

# Energy efficiency in industry

Dr Anne Karin T Hemmingsen is working tirelessly to help Norway meet its ambitious targets on energy consumption and emissions reductions. Here, she talks about the progress made so far



**From what context did the Competence project for Reduced Energy use through Advanced Technology InnoVations (CREATIV) first emerge?**

In 2008, Norwegian political parties reached an agreement to boost national climate efforts, requiring Norway to reduce its carbon dioxide emissions by 30 per cent by 2020. This climate agreement includes a rapid and significant increase in funding for research into environmentally-friendly energy and climate-related issues. CREATIV is founded within RENERGI, the Future Clean Energy programme run by the Norwegian Research Council as a national initiative for energy efficiency in industry.

**Can you offer a brief outline of the key objectives of the project?**

Norwegian industry consumes more than one-third of the total Norwegian energy consumption, and emits more than one-third of the national emission of greenhouse gases. Our main objective is to demonstrate that a reduction in both energy consumption and greenhouse gas emissions of 25 per cent will be

feasible by 2020 through a long-term research and development effort. This is more than the EU requirement of a 20 per cent reduction of primary energy use, and the results will, of course, be implementable in nearly all countries in the world.

In addition to our main objective, a number of co-objectives will also be fulfilled. Firstly, we aim to perform and publish fundamental groundbreaking research on waste heat recovery and efficient heating and cooling. Secondly, in close collaboration with the members of our consortium, CREATIV will develop the most promising emerging technologies to the demonstration stage, and will proactively partner in the establishment of industrial pilot plants and demonstration projects. Thirdly, we will educate and train the current and next generation of energy efficiency specialists in Norwegian industry. Fourthly, we will be working to disseminate existing and emerging scientific knowledge and know-how effectively to Norwegian industry, developing our consortium into an active network for this purpose. Finally, we will actively seek participation in areas where we may influence public and private investments in energy efficiency.

**Can you outline the importance of research into energy efficiency in relation to emissions targets, climate change and renewables, biofuels, and carbon capture and storage?**

A recent International Energy Agency study demonstrated that energy efficiency measures will have to account for more than half of the sum of all measures required globally to avoid unacceptable global warming in the 21<sup>st</sup> Century. This makes energy efficiency the most important climate issue of our time; even if we should win the battles on renewable energy, biofuels and carbon capture/storage, we will lose the war on global warming unless energy efficiency is

substantially increased. Energy saved does not cause emissions, reduces the need for new controversial power plants and expensive distribution infrastructure.

**CREATIV has many industrial partners. In what ways has this influenced the project?**

We are very pleased that many industrial partners from a variety of branches are involved in the project, including: suppliers; aluminium producing plants; representatives from the dairy, fish and meat industries; supermarkets; and paper producing companies. Despite the variety of concerns amongst these companies, they all share a focus on energy efficiency. Our main objective is to demonstrate the potential for reduction in both energy consumption and greenhouse gas emissions in Norway as a whole. It has been very positive for CREATIV to focus on so many different areas of industry.

**CREATIV emphasises participation with stakeholders in order to drive energy efficiency knowledge sharing? Are there any conferences on the horizon that you will be involved in?**

There are three particularly interesting conferences coming up which we will be participating in: the 2<sup>nd</sup> International Institute of Refrigeration (IIR) International Conference on Sustainability and the Cold Chain in Paris in April; the IIR Ammonia Refrigeration Technology Conference in May in the Republic of Macedonia; and the 11<sup>th</sup> IIR Gustav Lorentsen conference in 2014. Earlier conferences we have focused on include the 23<sup>rd</sup> IIR International Congress of Refrigeration; the 10<sup>th</sup> IIR Gustav Lorentsen Conference; and the 6<sup>th</sup> Kyoto International Forum on Energy and Environment Symposium on Environment, Energy and Materials. In total, CREATIV has had 17 conference and journal papers published and we are always looking for possibilities to disseminate the results from CREATIV more widely.

