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ENERVALUE Project: an ICT tool for Energy Efficiency in Buildings

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ENERVALUE Project: an ICT tool for Energy Efficiency in Buildings

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Abstract: ENERVALUE project by combining cost optimization and energy efficiency targets, aims at developing an advanced ICT tool for Energy Efficiency in Buildings. This tool will help the decision making of collectivities or enterprises as to the implementation of measures related to energy efficiency based on the analysis of various criteria such as environmental, energy and financial economic criteria. The main objectives are to provide implementation plan of corrective measures for the improvement of the energy performance of buildings in a cost-effective way and to reduce the carbon footprint of the studied building. This paper will introduce the project and the tool by describing its objectives, its structure and its usage through a use case.

Key words: Energy Efficiency in Buildings, Diagnostic Tool, Decision-Support System

Introduction

Nowadays, the climate change stemming from Greenhouse Effect Gases (GEG) mainly from carbon dioxide (CO2), and the depletion of fossil energy resources are the two major challenges for the future of the planet. This paper will introduce the ENERVALUE project, an applied research project being in line with the strategic priority “Energy Efficiency” including the reduction of the energy consumption, GEG emissions, the limitation of the energy dependency and the growth of the economy and its global competitiveness. ENERVALUE project by combining cost optimization and energy efficiency targets, aims at developing an advanced ICT tool helping the decision making of collectivities or enterprises as to the implementation of measures related to energy efficiency based on the analysis of various criteria such as environmental, energy and financial economic criteria. This project is carried out under the “Ecoinnovation” action area described in the Spanish plan of science, technology and innovation 2010, so-called PCTI2010.

In addition, in times of economic crisis and at the same time with the increasing energy price, enterprises or collectivities must face the challenge of developing sustainable strategy and measures to minimize and control costs and to become more energy efficient. ENERVALUE project will meet their need specifically related to the management of the buildings or offices. Indeed, the targeted application domain of the tool is the Energy Efficiency in Buildings and the main objectives are to provide them corrective measures implementation plan for the improvement of the energy performance of buildings in a cost-effective way and to reduce the carbon footprint of the studied building in a long-term strategy.

ENERVALUE tool will then offer the possibility to the users to evaluate prospective scenarios of measures for energy efficiency for a given building and by this way to identify measures and prioritize them in a short, medium or long-term strategy. The interface will be designed in two versions: one for expert users (like energy manager) and another one for non-expert users. From a perspective point of view, the use of this type of ICT-based tool would generate societal benefits by fostering the adoption of energy efficiency measures and subsequently by expanding the usage of the tool to the residential level.

This paper will introduce the project objectives, and describe the tool and the different associated studies for its development. Then, this paper will also present its usage based on the use case of the lighting system of a building as well as the interface mock-up.

ENERVALUE Project

ICT for environmental sustainability as research framework

"*Sustainable development calls for a convergence between the three pillars of economic development, social equity, and environmental protection" [UN, 2010*]; the figure 1[1] provides a scheme of sustainable development. In an innovative society driven by the sustainable development, the environmental sustainability objectives are regarded as a necessary priority. The concept of environmental sustainability is referring to any process that is in interaction with the environment and running with the objective to preserve the environment and its regeneration capacity.

