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E-HUB
Energy-Hub for residential and commercial districts and transport

SEVENTH FRAMEWORK PROGRAMME

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D1.4 Energy Rating System and Evaluation Methodology

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1 Executive Summary

The E-Hub project, funded under the FP7 programme “Energy efficient Buildings (EeB)”, aims at developing energy infrastructure concepts that are able to utilise the full potential of renewable energies available at district level. This report describes an evaluation method of a general approach for evaluating such energy systems.

Methodology
The evaluation methodology distinguishes between the conceptual phase and the design and operation phase. In the first phase, the outcome will be a sketch of an optimised energy system (in terms of energy, ecology or economy). In this phase the evaluation will be based on *annual* energy demand of a district.

In the operational phase, the outcome of the evaluation methodology is an optimised control strategy, minimising fossil energy (or maximising the share of locally available renewable energy), minimising CO_2 emissions, or minimise the cost of energy delivered). As the price of energy is expected to vary on a minute scale, the evaluation is based on detailed load profiles of electricity demand, heating demand and cooling demand of the district. The evaluation methodology should be implemented in the control strategy in WP4, so the control strategy what object to achieve (e.g. minimise cost).
The process of the evaluation is carried out in a Multi Criteria Analysis, schematically shown in the figure below

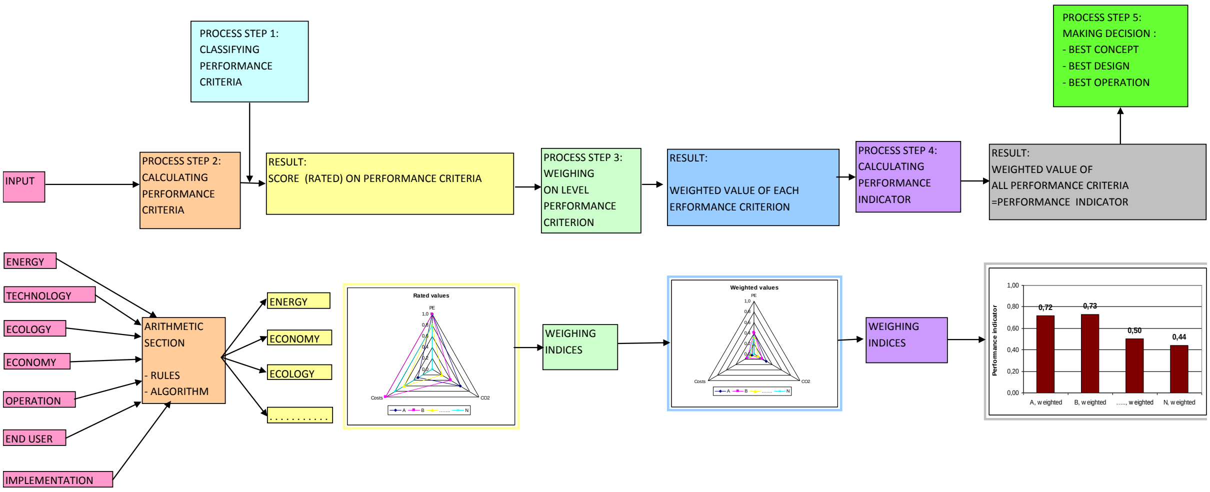


Figure sketching the Multi Criteria Analysis methodology

It consists of the following five steps:

Step 1: Classifying performance criteria
The relevant performance criteria are subdivided in classes according to the rating values between 0.0 and 1.0. Among the performance criteria are: (primary) energy (PE), ecology (CO_2) and economy (€). The rating is based either on expert judgment, values from reference tables or other sources.

Step 2: Calculating performance criteria
The rated performance criteria of the relevant alternatives (A up to N) are calculated. Therefore we need an arithmetic section that consists of rules and algorithm, which depends on several aspects like technical, ecological, economical, operational, implementation and end-users.

