Knowledge-based energy management for public buildings through holistic information modeling and 3D visualization

KnoholEM

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CONFINDUSTRIA
Bari e Barletta-Andria-Trani

About us-1

Tera is a SME born in year 2007, based on the merging experiences of a group made by engineers and managers-consultants.
These experiences and know-how were gained in several context, relating to both industrial development and R&D, in regional, national and also European R&D cooperative project .

TERA S.R.L.
Conversano – Bari
Italy

About us- Skills

Tera focuses its own innovative solutions on the energy efficiency, as a guideline and not only as a final application.

TERA's expertise can be summarized in the following fields:

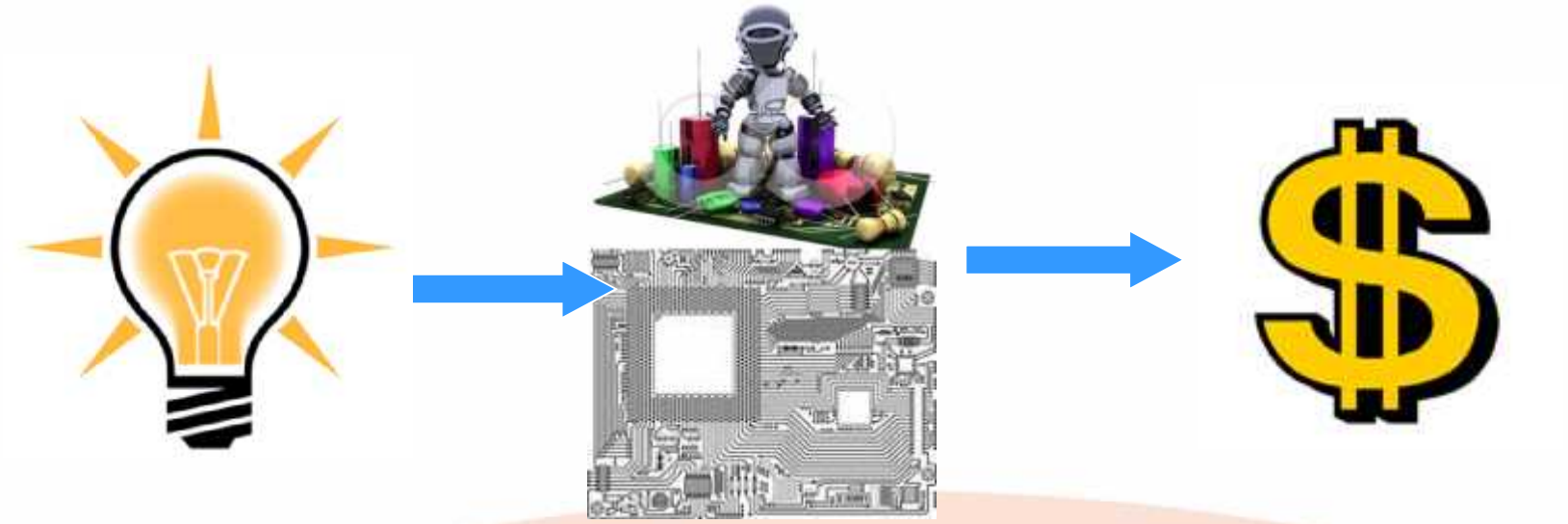
- **Monitoring and Control Systems for energy production/consumption**

- **Electronic energy conversion technologies for renewables**
- **Wreless Sensor Networks**

- **Hybrid Power train control solutions**

Other activities - B2B Services

- RTD Performer
- Technology Advisor – technology transfer for the benefit of SMEs which need to turn innovative ideas into good business



R&I experiences

- OSTIS ("MADE IN ITALY" - ITALIAN MINISTRY OF ECONOMIC DEVELOPMENT)

Tera analyzes technology scenario and defines/draws up the specifications of the systems to satisfy the required functional features; Tera performs energy validations/audits at the end of the project;

- KNOHOLEM ..as detailed below..

experiences 2 - miscellaneous

- **Micro wind / PV systems for energy supply small stand alone loads for niche markets like broadcast telecommunications**

- **Intelligent LED lighting system, automatically varying intensity of light emission depending on traffic conditions**

- **Active dyrect or indirect involvement in Manufacturing/Technological districts in Apulia Region --"Mechanics" ,"Sustainable building", "Energy"--**

- **Permanent collaboration with the European Platform Knowledge4Innovation (K4I)**

FOCUS on Knoholem

WP3 - Optimization Algorithm and Real-Time Hardware

Lead beneficiary (among others)
TERA S.R.L.

