ProEcoPolyNet

n°3

March 2008

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Summary

The ProEcoPolyNet project was launched in May 2006 with as objective to contribute to the bundling and sharing of European Research know-how in three thematic interlinked areas: eco-buildings, polygeneration and renewable energy heating and cooling technologies.

Polygeneration

What is Polygeneration? Polygeneration systems are a combination of cogeneration systems and thermal cooling systems. They produce heat, electricity and cooling energy.

The cogeneration system, also called combined heat and power system (CHP) converts the primary energy (natural gas, biogas, rape oil, fuel oil etc.) into heat and electricity.

To increase the efficiency of CHP systems and raise the full load hours of the system, the heat produced outside the heating season for example, is converted into cooling energy.

The ProEcoPolyNet polygeneration workpackage: The activities undertaken under the work package on "Polygeneration" of the ProEcoPolyNet project aim to facilitate market penetration of technical applications/solutions related to “polygeneration technologies”.

The partners involved in this work package started by a detailed screening aiming at identifying most innovative technology and RTD results relevant to the topic of the work package, resulting in a "WP 4 screening results of RTD activities" list gathering more than innovative projects.

Furthermore, some 20 "Technology profiles" were developed to present project and available technologies and analyse the market situation of the systems presented. The technology profiles can be roughly classified in the following main categories:

- detailed analysis of existing equipments and appliances
- case studies installations: cogeneration and trigeneration
- detailed presentation of key technologies for the future
- RTD project for the development or the improvement of technologies and systems related to polygeneration

A guidebook on polygeneration systems in general, which details the main principles of this field, has also been developed, providing an general introduction to the matter.
Finally, 4 European events were organised:

- Expert information exchange workshop on micro CHP (COGENeration Conference, Brussels, Brussels, Belgium, May 2007)
- Supplier/Customer seminar (Brussels, Belgium, 12.02.2008, COGEN Europe office)
- European seminar on Trigeneration (Milan, Italy, February 2008)
- Project dialogue seminar on small-scale and micro CHP (Århus, 29.02.2008, Denmark)

In addition, a regional and national expert workshop focusing on discussing technological innovation took place in Berlin, during the Berlin Energy days, in May 2007.

In this Newsletter, you will find introductory presentations of the outcomes described here above. For complete results and detailed information, please consult the ProEcoPolyNet website: http://www.proecopolynet.info

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ProEcoPolyNet Project partners:

Berliner Energieagentur GmbH - O.Ö.Energiesparverband (ÖÖ ESV) - Energy Consulting Network (EC-Net) - Austrian Energy Agency - University of Manchester - VDI - FEDARENE - FAST - Building and Civil Engineering Institute ZRMK - REHVA - Jozef Stefan Institute - COGEN Europe - Motiva Oy

▷ Polygeneration - Existing equipment and appliances

4 Small CHP market stars and challengers screened and compared

Small/micro CHP appliances are already available on the market - some of them for years - or close to be. 4 of these, have been analysed, each of them representative of a specific technology and approach of CHP principle:

- **SenerTech Dachs RS**: The Dachs RS is the first small rapeseed oil driven CHP which is available from serial production in the German (and later on in the European) market. It is based on the Dachs HR, a CHP of similar size developed for the use of mineral hating oil 28 years ago. Until now, 6500 of these units have been sold and installed. For more information, see the SenerTech Dachs RS Technology Profile
- **SOLO Stirling 161**: This micro CHP unit is powered by a 90° V-2-cylinder Stirling engine is under serial production since 2004. The SOLO can work on fossil fuels (oil or gas) as well as renewable energy sources (solar and biomass). The emission of harmful substances from Stirling burners compare with the latest data in modern gas burner technology and may be as low as 1/10th of the emission from gas driven Otto engines with catalysts. For more info, see the SOLO Stirling 161 Technology profile
- **Ecopower**: This micro CHP unit powered y a gas driven piston engine allows to independently produce heat (heating and domestic hot water) and power in a compact appliance which is ready for connection. Power production increased by up to 60% thanks to patented output modulation. It is a commercial product available in several EU member states. For more info, please consult the Ecopower technology profile
- **Galileo 1000 N**: Fuelled with natural gas, Galileo 1000N is a fuel cell (Solid Oxide Fuel Cell - SOFC) with a back up burner that provides the basic demand of electricity and total demand of thermal energy for single family house or small multi family homes. The Technology is not ready for the market. Market launch will be expected not to be before 2010. For more info, please consult the Galileo 1000 technology profile

