Programme Review 2012

(NMP2-SL-2010-260105)

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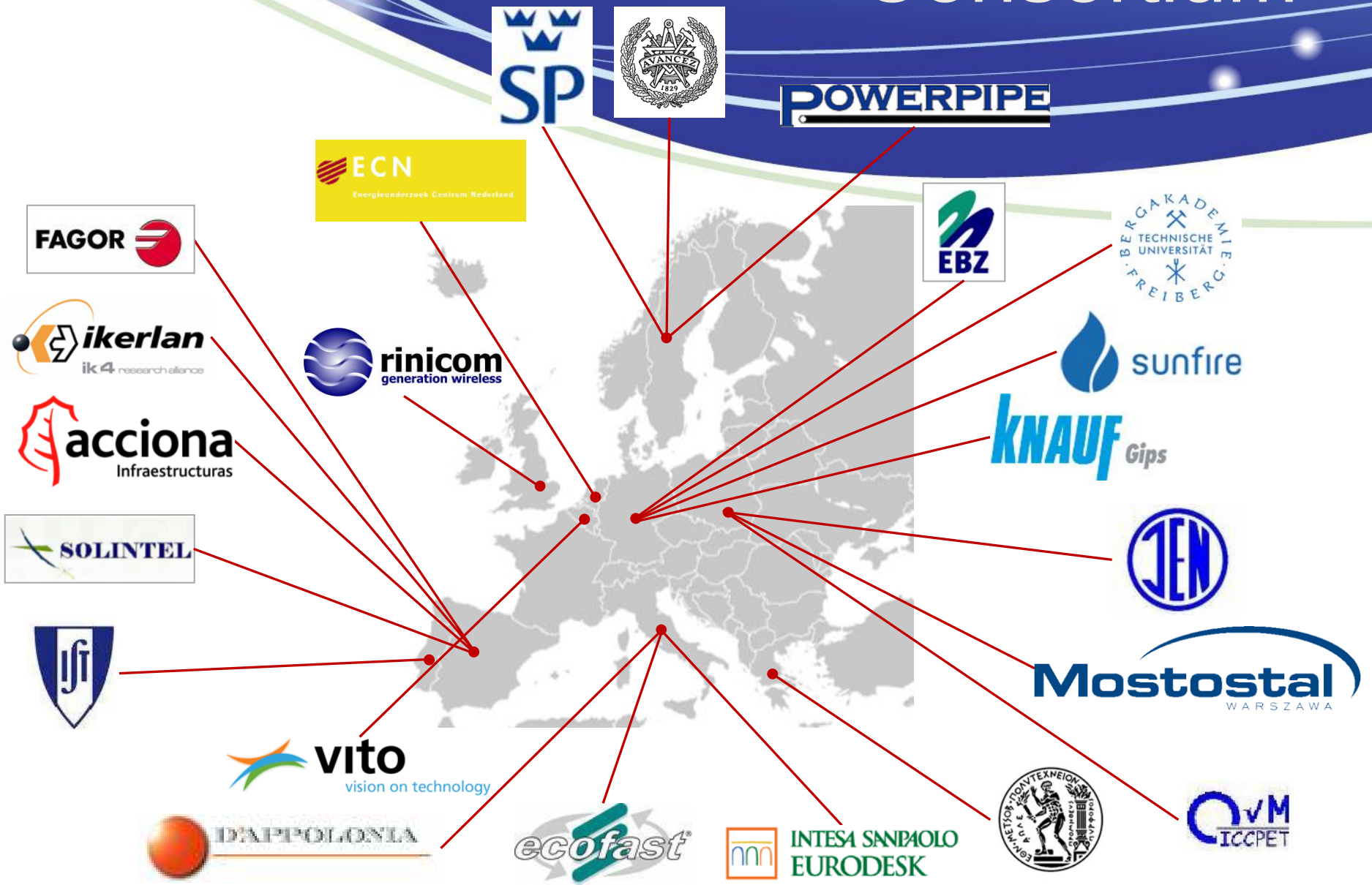
Mostostal Warszawa, Poland