PROJECT OVERVIEW (1)

KnoholEM is a Collaborative research project co-financed by the European Commission within the scope of the 7th Framework Programme-

Its international consortium consists of 13 partners from 6 different countries.

The main objective of the project is to elaborate an intelligent energy management solution for energy efficient buildings and spaces of public use.

Area: ICT for energy efficient buildings and spaces of public use (EEB-ICT-2011.6.4)
Project No: 285229,CollaborativeProject
Total cost: 4.47millionEuro
EU contribution: 3.2millionEuro
Start date: September1,2011
End date: August31,2014
Coordinator: Building Research Establishment (BRE), Watford,UK

PROJECT OVERVIEW (2)

KnoHolEM aims to improve energy efficiency of public buildings (by up to 30%)
in Europe by offering a system that monitors energy consumption and then controls energy consuming devices
based on the usage of the buildings occupants.
It achieves this through progressive cycles of integration of
computer models that are used to predict and manage energy efficient behaviour. This aims to overcome the high variety, and resulting extant incompatibility, of the different models currently used in the construction and building management industry, while
responding to on-going changes in usage and configuration of individual buildings.

PROJECT OVERVIEW (3)

The energy savings that are realised are achieved by the development of a **machine learning environment** that determines the most appropriate usage of energy consuming devices based upon **occupant usage patterns** that are analysed against the energy building model and the historic energy usage data from the building. From this analysis the Knoholem system will determine the most appropriate action to take in order to minimise consumption. This information is fed by a gaming environment to the **Facility Manager** where he/she can let the system run or override if feels that another course of action is required. For instance this could occur when the Facilities Manager **is receiving real time information form the building occupant's via the user in the loop interface.**

PROJECT OVERVIEW (4)

One of the major challenges that this project is aiming to overcome is the **interoperability and usage of data** in order to monitor and control the energy consumption within the building. Building information models go some way to alleviating this, especially when using standardised **Industry Foundation Classes (IFC)** as a meta-model. However, while IFC is strong in modelling building geometry and construction detail as well as HVAC and electricity supply systems placement and trunking, it **does not provide strong support for building control rules, user behaviour models or behaviour of sensor and actuator systems**.

It is also a challenge to correlate these models with **actual energy usage and sensor logs**, as needed to compare and reconcile predicted energy efficiency with operational energy usage and comfort levels.

PROJECT OVERVIEW (5)

KnoHolEM addresses this challenge by applying a holistic, knowledge based approach that maps these disparate models into a single, **open ontology format**. In this way the relevant elements from different models can be easily captured, filtered, searched, mapped and interlinked. Existing tools and platforms can be leveraged to use this schema to flexibly extend, tune and manage the evolution the open model schema. Specific tools will then be developed to provide stakeholders with **visual interfaces** to easily create logical relationship between elements to define rules that model the dynamic behaviour of different elements. Key here is the ability to put the **user in the loop**, allowing building occupants to directly visualise and interact with useful projections of the model.

These tools will interface with existing energy modelling tools, **building control systems** and operational log feeds to support the iterative and increasingly accurate modelling of energy efficiency-related behaviour through correlation and analysis of energy modelling predictions, energy system control rules and building performance data. 'User in the loop' framework in an easy to use 3D model will therefore provide reduced energy consumption by only providing the energy required for the occupants in the building at any given time.