## Aiming at **efficiency**

In response to the growing need for industry to become more sustainable, **CREATIV**, a new consortium based in Norway, is finding novel ways to make energy use more efficient, reducing both consumption and emissions is the process

**THE EXPANDING WORLD** population, industrial growth and burgeoning demands for food, energy, infrastructure and basic materials, scientists, policy makers and governments worldwide are acknowledging the urgent need for greater environmental concern. In response, Norway – often cited as one of Europe’s most economically and environmentally progressive countries – has set itself ambitious targets for cutting both energy consumption and emissions.

### A CROSS-DISCIPLINARY CONSORTIUM

Central to Norway’s efforts in achieving its goals is the Competence project for Reduced Energy use through Advanced Technology Innovations (CREATIV), led by Dr Anne Karin T Hemmingsen and comprising a variety of key end-users including: Norwegian industries, leading international suppliers of energy efficiency equipment, and a number of outstanding research groups. The CREATIV team first set about identifying fields in which operations could be made more efficient. These include: refrigeration; thermal processing; industrial air ventilation; better utilisation and storage of thermal energy; and the use of surplus heat to produce electricity. In actively pursuing advances in these and other areas, CREATIV has accrued a range of partners so extensive and varied that the consortium’s research could now account for over two-thirds of Norwegian industry energy reduction targets.

Those involved in carrying out this research include the Foundation for Scientific and Industrial Research (SINTEF) in Trondheim, where Hemmingsen herself is Research Director; the Norwegian University of Science and Technology (NTNU), also in Trondheim; and the Institute for Energy Technology (IFE) in Kjeller. “In close collaboration with the CREATIV consortium, these research partners will develop, demonstrate and deploy new technologies to significantly improve energy efficiency in industry,” Hemmingsen explains.

### MULTIPLE INNOVATIONS

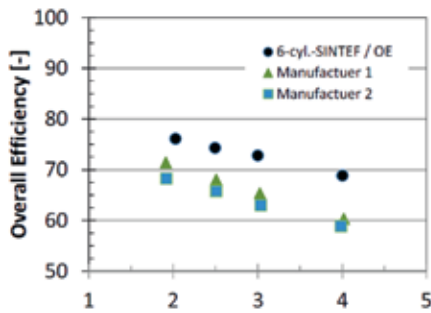
Formed in 2009 and funded for an initial four-year period, CREATIV is set to conclude its findings in 2013, and has already produced enough research to more than justify the initial capital investment. The Norwegian aluminium industry, for example, presently loses around 15 terawatt hour (TWh)/year of the 34 TWh/year it uses as waste heat, and the CREATIV team has, in cooperation with the industry and other projects, developed sustainable concepts and generic tools for using the high temperature surplus heat to generate electricity. In addition, they have also developed concepts and technology which could utilise the low temperature surplus heat, either lifting it to high value surplus heat – which could save Norway’s aluminium plants one TWh – or using the surplus heat to power refrigerators in, for example, absorption chillers in salmon

slaughterhouses. The challenges are often related to the peripheral location of those industries with high amounts of surplus heat.

In terms of food production, CREATIV has optimised a hot water tank and pump system to be used in dairy production which could reduce energy consumption by between 20 and 40 per cent compared to current systems. Within the meat industry, installation of novel hot water heat pump system has been installed. The team at CREATIV have shown that utilisation of the surplus heat has reduced the production of CO<sub>2</sub> equivalent (CDE) by 80 per cent per ton of meat. The team has also, in collaboration with other ventures, installed a 250 kW CO<sub>2</sub> refrigerated sea water prototype on a fishing boat to cool and preserve the catch. In addition to be very compact, the system has the ability to save 40 per cent of the energy currently used to pre-chill the water tank into which the catch is placed.

From land based fishing plants to the market, the fresh fish is transported in boxes with ice.





The development and testing of a new high efficient CO<sub>2</sub> compressor have led to a significant higher overall efficiency of a 100 kW refrigeration pilot plant.

