

MITIGATING *Climate Change*

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Many Finnish projects are actively finding new ways to help mitigate climate change

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Wood energy expertise for



Antti Asikainen (left) and Lauri Sikanen of the Finnish Forestry Research Institute discussing wood energy potential with Cliff Beck from Scotland.

Many regions around the EU are looking to increase their use of biofuels, to reduce net greenhouse gas emissions and improve their energy self-sufficiency. Finnish researchers are working in various ClimBus projects to build up vital information on local potential for exploiting wood energy.

According to **Antti Asikainen**, Professor of Forest Technology at The Finnish Forest Research Institute (Metla), such research primarily aims to study the applicability and competitiveness of Finnish technologies for the procurement and utilization of forest biomass for energy in new market areas: "The idea is to give both customers and technology suppliers the reliable research results they need on how these technologies will perform in new environments."

Projects are designed to help assess the feasibility of proposed heating plants to be fired with wood chips made from locally available logging residues, sawdust and bark from mills, or harvested timber not used by other local industries.

Researchers from the VTT Technical Research Centre of Finland focus on the economic viability of heating plant operations, while

Metla's experts concentrate on the availability of suitable fuel. Metla researcher **Lauri Sikanen** stresses the importance of investigating the whole supply chain all the way from the forest to the heating plant, including harvesting, chipping, transportation and delivery: "If even a single link fails, the whole chain breaks down. People along the whole chain must understand what everybody else requires."

Tailored solutions for local conditions

Sikanen believes that many Finnish forest technologies can be applied in quite different geographical regions as long as they are carefully tailored to suit local economical, physical and cultural conditions. "Different countries have different resources," says Sikanen. In Poland and France, for instance, some densely forested regions are relatively unexploited, while Scotland has plenty of low quality roundwood suitable for energy use."

The Baltic Countries have been among the regions moving fastest towards bioenergy since the late 1990s. Other areas with potential include upland forested regions

Technologies that lead directly to energy savings play a major role in mitigating climate change, but there is also increasing demand for services that can help energy producers and users to shape energy consumption patterns favourably.



IT services to promote energy efficiency

New remote metering technologies allow electricity distributors to monitor their clients' hourly consumption rates through signals collected automatically by special software through GSM networks or power lines. The new systems mean less work for the meter man, but they have mainly been driven by other potential savings.

Landis+Gyr Enermet has developed a wide range of metering equipment, software and services for electricity companies, linking new information and communications technologies to sophisticated automatic electricity meters.

By encouraging consumers not to use electricity during periods of peak demand, electricity companies can manage energy loads to reduce the need to run more expensive and more polluting electricity gen-

erating capacity. Many household heating systems are already set to use low-tariff off-peak electricity.

Better information can also help small-scale power producers running distributed energy networks to decide when to contribute energy into grids, or purchase power externally.

Large and medium-sized industrial companies already run power optimising systems, but suitable software could eventually even be installed in smart meters in connection with home automation systems.

Easier reporting and budgeting

The information obtainable from today's advanced electricity meters can also help businesses meet increasingly strict requirements for the reporting of their energy use.

Finnish energy services provider Energiakolmio Oy has developed an energy consumption reporting service known as EnerKey.com, which compiles comprehensive information on an hourly basis about the electricity, heat and water consumption of properties, as well as the related costs.

"Enerkey is particularly used by large industrial companies such as foodstuffs producers and retail chains who have many properties in separate locations – and also by some municipalities," explains Energiakolmio manager **Jukka Muilu**. "EnerKey automatically collects data from grid owners' meters and transmits it to our server system via telephone lines, or also increasingly via the internet and wireless GSM communications. We can also collect data on the consumption of gas,

heating oil, and hot or cold water in district heating and cooling systems."

New software developed by Energiakolmio enables all this separate information on consumption rates to be compiled on the same system, facilitating comparisons between different locations, or with other energy users. "This information helps our clients to identify areas where energy savings can be made, and also makes their reporting much easier," says Muilu.

In future more and more businesses and even individual householders are likely to look to energy service providers to help control their energy consumption.

FOR MORE DETAILS SEE:
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New services

New economic instruments related to European and global efforts to combat climate change, such as the EU emissions trading scheme (ETS), are of vital importance to many companies. New services can help such companies to plan for the future in spite of the many uncertainties.



EU regions

Finnish forest technologies can be applied in many countries to support carbon-neutral wood energy schemes.

planning is needed before investments can be made," says Asikainen.