Three of the above micro CHP Units have been tested and compared in a **comparative study of existing micro-CHP units** realised by the Reutlinger University and supported by the German Federal Ministry of Education and Research. The study also considered another existing model of micro CHP unit: the SM5A biogas engine of Stirling Denmark. The study points out, among others, the differences between the different models in terms of both electric efficiency and gas emissions, concluding that the SOLO Stirling 161 is the best combination of sufficient electric and overall efficiency and acceptable emissions. For more info and results, please consult the "Experimental Examination of Different Micro-CHP" Technology profile

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▷ Demonstrating Polygeneration: Cogeneration installations

Sewage plant at the Hallstättersee (Source: www.rhv.at)

"Electrifying" sewage biogas

The sewage plant of Hallstättersee, in Austria, is operating since 1979, treating waste waters from different local communities and ski stations around. After the enlargement of the plant in 2003, several measures where implemented to increase the energy efficiency of the plant, starting with optimising programs and the installation of a PV system (surface: 143,4m²).
Besides, the project "electrification of sewage gas" was developed, based on the installation of a micro CHP system based on two micro gas turbines (CR 30) and a biogas conditioning station. The electricity generated covers the power demand of the sewage plant. The thermal energy produced supplies the thermal distribution network of the whole facility and is used to heat the digestion tower.
Excrescent biogas is used to operate two additional gas boilers which are used for additional heating of the facility buildings and the digestion tower.

Reinhaltungsverband Hallstättersee, A-4822 Bad Goisern, www.rhv.at

See also:
ProEcoPolyNet "Sewage Plant Hallstättersee" technology profile

Small scale biomass boilers and chillers

Ab- or adsorption chillers have just been available with rather large cooling capacities, unsuitable for small scale application such as office or residential

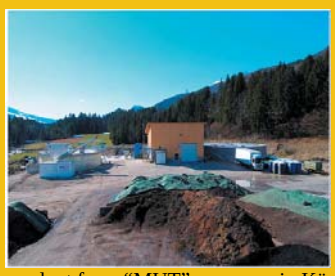
The Centro Eccellenza Bioenergia

building air conditioning. Only recently smaller engines (10-20 kW) started to emerge - and even smaller one are now under way. A greater number of field testing is still needed to elaborate practical guidelines in this field. Upfront investment costs are also still an obstacle, being still 2 to 2.5 times higher than conventional systems.
An interesting case study is the installation of a joint heating and cooling biomass system in Stigliano (Italy), at the Centro Eccellenza Bioenergia, an office building of 1000 m³ that acts as a regional formative centre for Bioenergy Applications. The system installed is based on a biomass boiler used for hot water production, space heating in winter, and air-conditioning in the summer.

Dr Francisco Pesce, Agricultural Dept - Basilicata Region, Potenza, Italy, frpesce@regione.basilicata.it

See also:
ProEcoPolyNet "Absorption chiller driven by bio-heat" technology profile

Biomass, biogas, electricity, heat and wood chips



Biogas plant from “MUT” company in Kössen/ Tyrol (Picture: “MUT” company)

Built in 2006, the "MUT" biogas plant, located in Austrian's Tyrol, treats organic waste produced by the region's gastronomy and private households. Before the creation of the plant, the organic waste was only used to manure agricultural field. Since the plant is operating, the biomass is used to operate a CHP unit (183kWth/1580kWel). 10% of the electricity produced is used to operate the plant, the remaining 90% being fed into the grid. The thermal energy is used, for 50 %, to run the fermentation process. The rest is used to to dry wood chips, generating additional revenues. Furthermore, the remaining ferment can still be used for agricultural purposes and is even better than the non-treated biomass, as it is less odorant and has a lower viscosity.