“Through superchilling of fish – where a small amount of free water inside the product is frozen – there is no longer any need for ice inside the fresh fish boxes, leading to more space for fish and a reduction in the CDE of 20-30 per cent,” Hemmingsen explains

CREATIV is also looking at revolutionising refrigeration systems, replacing halocarbon refrigerants – significant leaks of which are emitted every year – with natural working fluids like CO<sub>2</sub>. Developing systems which make best use of these fluids’ characteristics is a challenge, but the team are confident that this could eliminate the environmental uncertainty of leaking large quantities of greenhouse gases.

Finally, for the supermarket industry, Hemmingsen and her colleagues are currently constructing a fully integrated energy system with CO<sub>2</sub> refrigeration plants. An up-running system shows a use of only 85 per cent energy compared to current supermarket practices. The next generation system with higher potential is under construction. Additionally, a highly efficient CO<sub>2</sub> compressor and an ejector booster system have been developed which, when installed in a pilot plant, has shown to have the potential to reduce overall energy use for a refrigeration plant by up to 20 per cent: “We are very pleased with our results so far, and with another year of new research and time to summarise the existing results, we will be able to fully ascertain the potential of these studies to reduce energy consumption,” Hemmingsen summarises.

### DISSEMINATING THE FINDINGS

The focus at all times has been on finding an appropriate, healthy and mutually beneficial balance between basic research and industrial research: “As a research initiative, CREATIV will not achieve the goals in isolation,” Hemmingsen stresses. Although the project essentially focuses on competence building, successful adaptation by policy makers and industrial partners is still crucial: as Hemmingsen expands: “We have had the chance to present CREATIV’s findings at annual conferences arranged

by the Norwegian Research Council and Enova, in addition to holding meetings with representatives from the Ministry of Petroleum and Energy”. Through such commitment to communicating with policy makers and industry professionals, CREATIV is giving its energy-efficient strategies the best possible chance of being translated into concrete action and progress. The consortium has also been proactive in communicating its findings through open workshops, conferences and journals.

### EVALUATION AND PROGNOSTICATION

Now entering its final year, the consortium is preparing to summarise its results and conclude supplementary research which is expected to demonstrate conclusively that Norway’s environmental targets are achievable. Unsurprisingly, Hemmingsen is keen to highlight the commitment of the various partners involved in the project: “There has been an enthusiasm and motivation amongst our collaborators that are impressive, and this is reflected in the good results of the project so far”.

It is estimated that the areas covered by the consortium’s research could account for over two-thirds of the Norwegian industry energy reduction targets

Going forward, the key is that the industries involved in the study will continue with further long-term research regarding the generic scientific topics identified by CREATIV. At the same time will invest the required time and money in pilots and demonstration projects in order to fully implement the energy efficient technologies developed in CREATIV. This will be far too expensive to be financed through the CREATIV initiative,” Hemmingsen emphasises. Such efforts therefore require the good judgement of policy makers to understand the scope of possible benefits.

Following the successes of CREATIV, a number of similar projects have already been established that address energy efficiency in both on- and offshore industries. Hemmingsen’s team are already making plans to work with them and others wherever possible. These forms of collaboration, it is hoped, can play a small part in bringing about a paradigm shift in the way energy efficiency in industry is managed in the future.

## INTELLIGENCE

# CREATIV

### OBJECTIVES

CREATIV represents a platform for research and development with focus on energy efficiency in industry. It aims to boost development and deployment of energy efficient technology in industry and will promote innovation and value creation based on research of high scientific quality.

### PARTNERS

- SINTEF Energy Research, Norway
- Danfoss Doshisha, Japan
- IFE
- Industrial Technology Research Institute, Taiwan
- John Bean Technologies
- NGI, Norway
- Norsk Hydro
- Norwegian Seafood Federation
- NTNU, Norway
- NTNU Samfunnsforskning, Norway
- Obrist Engineering, Austria
- REMA 1000
- TINE
- TLK Thermo GmbH, Germany
- Norske Skog, Norway
- KTH Royal Institute of Technology, Sweden
- SystemAir
- SINTEF MK, Norway
- Shanghai University, China

### FUNDING

- Norwegian Research Council
- Industry partners

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