

ICT for Sustainable Homes

October 24-25, 2011 – Nice, France

*“Roadmap for Further Research on ICT
for Energy Efficiency”*



Energy Efficiency and Risk
Management in Public Buildings

DSS: Modeling Energy Flows at Both Operational and Strategic Levels



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Agenda

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EnRiMa Project

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

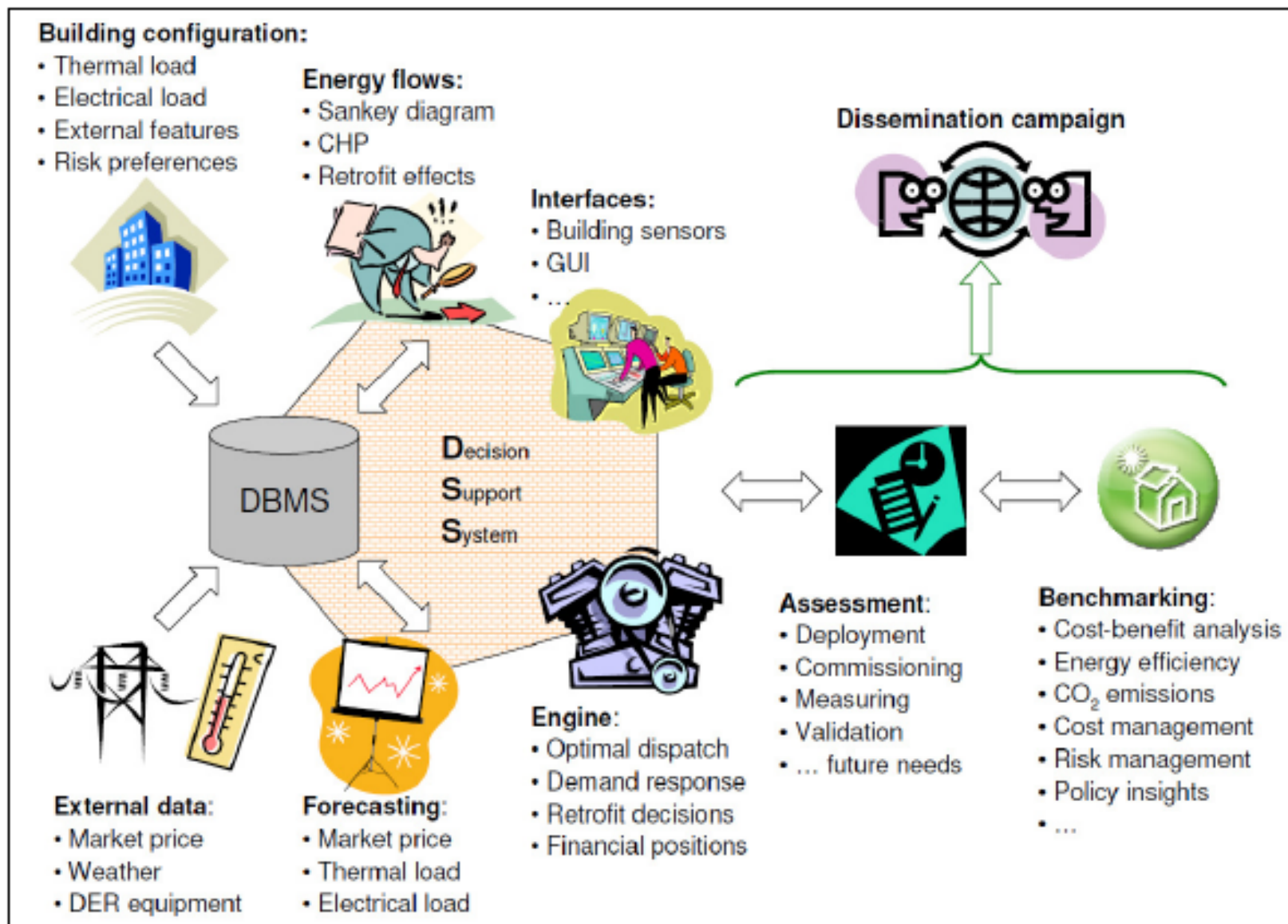


<http://enrima-project.eu/>

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 CO₂-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

