FCV-R by 2015 (Source: Toyota Motor Company)

Japanese studies have shown that converting fossil fuel to hydrogen does have the potential to lower the fuel import burden. Energy efficiency improves and it becomes possible to make use of lower-quality and hence lower-priced sources of fossil fuel. However, Toyota is not content with the well-to-wheel efficiency of natural gas to hydrogen and emphasises that renewable hydrogen must ultimately be the way forward (although it hasn't discounted the possibility of using carbon capture and storage). There is also considerable by-product hydrogen from the chemical industry in Japan and Toyota estimates this could potentially supply as many as five million cars.

As to the vehicles, many of the technical challenges have been met and Hirose said we should expect costs to come down significantly. The manufacturing cost of the Toyota fuel cell hydrogen vehicle now in development is likely to be a quarter of the cost of the current FCHV-adv. Platinum loadings in the fuel cell have been reduced by 75% in the cathode and 90% in the anode and Toyota is still aiming to bring these in line with the loading of conventional diesel aftertreatment systems. New production methods and materials will also result in stronger, lighter and cheaper components. The company has a steady eye on the 2015 commercialisation date and a new production facility for its fuel cell vehicles is in the planning phase. This factory is likely to be of conventional size, with an eventual capacity of around 200,000 vehicles annually. Although the company is fully anticipating that production ramp-up will occur more slowly than is conventional, this signals much confidence in the future commercial success of FCEV.

German Aerospace Centre (DLR)

DLR has taken a leading role in the development of hydrogen fuel cell technology for aviation. Dr Josef Kallo, who heads the Department of Electrochemical Systems at DLR, outlined the many advantages offered by fuel cells in this application, including improved fuel economy and emissions reduction, low noise and weight reduction. Using fuel cells, battery size can be reduced and the need for conventional auxiliary power units (APU) and ram air turbines (RAT) can be completely eliminated. The low maintenance requirement and reliability of fuel cell systems is also a draw, particularly in emergency power applications. He assured the audience that the safety and suitability of hydrogen and fuel cells for use in aircraft have both been verified.

DLR has developed and tested a fuel cell nose wheel in an Airbus A320. Jet engines are extremely inefficient during ground manoeuvres so an alternative drive system for the nose wheel can cut emissions at airports significantly and, due to the very high torque needed to move a 70 ton aircraft on the ground, an electric motor is ideal for this. DLR's tests have shown that between 700 and 1,000 hours of engine runtime can be saved per plane (A320 size) per year. This extends the period between mandatory engine refurbishments, which are extremely expensive. A fuel cell electric nose wheel would thus show a rapid return on investment – even before the very substantial fuel savings are added in.



*The Antares H3, jointly developed by the German Aerospace Centre (DLR) and Lange Research Aircraft GmbH
(Source: Lange Research Aircraft GmbH)*

In partnership with Lange Aviation, DLR is also developing a light aircraft with fuel cell propulsion. The Antares DLR H2 was a proof-of-concept model and used a modified stationary fuel cell system. After its successful test flight the team received a boost in funding to develop the Antares H3 with a customised fuel cell system. Flight endurance has increased from 15 to 50 hours, and a direct drive system is used to eliminate the need for control electronics and increase efficiency by 30%. Confidence in the H3 is high and a transatlantic demonstration flight by the northern route is being considered. Ultimately, plans are for Lange Aviation to develop the Antares H3 for sale.

Concluding Remarks

The imperative to cut carbon emissions is now as much economic as it is environmental – and applies equally to the developed, emerging and developing nations. Although uptake can at times feel discouragingly slow, the persistence of those working to develop and implement clean energy technology is critical. The ZERO11 conference was a reminder that the value of this work cannot be overstated.

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