Collaboration with key local actors

Another current project is looking at demand in various parts of Europe for the technology and know-how needed for smaller scale wood energy production. This involves examining local markets, running field trials, and building up networks with local planners, forestry organizations and energy businesses. In Northern Italy, for example, wood-fired heating plants have been set up widely because subsidies are readily available. But since subsidies do not extend to the fuel supply, there is good local demand for the holistic planning of supply chains.

A forthcoming ClimBus project aims to encourage the export of Finnish technologies to help build up wood energy business in even further-flung regions. "The new project will focus on potential markets in North and South America, Russia and probably also one of the two newest EU members Romania and Bulgaria," adds Asikainen.

INTERNATIONAL BIOFUEL MARKETS STILL TAKING SHAPE

A major report recently prepared by Lappeenranta University of Technology (LUT) and VTT Technical Research Centre of Finland focuses on Finland's position in rapidly growing international biofuel markets. According to the report, international trade is becoming ever more important for Finland as imports of raw wood and exports of wood pellets rise. Projected increases in the use of biofuels for transportation also mean that countries with suitable products will stand to benefit greatly.

The report was prepared in collaboration with the EUBIONET II project and the Task 40 bioenergy scheme run by the International Energy Agency (IEA). "Task 40 aims to develop new markets to promote long-term sustainable international trade in biofuels, securing both supply and demand," says **Jussi Heinimö** of LUT. Although the report assumes that bioenergy use will continue to increase considerably over the next decade, it also identifies crucial factors such as public and political support for biofuels, and the need to guarantee the future availability of sustainably produced biomass. Global trade in oil and coal is well established, but international biofuel markets are still in their infancy. Task 40 aims to identify and remove trade barriers that could hinder the spread of bioenergy.

"More developed markets will give rise to new business opportunities. Finland has plenty of know-how and technology in the bioenergy field, but better marketing will be needed to ensure that Finland will benefit from the growth in international markets," adds Heinimö.



FROM WOOD TO BIODIESEL

In March 2007 the forest industry giant **Stora Enso** and **Neste Oil** set up a joint venture aiming to produce liquid biofuels from wood residues. A 14-million-euro demonstration plant at Stora Enso's Varkaus Mill due to start up in 2008 has been designed to develop and commercialise the production of wood-based biofuel. Stora Enso will supply the feedstock; heat and power produced at the plant will be used locally; and the raw biodiesel from Varkaus will be processed at Neste Oil's Porvoo refinery, where biodiesel fuels are already being produced from various organic feedstocks.

This promising project is a spin-off of the extensive collaboration between the forest industry, Neste Oil and researchers from the VTT Technical Research Centre of Finland encouraged through the ClimBus programme. Stora Enso and Neste Oil see Europe's rapidly growing market for liquid biofuels for transportation as a major business opportunity. If all goes well at the Varkaus plant, a full-scale production plant will ultimately be built at a similar mill-side location.

New biorefining programme under way

The new 5-year Tekes technology programme **BioRefine - new biomass products** has been designed to build up know-how on the refining of biomass, and to apply this expertise to create new processes, products and services related to the refining of biomass. The programme will run until 2012, and has a total budget of 137 million euros.

FOR MORE DETAILS SEE:
www.tekes.fi/biorefine

Services to help businesses plan climate investments

Pöyry Energy Consulting has developed a model to predict the future prices of EU allowances. The model is based on forecast levels of supply and demand, as well as information on sector- and country-specific marginal emission abatement costs.

According to **Sari Siitonen**, Principal for Carbon Markets, the future prices of allowances and their impacts on electricity prices are a crucial factor behind investments in industries such as energy production, oil refining, iron and steel, cement, and pulp and paper. The EU ETS price model is already

being used by Pöyry in workshops and feasibility studies for various clients. "Large international companies have of course been interested, but we've also presented the model to UK ministries," says Siitonen.

Since the EU trading scheme was launched in 2005, the prices of emission allowances have fluctuated between 30 euros and less than a euro today, due to the high supply of allowances. When the next trading period begins in 2008 prices are expected to rise again as the European Commission is now stricter in its approval of member countries' national allocation plans (NAPs). Siitonen stresses that before the first phase of the ETS it was hard for the EU to compile accurate statistics on emissions from sources to be covered by the scheme, but NAPs can now be based on actual emission figures from 2005.

"The expected steady increase in the supply of purchasable emission credits from Clean Development Mechanism and Joint Implementation schemes in developing and transitional economies is a major factor affecting allowance prices," says Siitonen. "Fuel prices for oil, gas and coal are also very important, as well as the availability of hydropower due to weather conditions, especially here in the Nordic countries."

