The I-CEMS

Advanced energy management techniques applied to the supply side management

Nome Relatore

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Born in Turin in 1972, received his Electrical Engineering degree in 2000 and his PhD in Electrical Engineering in 2004 from Politecnico di Torino .Since 2000 he is a Researcher in Centro Ricerche Fiat in the area of Cogeneration Systems. His main interest is in the field of power generation for distributed generation devices, grid connection and product development. Dr. Anzioso is actually a project manager at the CRF.

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I-CEMS acronym stands for **Italian Communal Energy Management System**, it is a system conceveid to be the core of a future virtual power plant (used e.g. in future smartgrids)

Target user of the CEMS:

distributed energy facility owner/manager (DFM)

What will it be used for:

- <u>planning</u> distributed energy sources installation;

- <u>monitoring</u> energy flows;

- <u>optimizing</u> distributed energy source production

Distributed facility Manager (DFM)

The **DFM** could be an **Esco** or an **utility** that:

- **Guarantees** the entire supply of electricity, heat and cooling to final customers connected to the network;

- **Sells** the complete energy service to final customers;

- **Interacts** with the **Electric Power Stock Exchange** purchasing the possible integration of electricity and selling the over needed electricity or transferring it to the park deficient sites;

- **Takes care management**, **fuel purchase** and **maintenance** of plants (i.e. co-generator, boiler, absorption cycle, electrical chiller, small scale district heating, telematic station, photovoltaic and solar panel);

- Performs **contracts** with **final customers**;

- **Own/Manage** the plants

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What is the I-CEMS made of?

The I-CEMS consists in:

- **Hardware Standard**:

  - energy flows meters

  - data communication infrastructure

  - computers

- **Software Custom**:

  - data gathering (databases, web-services, communic. protocols)

  - optimisation algorithms (deciding energy production)

  - recursive algorithms (for economic assessment of different plants configurations)

The I-CEMS concept is based on:

- **mixed integer-linear optimisation algorithms combined with Artificial Life based oprimisation techniques**

The other basic "ingredients" needed are:

- **load forecast** : (electrical, thermal, cooling)

  these are obtained through NeuralNetwork-based algorithms, trained on monitored data, and through other methods for load simulations.

- **data communication infrastructure** :

  connecting the CEMS "brain" to the plants and monitoring devices on the field

- **databases**:

  recording all data from the field and making them available via web-services

Nowadays optimisation algorithms allow for a fast numeric optimisation of complex functions

the I-CEMS is able to optimise a cost function keeping into account both environmental and economical variables

Expressing the cost equation as a function of distributed generation plants specifications (emissions, power output, technical limitations) and keeping into account the costs related to energy production and consumption it is possible to

