NOVEL ENERGY PROVISION SYSTEM FOR THE “SUSTAINABLE CONNECTED HOME”

Luigi Crema, Senior Researcher @ FBK - REET

and F. Alberti, A. Bertaso, A. Bozzoli (FBK)
F. Casalegno, Gaia Scagnetti (MIT)

FBK - Fondazione Bruno Kessler
REET – Renewable Energies and Environmental Technologies
Povo – Trento (ITALY)
SMART BUILDING
A new concept?

1. ICT for SUSTAINABLE WELLNESS

2. SUSTAINABLE ARCHITECTURE

3. SMART ENERGY SYSTEMS
Sustainable Connected Home
Context of development

MODULAR BUILDING, HIGHLY EFFICIENT (< 30 kWh/m2/year), ICT SUPPORTED (HIGH DECISION CONTROL AND THE HOUSE AS A PERSONAL TRAINER), SOCIAL LIVING THROUGH ELECTROCHROMIC WINDOWS

INTEGRATED SUSTAINABLE SYSTEM BASED ON RENEWABLE SOURCES ABLE TO PROVIDE ELECTRICAL, THERMAL POWER FOR HEATING AND COOLING, NATURAL ILLUMINATION CONTROL
Sustainable architecture
implementation of a vivid and specialized architecture that embodies particular sustainable principles, integrated into the landscape in an efficient and elegant way

Sustainable Connected Home
Context of development
**Sustainable Connected Home**

**Context of development**

*Smart energy system; use of natural and renewable sources for the energy supply of the home such as solar panels (thermal and photovoltaic), rainwater retention, biomass and windmills, mitigation of intermittent sources through thermal energy storages*
Sustainable Connected Home

Context of development

Information and communication technologies; integration of information and communication technologies to create a responsive system between users, architecture and energy systems.
Sustainable Connected Home
Context of development

Urban sustainability
integration of the individual home with the community with a focus on the urban aspects of sustainable living and the local economy
FBK – REET energy vision

The pilot projects

FBK-MIT
SUSTAINABLE CONNECTED HOME

Luigi Crema – crema@fbk.eu
Sustainable Connected Home

Development topic 1. m-CHP pellet stove

The model of the engine gives back a rated power output of 1 kW_{pick} at 1500 RPM. It is characterized by a compact design with nominal displacement, V_{max} - V_{min} of 175 cm³ (V_E: 72 cm³, V_C: 162 cm³; thermodynamic volume ratio \( \kappa:2.25 \)).

It has a Beale modulus, an index for efficiency and effectiveness of the engine, given by:

\[
B_n = \frac{W_0}{PVF} = 0.148
\]
Sustainable Connected Home

Development topic 1. Stirling engine
Solar Cooling

Pre engineering of the prototype

Blower for desorption circuit

Output air, desorption

Input air, desorption

Blower for adsorption circuit

Adsorption and Desorption tanks

Evaporator

A/W Heat Exchanger heating from solar collectors

A/W Heat Exchanger cooling side
Sustainable Connected Home
Development topic 2. solar cooling

THERMAL ENERGY STORAGE WITH COOLING EFFECT

Heat from the solar thermal collectors

Waste heat recovery

Cooling power generation

Cycle 2
ZE01 TANK Desorb
ZE02 TANK Adsorb

Waste heat recovery
Simulation of thermodynamic cycles

**Desorption cycle for regeneration and drying process**

![Desorption cycle diagram](image)

**Adsorption cycle for cooling power generation**

![Adsorption cycle diagram](image)

Data obtained by a *custom made software* based on real experimental data, verifying the *mass and energy conservation* in a steady state condition.
The FBK - REET Adsorption Technology

The system may be designed in different layouts, including open and closed loops with the indoor environment,

The system may have a retrofitted control on cooling power generation in real time,

The system may have a retrofitted control on the heat energy stored on the tanks in real time,

The system may work in heating mode inverting the cycle during winter period

The system may be scaled up/down on cooling power generation and cooling capacity.
Sustainable Connected Home

The Energy Box

Panels covered with wood tiles

Simple wood frame for hanging climbing
Sustainable Connected Home

The Energy Box

Luigi Crema – crema@fbk.eu

Water boiler

Pellet boiler

Storage Area for Pellets

Thermal Storage

Air Connections to/from the building

To/From solar thermal
N.B. the above heat exchangers can be located inside the box
Sustainable Connected Home

Full integrated hybrid energy system

1. Blowers are PWM controlled
2. Heating / Cooling circuits means only on regeneration and cooling of storage tanks
3. Thermocouples will monitor inside temperature gradient in tanks
4. External A/W heat exchanger means in outdoor environment just outside the energy box
The technology will start the demonstration in FBK by June 2012

The technology will be implemented of specific innovated subcomponents (new solar modules, new integrated energy systems) by June 2013

The system will realize an open platform of Smart Building as a Living Laboratory

Activities will proceed with further developments and with the realization of education and training initiatives, with testing of new ICT technologies, benchmarking of new energy technologies
THANK YOU FOR ATTENTION!!!

Luigi Crema
Senior Researcher at REET
Renewable Energies & Environmental Technologies
crema@fbk.eu