FC-district

New µ-CHP network technologies for energy-efficient and sustainable districts

The project optimises and implements an innovative energy production and distribution concept for sustainable and energy-efficient districts. The concept is based on a number of technologies: dynamic heat exchange between buildings exploiting SOFC based micro-CHP units for energy production; improved thermal storage, building and piping insulation; biogas production from food wastes; smart control and hybrid wireless network systems.

Overview

FC-DISTRICT addresses refurbished and/or new 'energy autonomous' districts, exploiting decentralised co-generation coupled with optimised building and district heat storage and intelligent district distribution networks. Continuous Solid Oxide Fuel Cells (SOFCs) operation along with effective in-building and district load control is expected to reduce annual primary energy consumption at district level up to 60%. Demonstration will be carried out in Spain, Greece and Poland in three phases: unit, building and district.

Objectives

The FC-DISTRICT objectives are:
Develop a high temperature SOFC with versatile fuel processor and optimised peripheries making possible successful integration with district networks. Combined Heat and Power (CHP) production and efficient fuel use results in reductions in carbon emissions and costs and reduces losses over transmission and distribution lines. It offsets the use of centrally-generated electricity from the grid and allows local voltage regulation.

Develop and implement advanced, durable and cost-effective insulation materials for improved building and district piping thermal response.

Integrate Food Waste Disposal units with anaerobic digesters to produce biogas.
Implement an 'Intelligent Heat Network' equipped with smart control and hybrid wireless network systems.

Optimise and tailor the characteristics of the energy and power distribution systems to meet the energy and power demand of various building and district typologies.

Achievements to date

Micro-CHP System

The novel SOFC based micro-CHP unit has been designed to fulfil the relevant European technological and market requirements (return of investment of five to seven years). It utilises a planar SOFC stack operating on Catalytic Partial Oxidation(CPOX) reformed NG and biogas and nominally provides 1.5 kWel and 2.75 kWth. The targeted electrical efficiency is over 30% and overall efficiency over 90% with a modulation range of approximately 1:3. Major peripheral components (CPOX reformer, inverter etc) and most important balance of plant components (post-combustor for the anode exhaust gas, high-temperature plate-type heat exchangers and heat recovery unit) have been developed and tested.

The FC-DISTRICT concept: Intelligent Heat Network with SOFC micro-CHP units

ETIC Systems
Innovative External Thermal Insulation Compound Systems (ETICS) based on Vacuum Insulation Panel (VIP) and Aerogel technologies coupled with Dry Wall Construction techniques are developed. The target is to maintain thermal performance, offering significantly reduced insulation thickness. In 2012, the new ETICS will be installed, tested and monitored at a demo site in Greece.

New pipes
The new heat distribution pipeline concept is based on combining Vacuum Insulation Panels (VIP) and polyurethane (PUR) in a hybrid insulated pipe. Results have shown that this configuration can reduce power requirements by 15-20% under constant temperature conditions. The production process development focuses on a twin pipe configuration (two service pipes in one casing pipe) with VIP.

Innovative biogas tanks
A prototype anaerobic digester has been developed to investigate tank working conditions, discharge and thickening control system. The tank is a crucial element of the district waste collection system and represents the first step for further biogas generation in anaerobic digestion facilities. The target is to integrate the production of biogas through the introduction of upgraded wastes into centralised anaerobic digesters.

Wireless communication system
A prototype hybrid network is developed and implemented. A ranked communication strategy is necessary to achieve the desired performance. The most appropriate communication standard has been chosen and successfully installed in the Polish district demo site. The system allows control of fuel cell units, heat demand, fuel supply and other devices at the district level.

Impact
The project will deliver new products for the European energy (SOFC), construction (ETICS, pipes, biogas tanks) and ICT (wireless networks) markets.

The implementation of the FC-DISTRICT concept will achieve building energy and power autonomy via demand-flexible balance at district level and will be appropriate for a wide typology of “districts”. Districts could include a typical housing estate, isolated rural communities, mixed suburban environments, academic or public communities such as universities or schools, commercial areas, industrial sites and trading estates, or municipal regions. Up-to-date simulations have shown a possible primary energy saving up to 50% at district scale.

Additional energy and cost benefits will arise from possible income from the local ESCO in case of electricity surplus and possible taxes reduction stemming from reduced CO_2 emissions and/or from reduced district wastes.

PARTNERS

Coordinator: Mostostal Warszawa S.A., Poland

Belgium: Intesa SanPaolo Eurodesk

Germany: TU-BAF, KNAUF Gips, EBZ, sunfire

Greece: NTUA, KNAUF Gypspopiia ABEE

Italy: D’Appolonia, ecofast

Netherlands: ECN, vito

Poland: Mostostal, IEN

Portugal: IST

Romania: OVM ICCPET

Spain: ACCIONA, FAGOR, ikerlan, SOLINTEL M&P

Sweden: CUT, SP, POWERPIPE

UK: rinicom

KEY FACTS

Start date: September 2010
Duration: 48 months
Total budget: €11.8m

- Optimised thermal power management at building and district level via dynamic heat exchange between buildings
- Innovative micro-CHP SOFC system for energy production, coupled with improved building thermal storage and insulation, advanced district heating piping, biogas production from food wastes, smart control and hybrid wireless network systems
- District level demonstration in Poland proves the concept, targeting up to 60% reduction in primary energy use and acts as model for heat-optimised districts

http://www.fc-district.eu