Project Overview

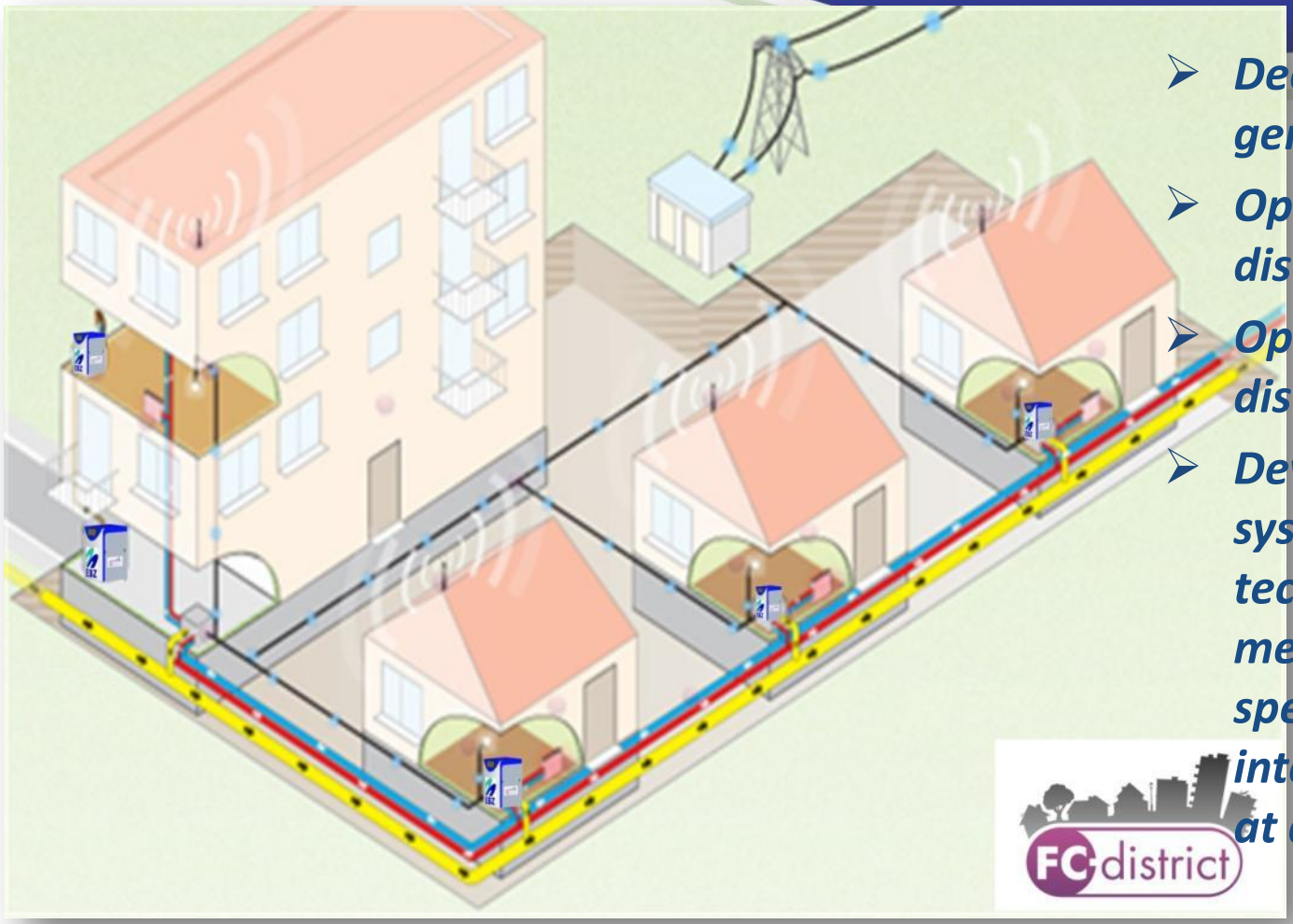
FC-DISTRICT: New µ-CHP network technologies for energy efficient and sustainable districts

- Work programme topic addressed: **EeB.NMP.2010-2/ New technologies for energy efficiency at district level**
- Project Coordinator: **Mostostal Warszawa S.A. (Poland)**
- Technical Coordinator: **National Technical University of Athens (Greece)**
- **22 partners** from 11 European countries
- Duration: **4 years** (starting date: 01.09.2010)
- Total budget: **11,837,575 €** (funding **8,000,000 €**)