PROJECT OVERVIEW (6)

The success of the technical approach derives from the choice of the

Semantic Web ontology formats standardised by the World Wide Web consortium,

which enables the use of a much wider range of open knowledge modelling/editing, parsing, reasoning, querying, storage and rule execution engines than is typically used in building automation projects. This is leveraged by

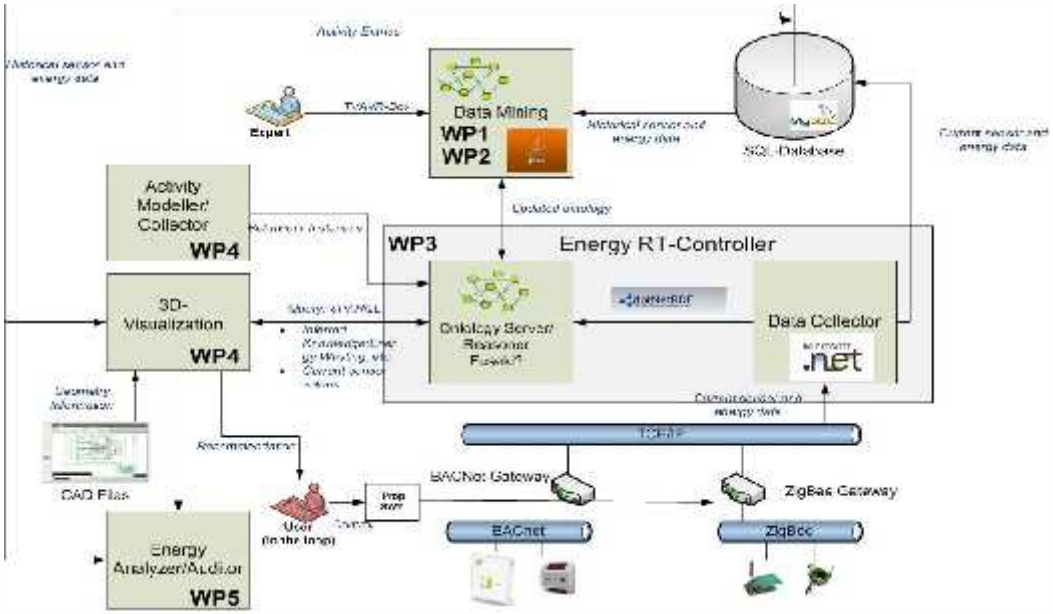
strong expertise in knowledge modelling, mining, reasoning, visualisation and web application development

for smart building applications. This commitment to an open knowledge format also maximises the ability to

publish schema, data sets and applications on the web

to promote their uptake, with support of specific dissemination expertise.