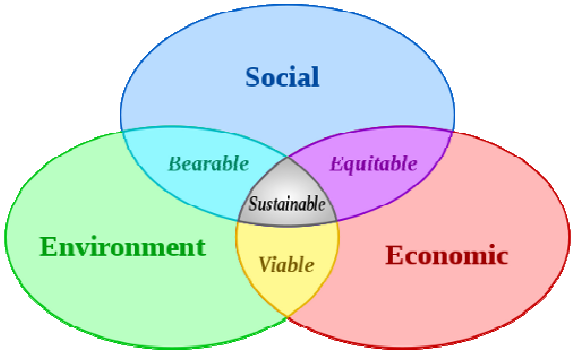

Figure 1 - Scheme of the sustainable development

In addition, in the Green ICT roadmap [VTT, 2010], VTT defines ICT for environmental sustainability as "*Use of ICT for optimising societal activities in order to improve environmental sustainability".* This roadmap report represents the vision for future developments based on three themes; 1) empowering people, 2) extending natural resources and 3) optimising systems. By analysis of this roadmap, VTT experts have identified four focal topics regarded as the most relevant research topics that have both significant potential in terms of environmental sustainability and great application opportunities for ICT. Energy Efficiency in Buildings, the application domain of ENERVALUE tool appears as a key research sub-topic of "Smart energy and Buildings" that is one of the four identified focal topics by VTT.

ICT for environmental sustainability objectives

The ENERVALUE project will contribute to the following challenges regarded as the key drivers of the ENERVALUE tool development for environmental sustainability:

- Energy Efficiency and Energy Saving, this challenge is the main objective of the project. By the use of the ENERVALUE tool, users will be able to take decision and adopt measures for the reduction of their energy costs and consumption.
- Reduction of Carbon footprint of studied buildings; this objective entails to carry out a study aiming at establishing the inventory of fundamental data required for a robust analysis of impact by taking into account the Life Cycle Assessment (LCA) of the equipment/products used in the building (more details in the study 2, see p5).
- Efficient management of data by the generation of valuable information in particular about energy and environmental parameters; due to the large amount of data processing by the tool, the visualization of the data "as is" will be not easy to understand neither friendly for the user. This generated information would provide a

[1] http://en.wikipedia.org/wiki/Sustainable_development

better way to handle the parameters and also allow the understanding of relations between different parameters. This expected better understanding would facilitate the decision making for environmental challenges, such as the reduction of the impact on environment.

ICT will play a key role in the fulfillment of those objectives. Concretely, ICT will improve measurability, management of large amount of data, visibility of emissions and energy use, and finally the understanding to support the decision making.

Scientific and technology objectives

The scientific and technology objectives of the ENERVALUE project are the following ones:

- To implement measures for efficiency energy in buildings by taking into account parameters related to economics financial environmental and energetic aspects.
- To focus on the services sector, including public administration and enterprises with offices.
- To develop an ICT-based tool providing:
  - ✓ Reliability by getting parameters stemming from reliable database.
  - ✓ Quick results by providing results in few steps without the introduction of a lot of data.
  - ✓ Clarity by giving data easy to handle for the responsible of results transfer.
  - ✓ Utility by generating valuable information allowing an efficient management of the results for decision in energy efficiency.

Socio-economic objectives

As highlighted before, the foreseen tool aims at supporting the decision making as to the adoption of measures improving the energy efficiency of the examined equipment and building in general. The subsequent objectives cover socio-economic aspects.

Related to economic aspects, the adoption of targeted measures based on an optimized selection of criteria for the improvement of energy efficiency would provide saving cost as to:

- The installation of the equipment necessary to implement those measures,
- The consumption of energy resources at medium - long term,
- The usage of such installed equipment at long term.

Related to social aspects, the usage of the foreseen tool would raise the societal awareness of the lack of the energy resources and their environmental impact and would enhance the implementation of measures for energy saving at the residential level. That is why ENERVALUE tool has also the objective to be accessible for everyone by offering a special version to non-expert users. By this way, this tool will help users to become eco-efficient and better manage their carbon footprint.

ENERVALUE Tool Presentation

In Energy Efficiency in Buildings, different types of tools like Building Energy Simulation (BES) or Energy Efficiency Diagnostic Tool, are distinguished by:

- The targeted building, i.e. when it is question of office building, collective building (e.g. cultural or social) or residential and when the study is about existing buildings or future new ones,
- Or by the final objective, i.e. the construction of a new building or the rehabilitation of existing building.