Consortium


SP
POWERPIPE
ECN
Energieonderzoek Centrum Nederland
FAGOR
EBZ
TECHNISCHE UNIVERSITÄT
BERGAKADEMIE FREIBERG
ikerlan
ik4 research alliance
rinicom
generation wireless
sunfire
acciona
Infraestructuras
KNAUF Gips
SOLINTEL
JEN
IST
Mostostal
WARSZAWA
vito
vision on technology
DAPPOLONIA
ecofast
INTESA SANPAOLO
EURODESK
ICCPET

FC-DISTRICT concept for sustainable and energy efficient districts



- ***Decentralized co-generation***
- ***Optimized building and district heat storage***
- ***Optimized heat distribution network***
- ***Development of systems, materials, technologies and methodologies specifically intended for integration at district level***

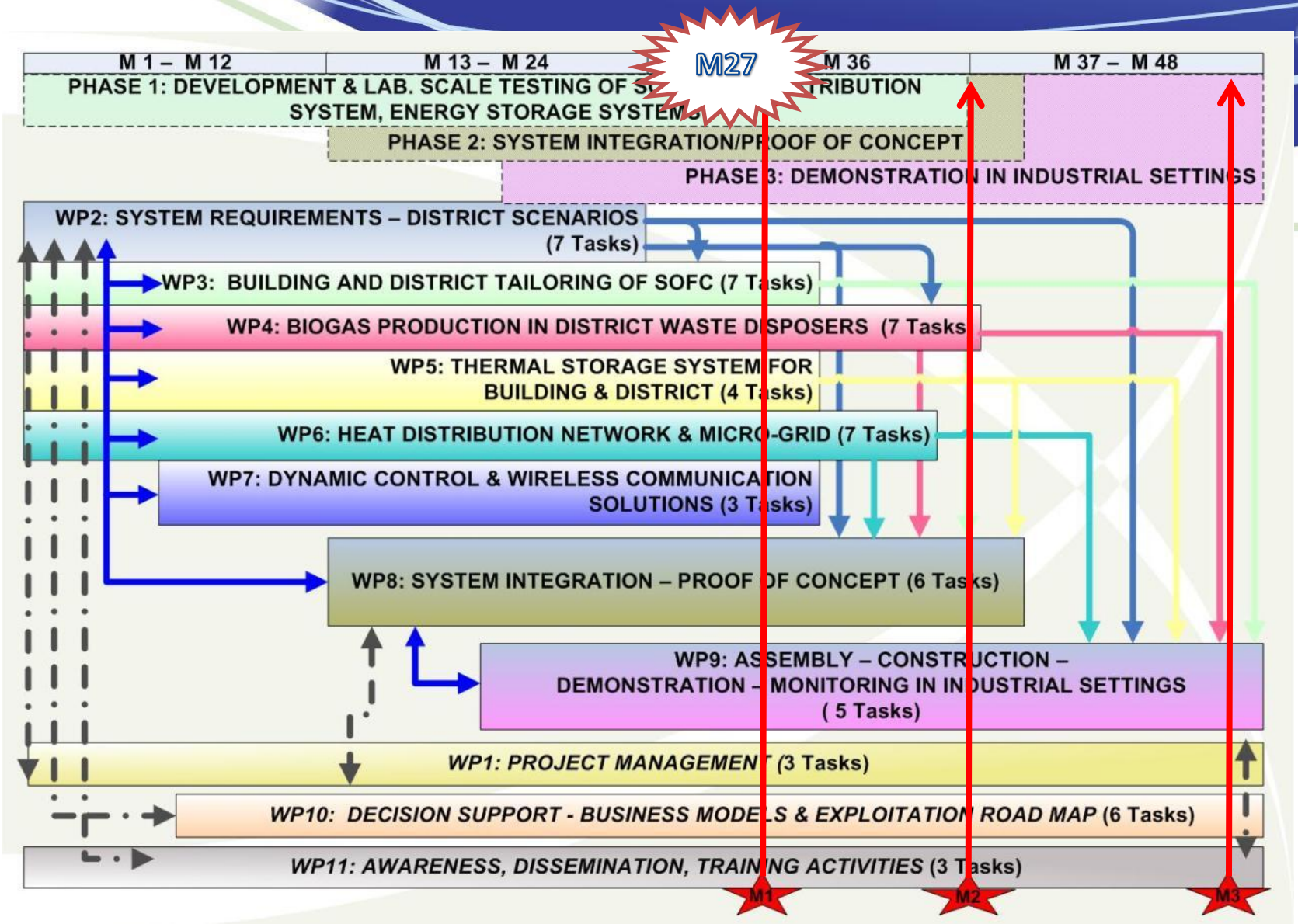
Main objectives

- Development of SOFC based micro-CHP appliance for single-family houses and district heating environments running on natural gas (potentially biogas)
- Advanced, durable and cost effective insulation materials for improved building and district piping thermal response
- Integration of Food Waste Disposers with anaerobic digesters to produce biogas
- Implementation of an “Intelligent Heat Network” equipped with smart control and hybrid wireless network systems
- Optimize and tailor the characteristics of the energy and power distribution systems to meet the energy and power demand of various building and district typologies