MUT waste treatment GmbH, A-6330 Kufstein/Tyrol, www.juely.at

See also:
ProEcoPolyNet "Biogas CHP in Kössen" Technology profile

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▷ Demonstrating Polygeneration: Trigeneration installations

Industrial site of the Energie Contracting Steyr company (Source: Energie Contracting Steyr)

Trigeneration with a micro gas turbine

Located in the town of Steyr, the Energy contracting Steyr operates since 2006 a trigeneration system that provides steam, hot water, district heating, compressed air and electricity for the factories of its industrial site. The system consists of a micro gas CHP unit (100°kWel/155°kWth), a heat recovery boiler and an absorption chiller (cooling capacity 35°kW). Cooling energy produced by the latest is used to substitute the air-conditioning system of the plant and cool down the intake air of the micro gas turbine, raising electric efficiency of the turbine, especially in summer period.
The same installation was previously in use in Graz-Thondorf (Styria), where it produced at the same time electricity for the public grid, thermal energy for an automobile factory and the district heating system of the town Graz.

Energie Contracting Steyr Ltd., A-4400 Steyr, www.energieag.at

See also:
ProEcoPolyNet "Trigeneration and micro gas turbine" technology profile

Solar thermal collector (surface 70 m²) at ÖÖ Ferngas building in Haid (Source: OÖ Ferngas AG)

Where gas and solar meet, in Upper Austria

In 2006 the Upper Austrian gas company OÖ Ferngas put up an innovative service centre in Haid near the city Linz, heated and cooled through a sustainable and efficient energy concept involving a high amount of renewables. The system is composed of (i) a solar thermal system, (ii) a micro gas turbine, (iii) an absorption chiller and a natural gas boiler (to cover the peak loads for cooling and heating).
It represents the first demonstration project in Austria which tests an absorption cooling system based on a solar thermal and a micro CHP system. The operational experience will show efficiencies, operation and maintenance costs and the profitability of these innovative energy systems. The knowledge and experience gained will be used for further comparable energy systems and will give useful feedback to the component manufacturers.

OÖ Ferngas AG, A-4030 Linz, www.ooeferngas.at

See also:
ProEcoPolyNet Trigeneration and solar cooling

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▷ Polygeneration: key technologies for the future

1. Stirling engines

2. Fuel Cells

Stirling Engines

The principle of Stirling engines has been known for a long time (at patent for the first Stirling engine was first granted to Robert Stirling back in 1816!). Unlike reciprocating internal combustion engines, the heat supply is from external sourecs, allowing the use of a wide range of energy sources including fossil fuels and renewable sources like solar or biomass.
There is an increasing interest in the use of Stirling engine based co-generation system for residential and commercial cogeneration because of their prospect for high efficiency, good performance at partial load, fuel flexibility, low emission level, low vibration and noise level. However, before these systems can see widespread acceptance, their affordability and reliability must still be improved

Dr Ian Beausoleil-Morrison, CANMET Energy Technology Center - Ottawa, Canada

See also:
ProEcoPolyNet "*Stirling engines*" Technology profile

Fuel Cells and CHP

In a fuel cell, the chemical reaction of combustion is made using an electrochemical reaction where the reactants are separate by a tight membrane that only allows ions crossing. To complete the electrical balance, electrons have to move through a circuit, which produces a current. Stationary power fuel cells typically burn natural gas.
The advantages of fuel cell cogeneration include low noise level, potential for low maintenance, excellent part load management, low emissions and a potential to achieve an overall efficiency of 85-90% even with small units. However, the high costs and relatively short lifetime of fuel cell systems are their main drawback. Ongoing research and mass production are expected to result in eventual reduction of the costs of fuel cells.