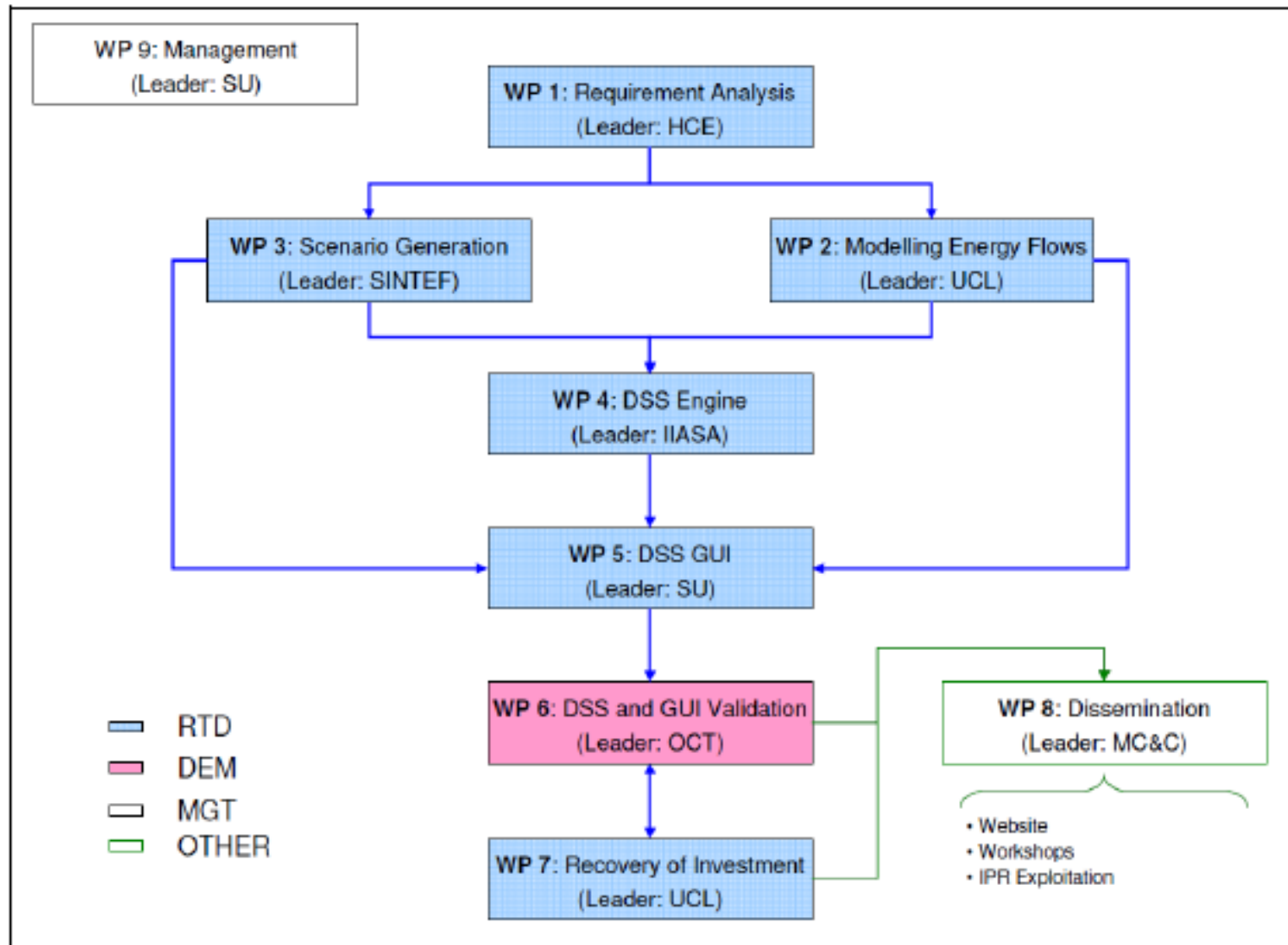


FASAD Building

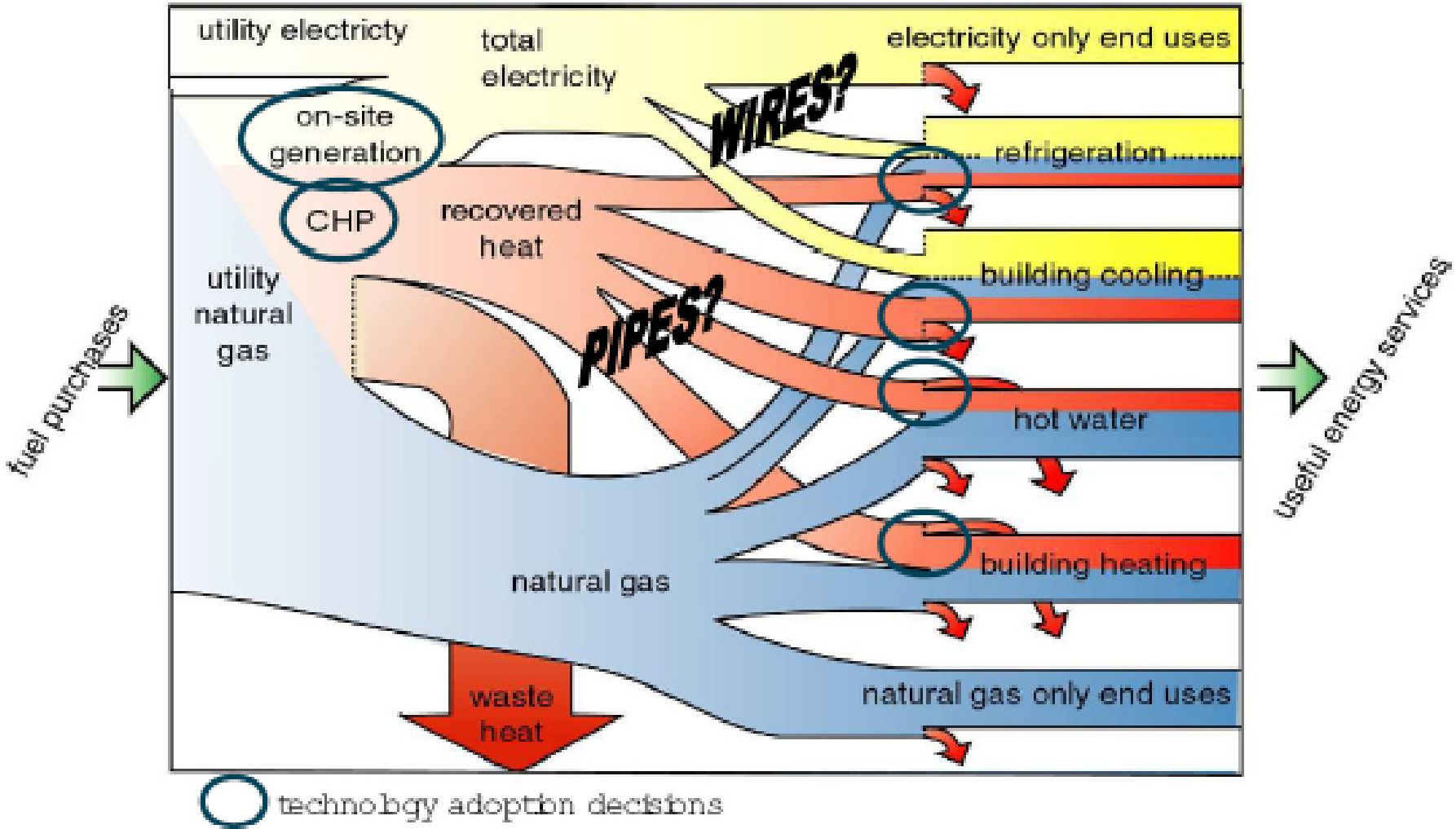


Pinkafeld Campus