Impact

- The project will contribute to the European energy markets with products from different fields: SOFCs, construction (ETICS, pipes, biogas tanks) and ICT (wireless networks)
- Up-to-date simulations have shown a possible primary energy saving up to 50% at district scale
- This addresses a wide range of “district” typologies (typical housing estate, isolated rural communities, mixed suburban environments, academic or public communities, commercial areas, industrial sites, trading estates, or municipal regions)
- Additional energy and cost benefits will arise from possible income from the local ESCO in case of electricity surplus and possible taxes reduction due to reduced CO_2 emissions and/or district wastes

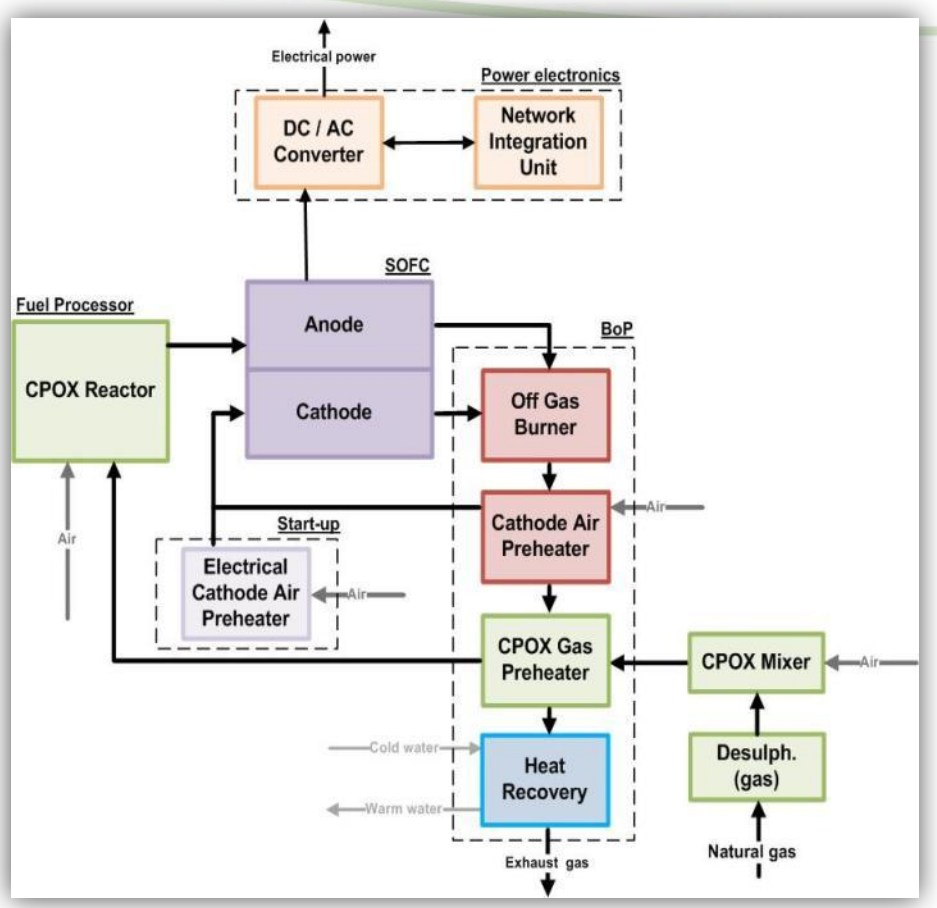
Project time plan - WPs



SOFC based micro-CHP system

- SOFC stack from the German company STAXERA (sunfire):
  - *max. electrical output 1.5 kWel*
  - *max. thermal output 2.75 kWth*

  on CPOX syngas
- Electrical efficiency > 30%
- Overall efficiency > 85% (targeting 90%)
- Modulation 1:3
- CPOX reforming of natural gas (biogas)
- Inter-connection with a district heat distribution system and an electrical micro-grid