Dr Ian Beausoleil-Morrison, CANMET Energy Technology Center - Ottawa, Canada

See also:
ProEcoPolyNet "*Fuel Cell CHP*" Technology profile

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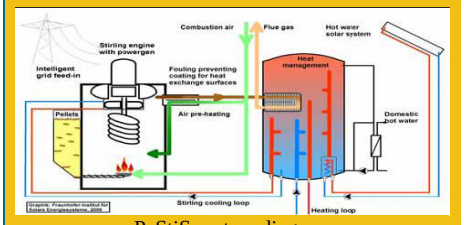
▷ Developing Polygeneration: Promissing RTD projects



PeStiS system diagram

European Virtual Fuel Cell Power Plant: The aim of "The Virtual Fuel Cell Power Plant" project was to develop, to install, to test and to demonstrate a virtual power plant consisting of 31 decentralized stand-alone residential fuel cell systems. The project identified three major hurdles to be overcome in the development of a product for the residential mass market, which are now addressed by research on a High-Temperature PEM Fuel Cell system undertaken by the company (previously leader of the EUVPP project). More on the EUVPP project in the ProEcoPolyNet *EUVPP technology profile*

Optimised Micro-turbines Energy Systems (OMES): OMES is a European demonstration project for the demonstration of the turbine technology at small scale CHP. Integration of a micro gas turbine in some industrial processes can lead to very high-energy efficiency. However, in order to pay back within reasonable time, an micro gas turbine for CHP has to operate intensively, which limits the number of suitable locations. More info on this project in the ProEcoPolyNet *OMES technology profile*, or directly from the project's website : www.omes-eu.com

Pellet-Stirling-Storage-CHP (PeStiS): The aim of this project is to develop a storage-integrated micro CHP (wood pellets as fuel) and components for installation in smaller residential buildings. The objective is a minimisation of the fuel consumption, a power modulated operation, optimised electricity production and low-cost maintenance. Different concepts are investigated in the view of achieving these objective. More info on this project in the ProEcoPolyNet *PeStiS technology profile*

Bio-Hydrogen: The project aimed at the development of a stable and cost-effective biogas reforming system enabling to produce "bio-hydrogen" from agricultural biogas plants, municipal waste water treatment plants and landfills. The produced "bio-hydrogen could then be used in PEM fuel cells. The prototypes developed and tested during the project showed the functional capability of the prototypes. However, to reach marketability, far more research is essential, and storage systems, costs-effective technologies and infrastructure for H2 storage are required. More info on this project in the ProEcoPolyNet Bio-Hydrogen technology profile.

SOCOOL Trigeneration system under construction

Small scale trigeneration (SOCOOL): The project focuses on the development of a small-scale combined cold, heat and power (tri-generation) system, which utilises the engine waste heat for cold production. The new cooling machine developed within this project will be low in cost (cheap to manufacture), will have a high efficiency, and must operate with a high reliability. Important objectives for further development are to produce a more compact system with an even higher volume-to-power ratio. More info on this project in the ProEcoPolyNet *SOCOOL technology profile*

3A Biogas: Three step fermentation of solid bio waste for biogas production and sanitation. The major part of solid state bio waste is processed aerobically (typically by composting). The new 3A biogas process for solid bio waste achieves a optimum combination of aerobic composting and anaerobic fermentation and includes sanitation of the compost. The process is divided in 3 phases: the first phase is aerobic, the second anaerobic and the third aerobic again, hence the name of the process "3A biogas". More info about this project and process in ProEcoPolyNet 3A Biogas technology profile

HEGEL - high efficiency micro-polygeneration units: The main objective of the project is to develop, build and test three innovative high efficiency applications of micro-polygeneration:

- ICED: A trigeneration plant to be installed in Torino (Italy). The unit will be innovative as it will make use of a reciprocating engine cogenerator (120 kWe) in combination with a LiCl liquid desiccant cooling system providing cooling and dehumidification.
- MTA: A micro turbine in trigeneration mode with two ammonia-water absorption cooling cycles, installed in a multifunctional building in Sant Cugat del Vallès (Spain). Capacity of 65/110/32 kW (electricity/heat/cooling)
- CS: A “Combi System” cogeneration plant consisting of the combination of a reciprocating engine and a Rankine cycle engine (bottoming cycle) operated on the exhaust gases of the reciprocating engine. This unit will be installed in Turkey. The capacity will be of 150 kWe with an electrical efficiency of 40%.

The project will also include the design of detailed maintenance procedures.
For more info: http://www.hegelproject.eu (or contact Franco Anzioso, Centro Ricerche Fiat, hegel@crf.it)

Project co-financed by the 6th Framework Programme for RTD of the European Commission

Edited by FEDARENE with the support of the partners of the ProEcoPolyNet Project.

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