Energy targets and emissions trading are crucial factors behind modern corporate planning.

Emission gaps

Pöyry has modeled 'emission gaps' for each of the EU's 27 countries, by comparing forecasts for future emission levels and the supply of allowances. "In countries like Spain, Italy, Finland, Austria and Denmark, reduction targets look very tight, and it won't be easy to find enough potential in industry," says Siitonen. "But elsewhere there is considerable potential for reductions by switching from coal to gas in the UK, and through energy saving in Eastern Europe, for instance."

The next challenge is to model scenarios for the post-2012 period. Uncertain factors include the sectoral and geographical scope of future emissions trading schemes, and the possible incorporation of carbon capture and storage. The EU has already set a 20% emission

reduction target, which would rise to 30% if other key countries joined a global scheme.

Looking at the wider picture

Another ClimBus project at Pöyry Forest Industry Consulting has developed benchmarking services related to energy efficiency and carbon dioxide emissions for the forest cluster. "Our improved benchmarking tools help clients to define company-wide energy efficiency improvement strategies, or identify improvements for single installations," says Senior Vice President **Petri Vasara**.

"Emissions trading is just one of the many factors influencing complex markets. If you only look at emissions trading, you probably miss the big picture. New targets for renewable and bioenergy and the global political situation are also important, for instance. We've already moved on from the evolution of benchmarking toolkits to a more revolutionary type of competitiveness analysis, which has grown out of the original project idea."

The new service, named 'competitive dominance', is based on the sophisticated analysis of sensitivity to many inter-related factors, considering a vast amount

of information on all conceivable circumstances. "The world is highly complex, but we aim to reduce its complexity for our customers by presenting their optimal positioning but hiding the complicated calculations behind the results," says Vasara. Innovative visual representations of companies' competitive positions are an important aspect of the new service.

FOR MORE DETAILS SEE:
www.tekes.fi/climbus



Sari Siitonen



FACTS ABOUT FINLAND

Population: 5.2 million | **Languages:** Finnish (94%), Swedish (6%), Sámi (spoken by the indigenous Sámi in Lapland) | **Area:** 338,000 sq km (10% lakes; 68% forests) – the fifth largest country in the EU | **Average temperatures in Helsinki:** July +17°C, February -6°C | **GDP per capita 2006:** € 31,900 (EU average: € 27,700) | Finland has been a member of the EU since 1995.



THE FINNISH FUNDING AGENCY FOR TECHNOLOGY AND INNOVATION

TeKes is the main public financing and expert organisation for research and technological development in Finland. TeKes funds innovative and risk-intensive R&D projects in industry, universities and research institutes.

www.tekes.fi/eng

- TeKes uses technology programmes like ClimBus to channel financing, networking and expert services into specific areas chosen for their importance to business and society.
- Technology programmes encourage innovations in businesses, services and industry, and enhance co-operation between companies, research organisations and the public sector.
- R&D projects related to climate change mitigation received €61 million of funding from TeKes in 2005 – approximately 14% of TeKes's total funding.



TeKes's technology programme **ClimBus – Business Opportunities in Mitigating Climate Change** aims to find innovative ways to mitigate climate change. ClimBus sees the urgent need to reduce greenhouse gas emissions around the world as an opportunity to promote environmental technologies and other favourable innovations. Foreign companies and organisations are welcome to collaborate in the ClimBus Programme together with Finnish partners.

MORE INFORMATION

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High-speed technology for electric motors

Half of the electricity used around the world drives motors of various kinds. Huge quantities of energy could be saved by making large motor drives run more efficiently. Experts from the Lappeenranta University of Technology are designing innovative energy-efficient high-power electrical motor drives and generators for large-scale industrial applications.

“The new motor designs are based on solid rotors made of a single piece of steel,” explains Professor **Juha Pyrhönen** of Lappeenranta's Electrical Engineering Department. “Most conventional rotors have several hundred interconnected parts, and it's almost impossible to make them rigid enough to run at the kinds of high speeds that can greatly boost energy-efficiency levels.”

The motor drives under development in Lappeenranta rotate at speeds as high as 12,000 revs per minute, and use more than three megawatts (MW) of power. The high-speed motor drives are much more efficient than conventional motor drives, leading to energy savings of up to 30%.