SOFC based micro-CHP system: the SOFC stack

- Used SOFC: Integrated Stack Module (ISM) supplied by sunfire (former staxera)
- Technical specification:
  - Power: 1.7kW with 40% H2 in N2 / 1.5kW with CPOX reformate
  - Max. fuel utilization: 85%
  - Stack size: active area 127.8 cm^2 * 60 repetition units
  - Cell: ESC4 by H.C. Starck GmbH
  - Interconnect: metal sheet (Crofer 22 APU)
  - Sealing: glass ceramic

staxera MK200 Stacks

staxera 1.7kW ISM

SOFC based micro-CHP system: the SOFC stack

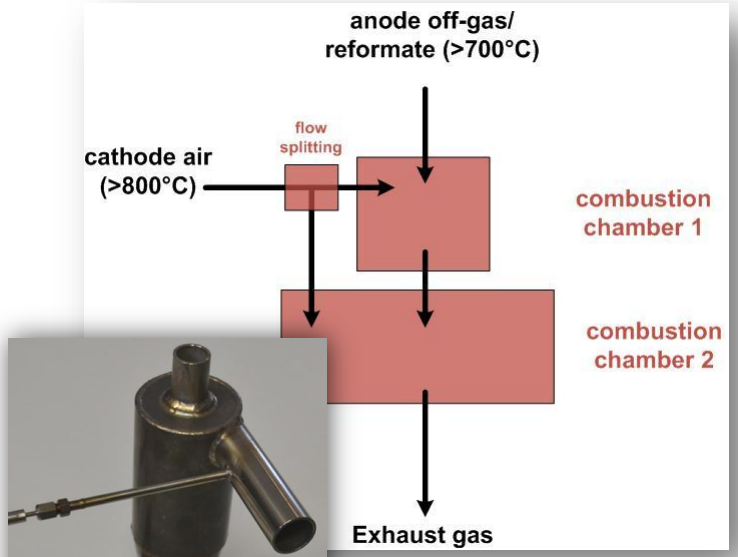
- Key features / results of sunfire ISM:
  - Very low pressure losses due to open cathode (< 10 mbar)
  - Pre-integration of stacks in thermal housing with defined interfaces
    → easier system integration
  - Redox stability due to use of ESC
  - 20.000 h CPOX system operation with <1% / 1000 h degradation
  - 150 thermal cycles without power loss proven (stack test)

staxera ISM mock-up (2010)

SOFC based micro-CHP system: Major and BoP components

- CPOX reformer tested for different limit gases (G20, G21, G231) and biogas in the range of 1kW – 5kW

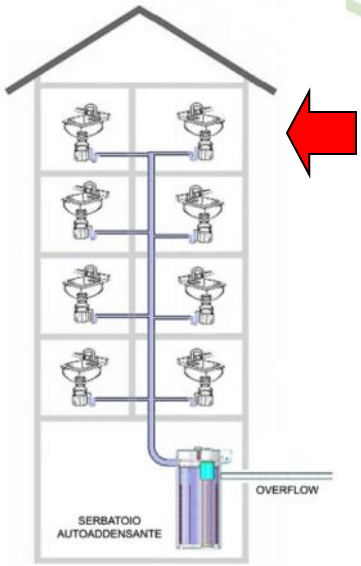
- Anode off-gas burner newly developed for this system:
  - conversion of anode off-gas with cathode depleted air to minimize control efforts and to avoid additional air streams
  - two staged – diffusion type process
  - burner emissions for CHP system steady state operation comply with the DIN EN 50465