In [Chou, 2001], different applications of BES are highlighted:

- Study of load profiles and energy usage patterns of building
- Selection of building systems for better energy performance of building
- Economic analysis
- Calculation of energy budget of a building
- Evaluation of energy saving options
- Complying with building regulations, codes and standards

According to ESMAP[2], Energy Efficiency diagnostic tool, also usually regarded as a decision-support system, is used to:

- Benchmark energy use,
- Prioritize sectors with significant energy savings potential,
- Identify appropriate energy efficiency interventions across service areas[3].

ENERVALUE tool is in line with an energy efficiency diagnostic tool as a decision-support system enabling the rehabilitation of existing office and collective buildings. The ENERVALUE measures will cover different areas or action fields, such as lighting system, heating and cooling system, electricity from renewable energy (solar and wind), building envelope, and windows and doors (including frame material and glass) as depicted in figure 2.

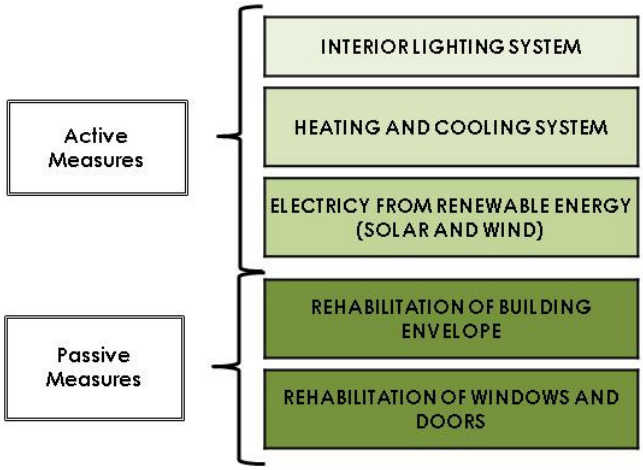

Figure 2 – Five action fields covered by the ENERVALUE tool

Schneider Electric introduced in a recent white paper [Schneider, 2011] a sustainable approach combining passive and active energy efficiency solutions. They define "*Active Energy Efficiency is defined as effecting permanent change through measurement, monitoring and control of energy usage. Passive energy efficiency is regarded as the installation of countermeasures against thermal losses, the use of low consumption equipment and so forth.*"

[2] ESMAP has contributed significantly to the development of knowledge tools to guide decision-making about climate change mitigation and low carbon growth, see www.esmap.org

[3] In ESMAP, TRACE (Tool for Rapid Assessment of City Energy) is a city energy efficiency diagnostic tool and offers cities a quick and easy way to assess their energy efficiency and identify sectors to improve. In this case, six service areas are covered: transport, buildings, water and waste water, public lighting, solid waste, and power and heat; see http://www.esmap.org/esmap/node/235

In ENERVALUE project, this sustainable approach has been adopted and hence, the tool could propose a plan for Energy Efficiency or Energy Saving combining passive and/or active measures related to the five action fields represented in the figure 2. In this project, thirteen measures - 11 active and 2 passive - have been implemented. The measures related to the interior lighting system are detailed in the section dealing with the use case of the tool.

Studies to develop the tool

In order to achieve the development of ENERVALUE tool, this project comprises different studies:

- The determination of key parameters describing environmental, energy and financial economic aspects,
- The inventory of fundamental data required for a robust analysis of impact,
- And the design of models and algorithms for the parameters valuation and impact assessment.

Study 1: Key parameters describing environmental, energy and financial economic aspects

ENERVALUE project main objective is to prioritize the measures for improving the energy efficiency based on the analysis of different parameters describing environmental, energy and financial economic aspects (see figure 3). The identification of those parameters is a crucial task because the result of this identification has to ensure a good level of engine applicability and a low time-consuming process. Regarding the Environmental and Energy criteria, additional specific parameters are defined and directly depend on the technology. In the figure 3, the specific parameters are related to the lighting technologies.