Project Structure



Strategic Level



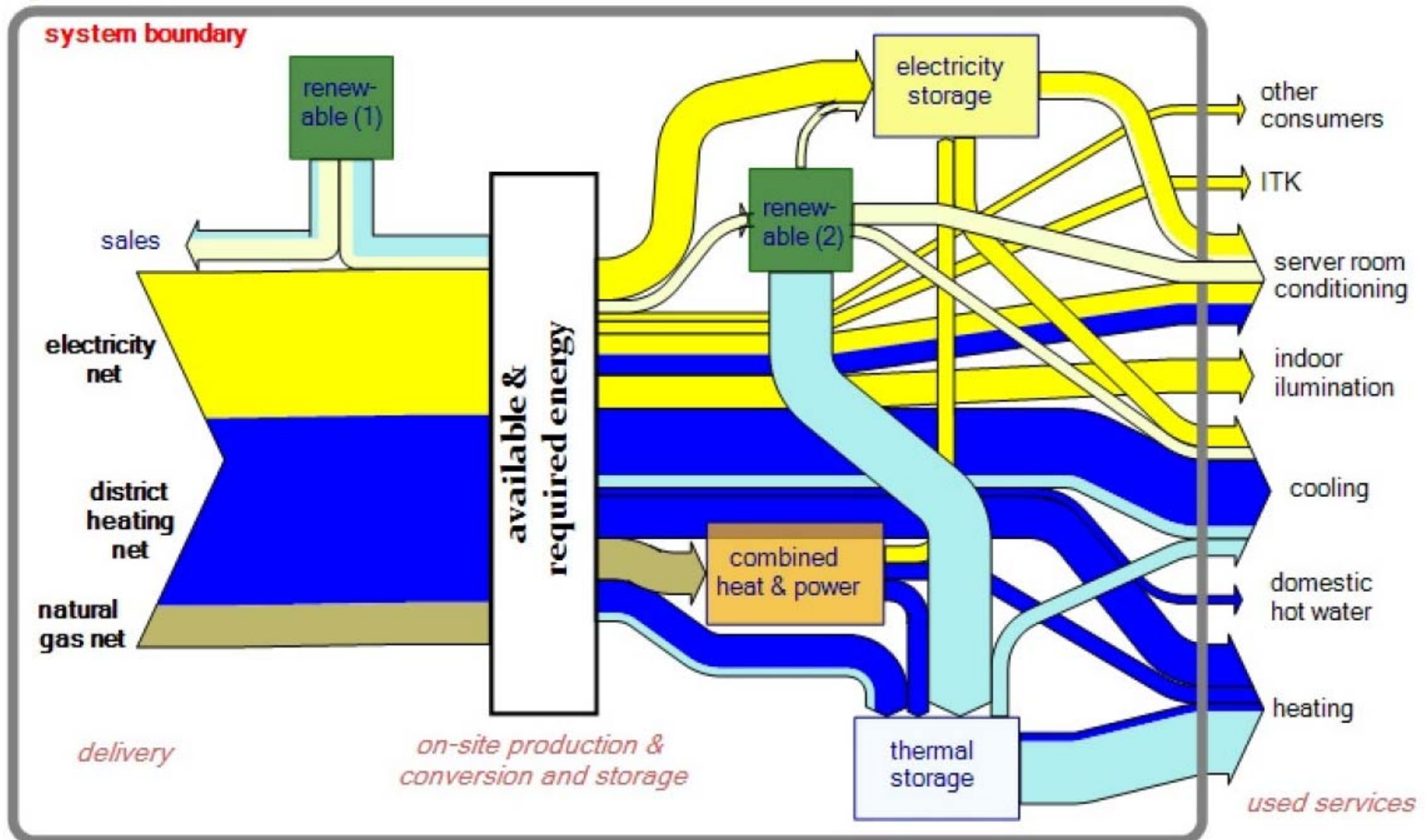
Strategic Level

- 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 CO₂ 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