SOFC based micro-CHP system: Demo Operation

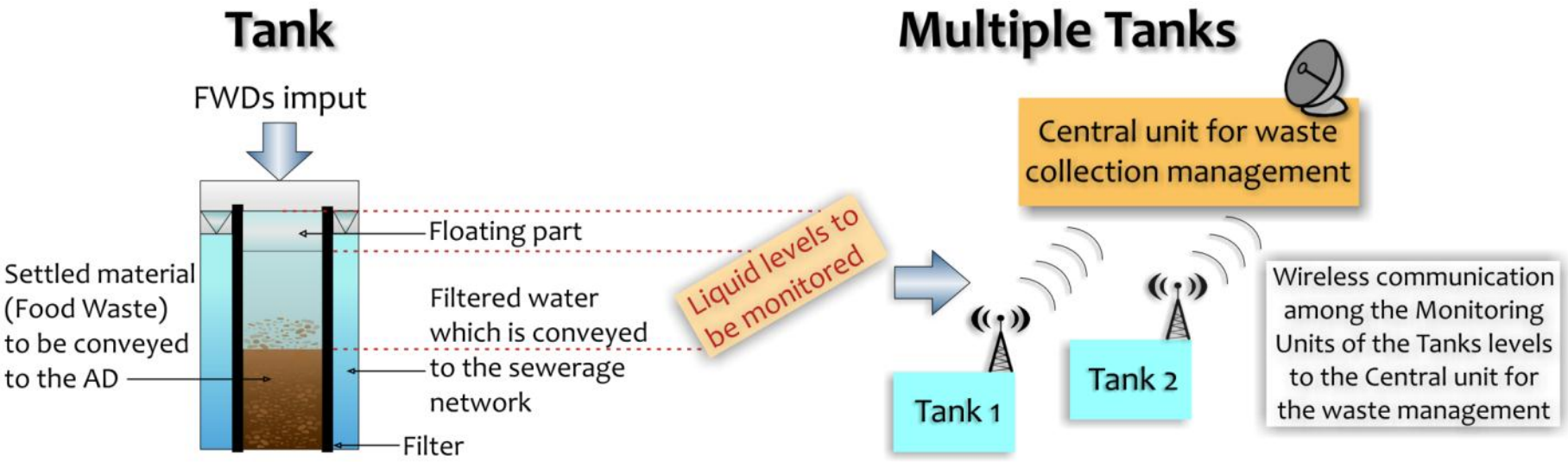
- Inverter especially developed for combined operation with the selected SOFC stack
- Other component developments: plate type heat exchangers/ natural gas desulphuriser/ electrical heater/ interface for heat recovery to the household water network
- First unit integration about to be completed/ preliminary operation at EBZ in December
- CE certification for field test operation by KIWA-Gastec
- The unit will be installed at three different demo sites:
  - Single house demo sites in Spain and Greece
  - District demo site in Poland (3 systems interconnected)

Biogas developments



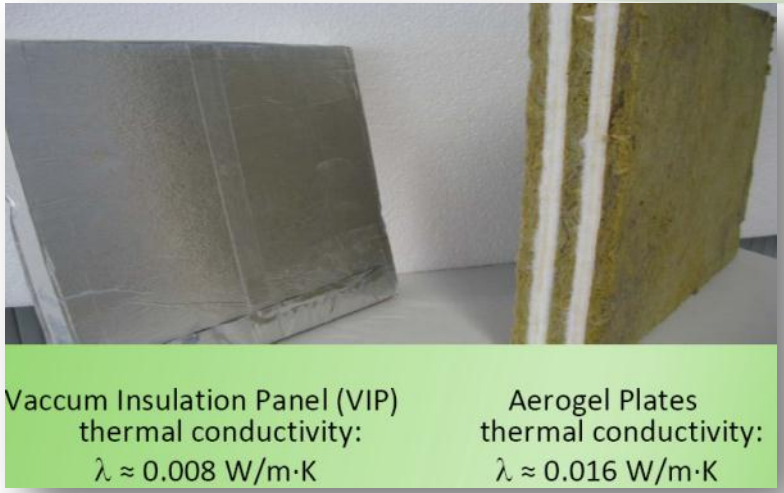
Anaerobic digestor

- Business scheme development and validation has been initialised
- Definition of specifications (materials, tank, filters) and technical targets has been completed



New ETICS

- Development of Innovative ETICS (External Thermal Insulation Compound Systems) based on:
  - Vacuum Insulation Panel (VIP) and Aerogel technologies
  - coupled with Dry Wall Construction techniques
- The target is to maintain thermal performance with significantly reduced insulation thickness
- The new ETICS have been installed, tested and monitored at a demo site in Greece
  http://demohouse.hmcs.mech.ntua.gr/demohouse_site

