DSS: Modeling Energy Flows at Both Operational and Strategic Levels

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Agenda

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• Comments & Questions
EnRiMa Project

• **Start date:** 1 October 2010
• **Duration:** 42 months
• **Total budget:** €3.49 million

• Partners:

http://enrima-project.eu/
The Aim of the Project

• To develop a DSS (Decision Support System) to enable operators to manage energy flows in public buildings by:
  – meeting energy needs in a more efficient, less costly, and less CO$_2$-intensive manner,
  – facilitating the operators' on-site generation dispatch, off-site energy purchases from diverse sources, and open positions in energy markets,
  – supporting long-term planning aimed at increasing energy efficiency, specifically analysis of retrofits and/or expansion of on-site energy subsystems, and
  – taking into account comfort tolerances and long-term risk preferences.
EnRiMa DSS Functionality
Test Sites in Spain and Austria

ENERGYbase

KUBIK Laboratory

FASAD Building

Pinkafeld Campus
Strategic Level
Strategic Level

- **Objective**: identify the decisions leading to the desired trade-offs between attainable goals of an operator:
  - minimization of the total investment, maintenance, and production costs,
  - diverse risk measures, uncertainty parameters, and environmental goals.

- **Decision variables**:
  - technology adoption and decommissioning,
  - purchase or sale of financial contracts, and
  - demand-side measures.
Strategic Level

- **Constraints:**
  - demand requirements, where long-term (e.g., yearly) load curves are used to represent demand for electricity and other energy types (e.g., heating);
  - capacity of the installed technologies together with their lifetimes and availabilities;
  - efficiencies of the available technologies and ageing of the installed ones, where replacement is possible before their lifetime has elapsed;
  - input-output energy conversions;
  - energy balances, where both import and export of energy is allowed;
  - implicit representation of energy storage for batteries and accumulators;
  - environmental constraints (e.g., maximum allowed \( \text{CO}_2 \) levels);
  - stochastic formulation will incorporate uncertainties vis-à-vis evolution of load-curves, equipment costs, fuel and energy prices, availability of new technologies, and lifetime of the existing equipment.
Operational Level
Operational Level

- **Objective**: the same as in the strategic model, but the goals are focused on short-term decisions:
  - minimization of the total operating costs (monetary equivalent of, for example, electricity and natural gas consumption) or maximization of user comfort with existing installed technologies and building envelopes.
- **Decision variables**:
  - operational levels of installed equipment.
- **Constraints**:
  - heat demand defined as energy needed to achieve the required temperature level, considering: external temperature and proportion of air taken externally, ambient temperature, supply-air temperature from an air-handling unit (AHU) and supply-air flow rate from the AHU – both piecewise linear functions of the required temperature and the current ambient temperature, and air properties such as specific heat capacity and density;
Operational Level

- **Constraints:**
  - temperature balance, connecting external and ambient temperature with supply-air temperature and supply-air flow rate from the AHU, considering air properties (specific heat capacity, density and overall thermal capacity of the zone), building properties (thermal wall resistance), and length of a decision-making period;
  - required temperature limits (upper and lower);
  - limits on proportion of air taken externally (upper and lower);
  - heat demand material balance that sums up various technologies available for heating;
  - capacity constraints for each technology (e.g., combined heat and power (CHP) and electricity generation);
  - electricity demand balance (purchased + generated – exported);
  - part-load efficiencies of the installed equipment.
Integrated Functionality
Thank you for attention!

- Comments & questions are welcome!