Step 3: Weighing performance criteria
The importance of the performance criteria is determined by weighing indices. With these indices the weighted values for the alternatives per performance criterion are calculated. The weighing indices are based on expert judgment if necessary by using a tool to determine ‘objective’ values.

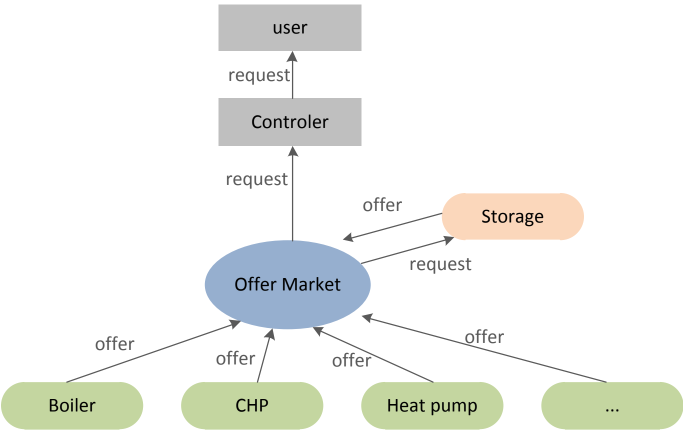
Step 4: Calculating performance indicator
When one alternative scores the best on all performance criteria it’s the best choice. But normally that

is not the case so in this step per alternative the weighted values are summarized, resulting in one performance indicator. The highest score represents the best alternative. In this example alternative B.

Step 5: Making decision
This last step is more or less the result of step 4 and results in the best concept, design or operation mode.

A number of aspects are being considered for inclusion in the evaluation methodology.

- Existing regulations as background information and source for calculation methods, e.g. EU Directives and regulations on energy performance of buildings (EN 15603:2008, EPBD 2010/30/EU), described in § 5,
- Power generating and energy storage equipment to be used in an E-hub system were studied in deliverable 2.1 *Inventory for existing technologies for energy storage and conversion*. The main technologies are reproduced in §8 including their Key Performance Indicators (KPI's) which will be used in the quantitative methodology tool.
- Economic considerations, discussed in §9, based on operational cost (or energy production cost) which include fixed values (instalments, depreciation, interest rate, taxes …) and variable cost (which is assumed to be time varying). The cost analysis is numerically detailed in §12. The equations developed will be used in the quantitative evaluation tool.
- The control strategy will be implemented as a trading market for energy in a so called "multi agent" system), in which appliances generating and consuming energy continually make bids to sell or buy energy, illustrated in the figure below.



  This mechanism should be able to find the most economical energy producer in real time with prices fluctuating according to the availability of (renewable) energy. Thus, variable cost mentioned before can easily be calculated by adding for each time step the 'market' energy price times the volume of the energy traded.
- In the conceptual phase , an important element is the question of how to finance the investments required for Energy Efficiency systems, such as an E-hub. In §13, after an introductory section, an overview is given of the basic criteria for the appraisal of an Energy Efficiency investment project from the point of view of a financial institution. These criteria need to be implemented in the evaluation tool for the conceptual phase.

In summary, this deliverable introduces the basic approach for an evaluation methodology. It considers the different phases of a project which can be defined as a conceptual, design and operation phase. Aspects taken in to account are(primary) energy (kWh), ecology (mainly CO_2)and economy (€).

In the economic analysis, it appeared that an important element is the cost for investment and the associated guarantee that financing institution require. This resulted in a list of criteria for energy efficiency projects that financing institution can use to evaluate the project and assess the risks.

The methodology proposed will be elaborated into a quantitative MS excel evaluation tool in task 2.3, taking into account the considerations brought forward in this report. A version including only the 3 main aspects of energy, ecology and economy is already available. The tool will be used in task 2.4 to evaluate the impact of the model districts, identified in task 1.1 including the proposed E-hub system for each district. The methodology will also be implemented in the control strategy for the E-hub energy system.