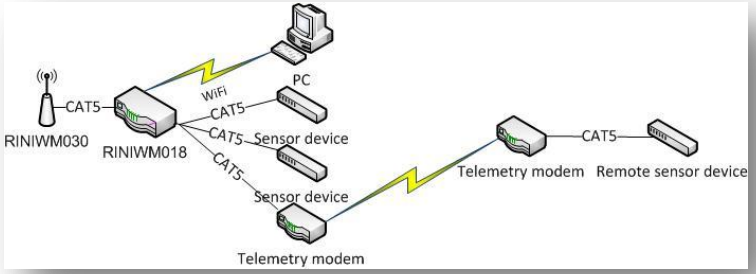


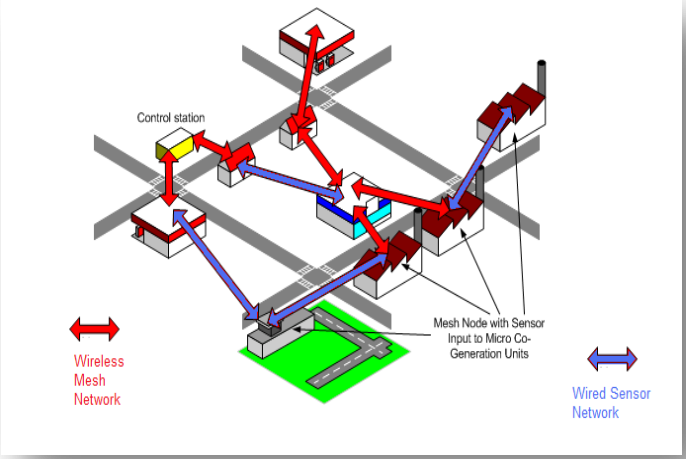
New pipes with improved insulation

- The new heat distribution pipeline concept is based on combining Vacuum Insulation Panels (VIP) and polyurethane (PUR) in a hybrid insulated pipe
- 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
- Test district heating twin pipes (2xDN80) of length 6m have been manufactured with vacuum panels on the flow pipe

Dynamic Control and Wireless communication solutions

- Development and implementation of dynamic control of micro-CHP units at the demo sites
- Development and implementation of a novel hybrid mesh sensor network
- Prototype communication systems installed
- Control strategies for district communication are still under development





Work at demonstration sites

Spain

Facilities of Ikerlan in Miñano

Greece

DemoHouse in Amphilochia

Poland

Facilities of IEN in Warsaw

Work at demonstration sites: Spain and Greece

- First micro-CHP system will be installed at the Spanish demo site at the end of January 2013
  - The site is fully prepared for testing long-term performance of the CHP as a single apparatus under realistic residential conditions
- The Greek demo includes also: heat pump, sensors, heat and electricity meters
  - First data acquisition-measurements without heating /cooling are being performed
  - The micro-CHP system will be installed in February 2013
  - The combination of all applied technologies will be tested for a 6-month period

Work at demonstration sites: Poland District Demo Site

- Identified spaces to be retrofitted with SOFC units at the premises of IEn-Poland
- New building has already been constructed by KNAUFKG where ETICS will be demonstrated
- Sensors, sensor location and measurement campaign have been defined
- Existing piping network will be replaced with the new VIP insulated pipes
- Micro-CHP system connection and wireless communication scenarios are still under preparation
- The installation of 3 micro-CHP systems will take place before October 2013 and the overall project concept will be tested for a 6-month period

Dissemination statistics for the first 2 project years

- 20 project presentations in public events
- 6 journal publications/18 presentations in international conferences
- Patent filled at the German Patent Office for the anode off-gas burner of the micro-CHP unit
- Project presentation in the EeB leaflet, - “EeB PPP Project Review 2011 and 2012”
- Exhibition of FC-DISTRICT prototype at the Hannover Fair
- 2 Seminars: Greek engineers on “Energy saving potentials/Cypriot architects on “Building shell thermal protection”
- Liaison to other EU projects (COST0901, e-Hub, Einstein Project), national and EU Technology Platforms has been established

Up-to-date FC-DISTRICT information

visit project website

fc-district.eu