find the optimal production schedule for a defined time range minimizing both costs & emissions taking into account all technical constraints
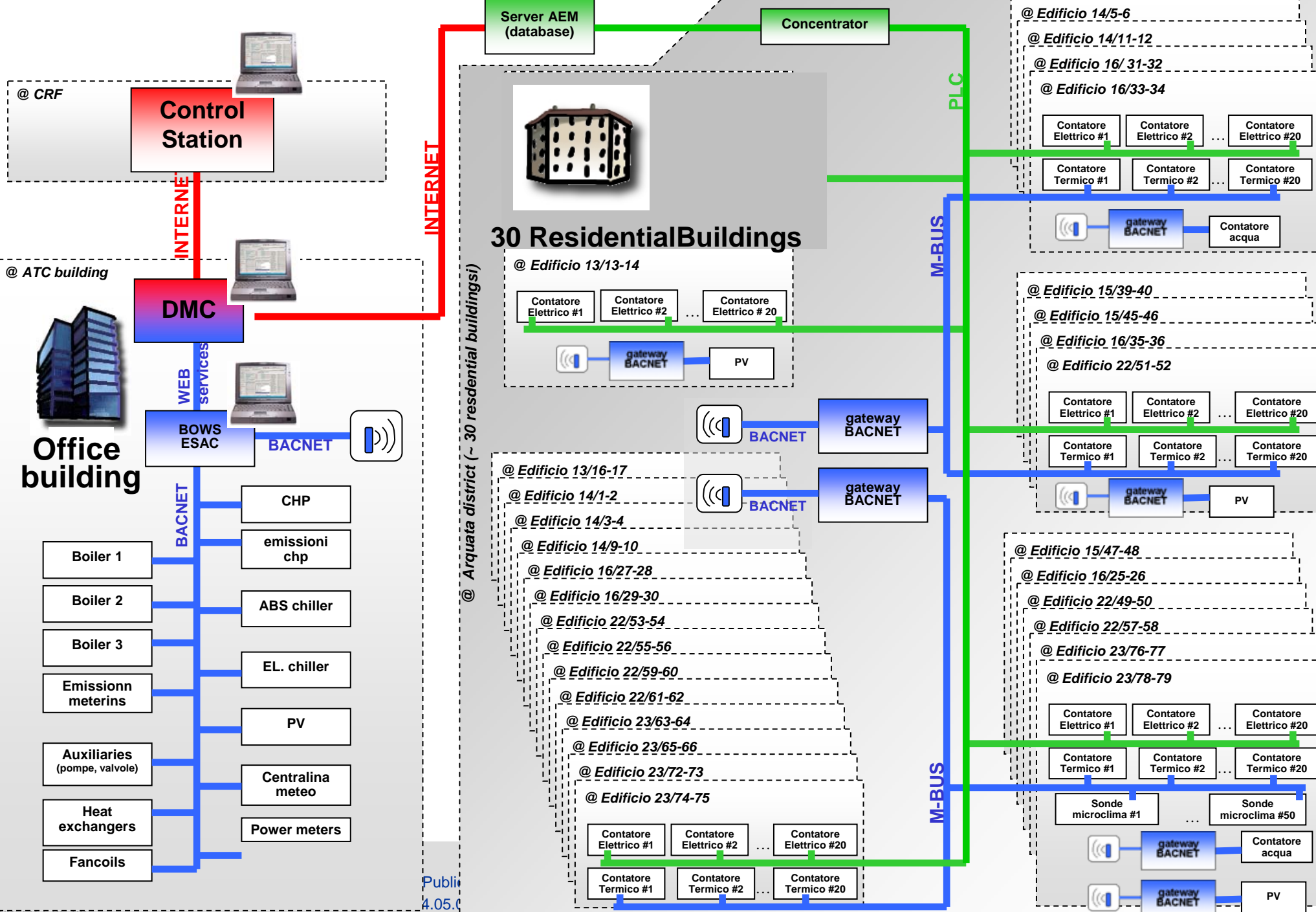