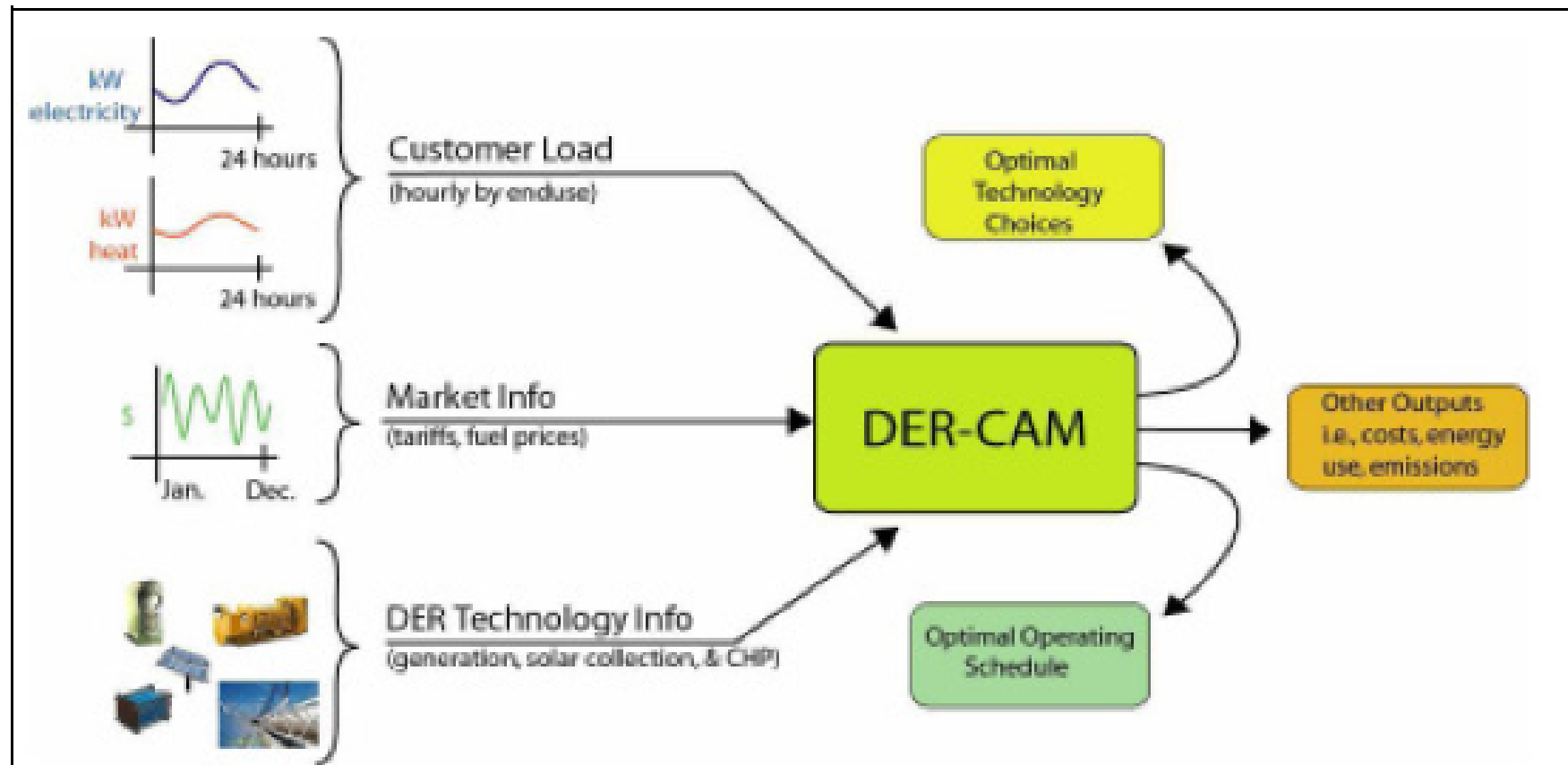
Operational Level

- 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!