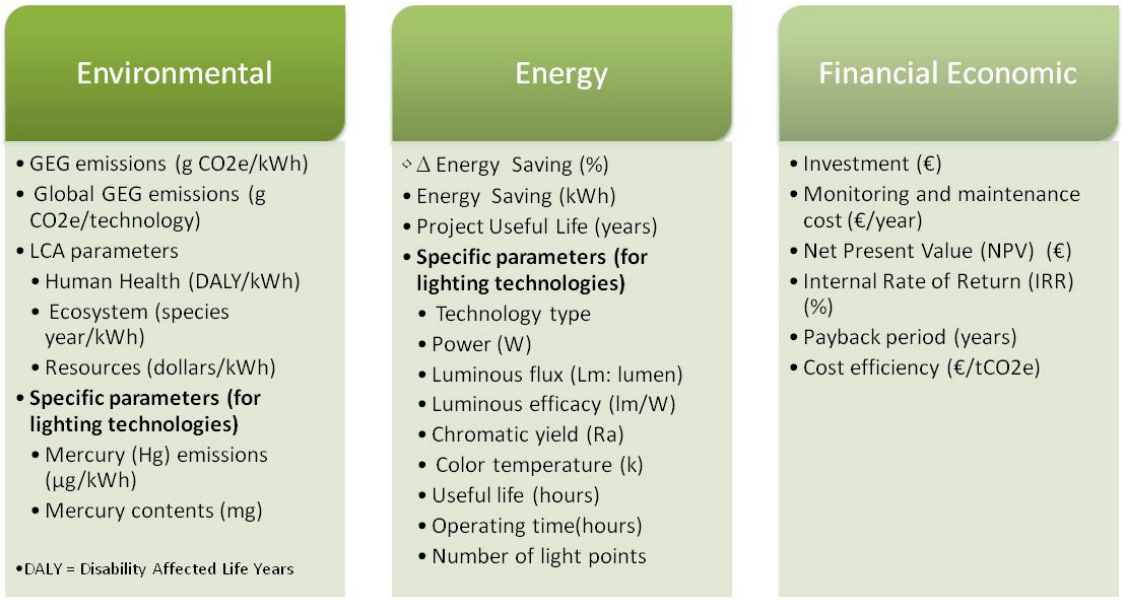

Figure 3 – Key parameters used by the ENERVALUE tool engine

Study 2: Inventory of fundamental data required for a robust analysis of impact

This study is driven by the final objective of the reduction of carbon footprint of the studied building and focuses on the product (vs. organization) carbon footprint. In this case, this study has to analyse the lifecycle of the product. Life Cycle Assessment (LCA) of a product, an activity or a service is referring to all activities generated by the product from the extraction of raw material to the waste materials, including its transport and its usage, enables the assessment and identification of critical point(s) of each activity that composes of the product global process.

Therefore, this study will examine not only the data related to the impact of a product itself but also all data related to the lifecycle of the product.

To carry out this study of inventory, it is necessary to perform the following steps:

- Design of questionnaire as inventory guidelines
- Establishment of a review process of data
- Data gathering
- Definition of a system of measures units
- Design of database module
- Presentation of the results

Study 3: Design of models and algorithms for the parameters valuation and impact assessment

The key challenge for this study is the capacity to manage a large amount of data and the data dependencies. It is essential to design clear criteria of measurement and comparison. This work will be based on the expertise of the research partners as to the development of assessment algorithms exploiting a large number of parameters.

ENERVALUE project is an on-going project. The first study is done, the second one will be finalized in July 2012 and the third study is just started. The tool is still under development and its first version will be completed at the end of November 2012, afterwards the validation sessions will be carried out and would last one year including the implementation of pilots.

Structure of ENERVALUE Tool

As illustrated in the figure 4, the ENERVALUE tool is mainly composed of an engine and data bases including norms, parameters and measures and needs as input data the definition of the building (e.g. type, location), the amount of the energy invoices (optional input data) and the description of the current equipment related to the action fields (already shown in the figure 2).