A simplified functional layout of **I-CEMS** implementation within Polycity:
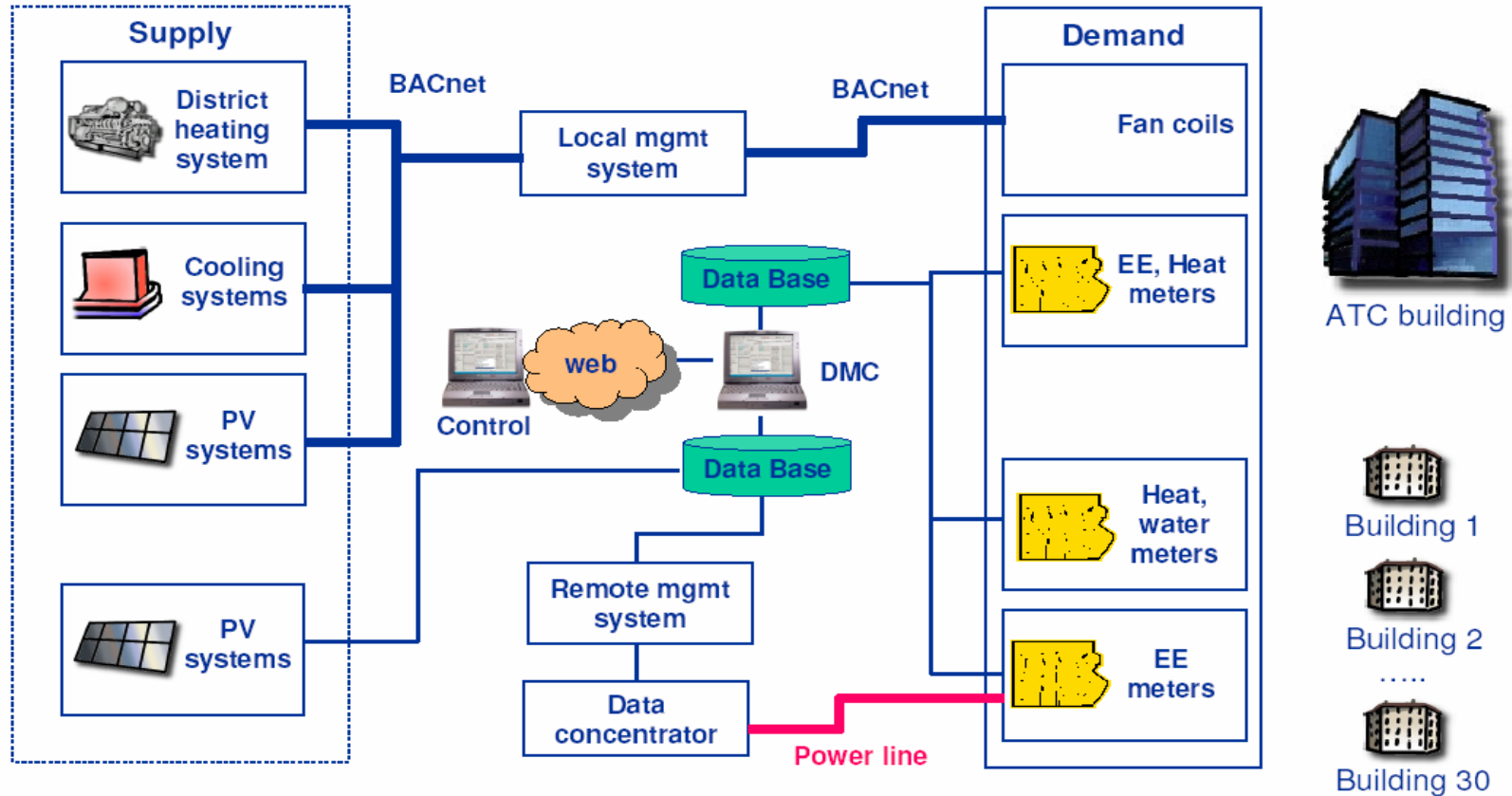
**It may sound fairly simple but…**