SYSTEM ARCHITECTURE



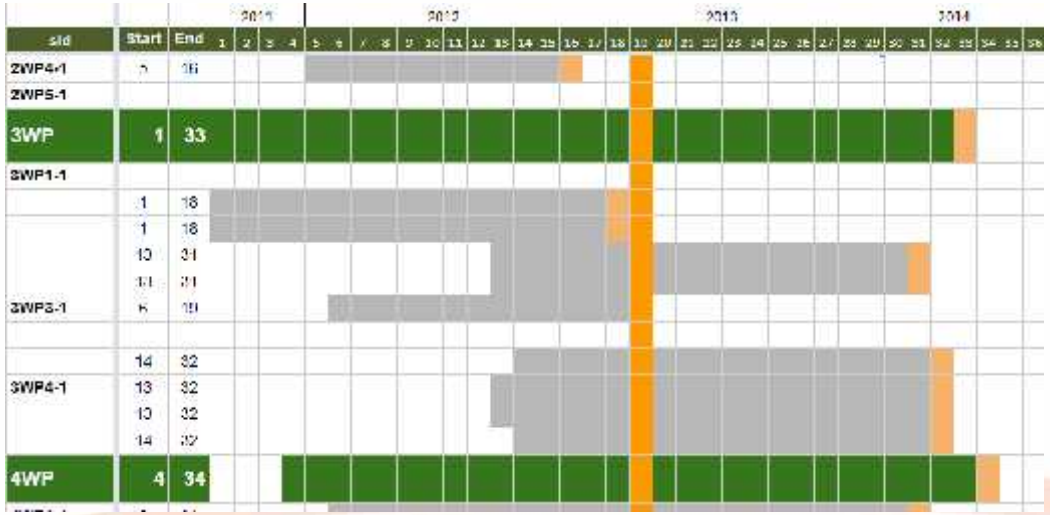
WP3

Task 3.1: Algorithms and logic of energy efficiency in the building-grid

Task 3.2: Validation of energy efficiency algorithms

Task 3.3: Communication electronic and plug-and-play multi-standard protocols

Task 3.4: Electronic framework for the control of buildings



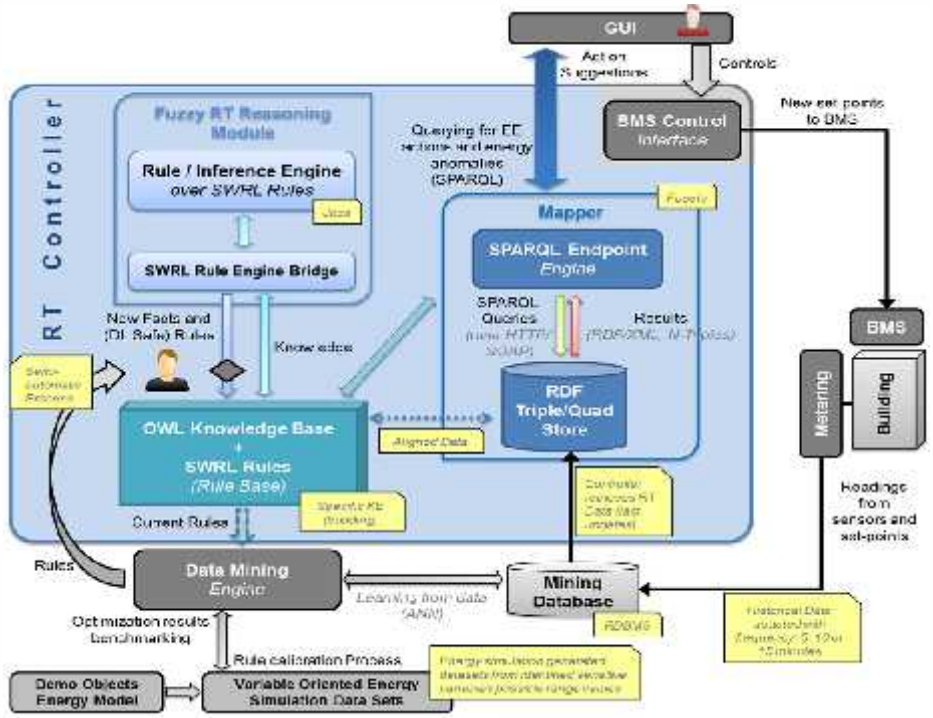
WP3: Optimization algorithm and real-time hardware - WP Objectives

In Task 3.1 and 3.2, the activities are related to an optimization logic aimed to define a new approach in public building energy management by means of models that result from the ontology. Accordingly, Task 3.1 and 3.2 include the design, development and validation of the Energy Real Time Controller (EnRTC), a software component that could be considered the core of the KnoholEM solution.

WP3 responds to one of the main S&T project objectives - Specify and develop a (near) real-time energy monitoring, optimization, and actuation capability that provides energy consumption accounts. This involves: Establishing a live repository of historic and real-time monitored data of the demonstration buildings accessible using a simple interface/functionality for testing and validation/assessment purposes. Smart sensing infrastructure that exploits existing building automation systems, by developing an energy controller with energy optimization logic.

An actuation capability on the building management system is under investigation to implement user-directed energy saving plans by defining protocols and standards in building grid communication and relevant hardware and software components.

OVEREALL ENERGY CONTROLLER SYSTEM



WP3.3 OVERVIEW

The objective: to define the architecture and the most suitable communication procedures between KnoHolEM System (particularly KnoholEM local controller) and Demonstration Objects devices.

Different Building Management System (BMS), installed in each building, were analyzed from the protocol and network architecture point of view . Some problems have arisen regarding different methods of collecting data from the field: overlapping task 3.3 with task 3.4, a. Different solutions for the communication between KnoHolEM System (particularly KnoholEM local controller) and different DOs were analytically studied and heuristically compared, also considering some rough test results from Dos:

- **Direct Interface solution. direct communication with the field devices (sensors and actuators)**
- **Web Services based solution. communicate with existing BMSs that have services to call for requests and/or for settings;**
- **Database access solution. read (only) data from BMS Database Server where it's possible ("open/readable" database server).**

The solution of direct communication to hardware resources has the advantage of making the "general" BMS KnoHolEM totally independent from the existing BMSs: however, because the functionality of existing BMSs cannot be changed, there could be problems due to the parallel work of the different management software system.

GRAZIE – THANK YOU

For your attention

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