“Although the idea of a solid rotor sounds simple, it is extremely difficult to calculate all the forces involved, including the complex electrical currents and magnetic fluxes that run

through rotors. The material properties of the steel are crucial,” says Pyrhönen. “Rotors must have optimal electrical and magnetic conductivity, and also be strong enough to tolerate all the mechanical forces generated at high speeds.” The ClimBus research project at Lappeenranta University of Technology has particularly focused on the effects of rotor materials on the working of high-power motors.

According to Pyrhönen there is plenty of international interest in the new motor designs: “It helps that Lappeenranta has built up a reputation over the latest twenty years as a major research centre for solid-rotor induction motor technologies. More than 20 researchers from different special fields are involved in this project.”

Pyrhönen feels that the new high-speed high-power motor technologies are ready to break through onto major markets once enough competition develops to interest major industrial clients. “The need to save energy to help mitigate climate change is also an important factor.” Pyrhönen adds.

Motors for many uses

There are many potential uses for the new industrial motor designs, especially in pumps,

New designs for massive motors can save enormous quantities of energy.

compressors and fans. Vacuum pumps produced by Ecopump Oy in Kotka are already in use in several paper mills around Europe, where they remove moisture from the paper web during the paper-making process, using only about half as much electricity as conventional vacuum pumps. Aeration pumps designed using the new technology for use in wastewater treatment plants can likewise double energy efficiency.

Another spin-off from the ClimBus project has been new designs for small biomass-fuelled combined heat and power plants that can be located near fuel sources to reduce transport costs and emissions. The energy efficiency of small power plants producing about 1 MW of electricity and 4 MW of heat for local needs can be dramatically improved by connecting the power plant's turbine, generator and feed pump along the same gearless shaft.

A new Finnish company

called The Switch, formed through a series of mergers at the end of 2006, aims to market a wide range of high-power electrical technologies including gearless drives for large wind turbines and high-speed compressors for massive gas pipelines. “We have chosen full power converter technology for wind power, where there is a big demand,” says **Jukka-Pekka Mäkinen**, CEO of The Switch. “This is a growing area and will become a mainstream part of the industry because of the quality demands for electricity - but so far this technology is only used by a few players in the field.”

Research results from the ClimBus project have already been applied by Rotatek Finland, one of the companies now incorporated in The Switch, to develop high-power gas compressors in co-operation with an international customer. “A prototype compressor is due to be completed during 2007, and we're already involved in testing with the customer,” says technical manager **Panu Kurronen**. “The environments where these compressors will be used are so challenging they can be described as literally explosive! There's a lot of new technology and new materials involved, so it's been very important to have technical support from university researchers.”

NEW WAYS TO REDUCE EMISSIONS FROM WASTES

New ways to reduce greenhouse emissions by improving the management of municipal solid wastes are the focus of a ClimBus project studying commercial technologies with potential for export through Kyoto JI and CDM schemes.

“Worldwide, waste management only accounts for about 3-4% of man-made greenhouse gas emissions, but the potential for cost-efficient emission reductions is very high,” says Professor **Ilkka Savolainen** of VTT Technical Research Centre of Finland. The project has studied concepts including the recovery of methane gas from a major landfill in St Petersburg, the gasification of solid wastes in China for energy use, and the processing of biowaste to produce fuel for gas-fuelled vehicles.

Researchers from the Finnish Environment Institute have also looked at the net greenhouse impacts of certain commercial uses of recovered waste plastics and textiles.

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MODELLING FUTURE DEMAND FOR ENERGY TECHNOLOGIES

The ClimBus Programme also focuses on the longer-term future through research schemes such as the SETELI project, which aims to model global demand for clean energy technologies. SETELI especially seeks to help Finnish energy technology providers to get an overall view of future business opportunities abroad, by identifying potential market areas, and assessing the impacts of alternative energy policies and regulations.

Calculation tools have already been devised through the project to help define future scenarios. “For global climatic war-

ming to be limited to 2-3 degrees centigrade by the end of the 21st century, all kinds of measures will have to be adopted: energy must be used more efficiently; energy production methods that do not generate carbon dioxide must be taken into use; forestation must be extended; and solutions must be found for the capture and storage of carbon dioxide,” says project manager **Tiina Koljonen** of VTT Technical Research Centre of Finland.

The scenarios generated through SETELI facilitate assessments of the impacts

of alternative policies on investments, emissions and economies at global and regional level. The project particularly examines the impacts on markets around the world of financing policies such as the Joint Implementation and Clean Development Mechanism instruments of the Kyoto Protocol, and the European emissions trading scheme.

The SETELI project involves researchers from the Helsinki School of Economics and the Finnish Environment Institute as well as VTT.