One distinctive feature with respect to a conventional EMS is the final goal to monitor and at the same time schedule the production of **multiple distributed generation sites (at communal level) as if they where a single generation plant ("virtual plant")**, keeping into account the possibility of electrical power flow between different sites.

Arquata site

Other sites

The I-CEMS software modules
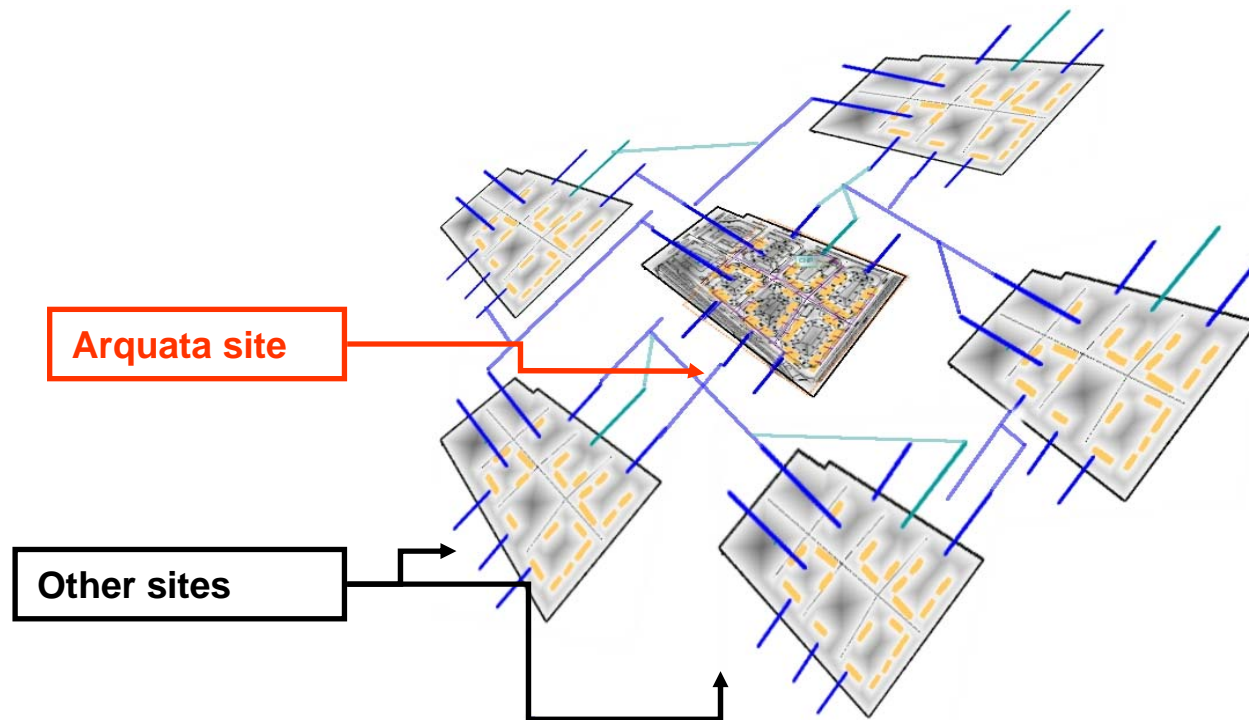
The basic ingredients described before will be essential tools for the **core of I-CEMS software consisting in 3 different software modules** :

1. **Energy Scheduler**: it will be designed to define optimal production plans (long term), based on multi-criteria optimisation algorithms (energy, costs, quality, safety) and simulated data.

2. **Energy Tuner**: it will be designed to manage real time operation of energy systems based on real data from systems and sensors

3. **Business evaluator**: it will be designed to evaluate the profitability of different plant configurations (investment) and operational strategies (management)

An additional function of the I-CEMS will act on demand side by automatically **warning final users** (for example through SMS) in case of consumption data indicating **misuse of energy** services. I-CEMS will be **able to provide this constant link** by mean of communication tools, **to support citizen** in **changing** their consumption **habits** toward **rational energy** use.

The Energy Scheduler

The **Energy Scheduler** is a model based system that **calculates the optimal production plan** (for each generators that could be regulated) taking into account:

- **Economics** (primary energy price, electrical power price, etc.)

- **Energy Source** (CHP,Grid, Boiler,PV…)

- **Technical Constraints**

- **Pollutant emissions**

- **Service Constraints**

- **Load forecasts** (obtained through databases and simulations)

It is a versatile tool that is used also to simulate the operation in order to provide the inputs needed by the Business Evaluator software module.

During real operation the error on load forecast adopted by the Energy Scheduler could reduce the redditivity.

The Energy Tuner will work to adjust energy plans (calculated by the ES) in real-time.

The used optimisation algorithm capability to follow optima in time variant cost function with minimum calculation time will be exploited in order to perform an efficient regulation.

Conclusion

The **I-CEMS is an Energy Management Tool whose distinctive features are**:

- **Multicriteria optimisation** (keeping into account more than just income)

- **Data infrastructure** (complete monitoring, recording and availability via web of energy flows)

- **Demand side management** (through final-users dedicated communication services – e.g. SMS text messages)

- **Multi site management** capability ("virtual plant")

The first step of the implementation in Italian Polycity site is expected by the end of 2007 (end of the project – 2010)

THANK YOU FOR YOUR ATTENTION