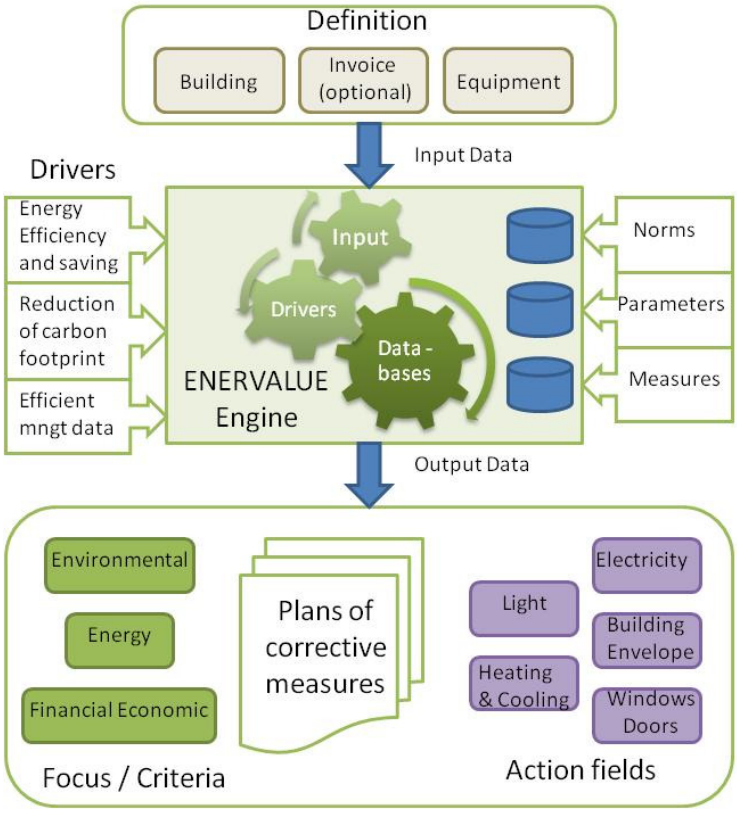

Figure 4 – Structure of ENERVALUE Tool

The objective is to provide plan(s) of corrective (passive or active) measures for Energy Efficiency or Energy Saving in the different action fields and by focusing on the three criteria: Environmental, Energy and Financial Economic.

Applicability of ENERVALUE Tool

As already said, one objective is to help the decision making of collectivities or enterprises as to the implementation of measures related to energy efficiency. For that reason, it is foreseen that ENERVALUE tool will be applicable to different types of building, including the most important building types of a city such as Governmental, Educational, Security, Cultural, Sport and Social.

Use case: the lighting system of a building

This section will provide more details about the ENERVALUE tool and its user interface mock-up through the use case: lighting system of a building. Hence, the action field for this use case is "Interior Lighting System" and the measures will be related to the light substitution and the regulation system and lighting control, as described in the figure 5.

Action Field: Interior Lighting System		
Measure	**1**	**Light substitution**
Technology	1.1	Incandescent light 60W
Technology	1.2	Incandescent light 120W
Technology	1.3	Fluorescent light with electromagnetic ballast
Technology	1.4	Fluorescent light with electronic ballast
Technology	1.5	11W CFL
Technology	1.6	20W CFL
Technology	1.7	LEDs
Measure	**2**	**Regulation system and lighting control**
Technology	2.1	Presence detection
Technology	2.2	Zone
Technology	2.3	Light point by light point

Figure 5 – Measures related to the Interior Lighting System

The interface mock-up is illustrated by different screen shots (in Spanish) representing the steps of definition of the input data and an analytical view of one measure, i.e. a light substitution measure for this use case.

Figure 6 shows how to describe the building to be examined:

1) the selection of the building: the user can select a building or add a new one, s/he has to give the name of the building, choose the type of building and may add a picture.
2) the amount of the energy invoice: the user has the option to provide the amount of the energy invoice.
3) the location of the building: this information allows detailing the geographical place of the building and the relative position with other next buildings.

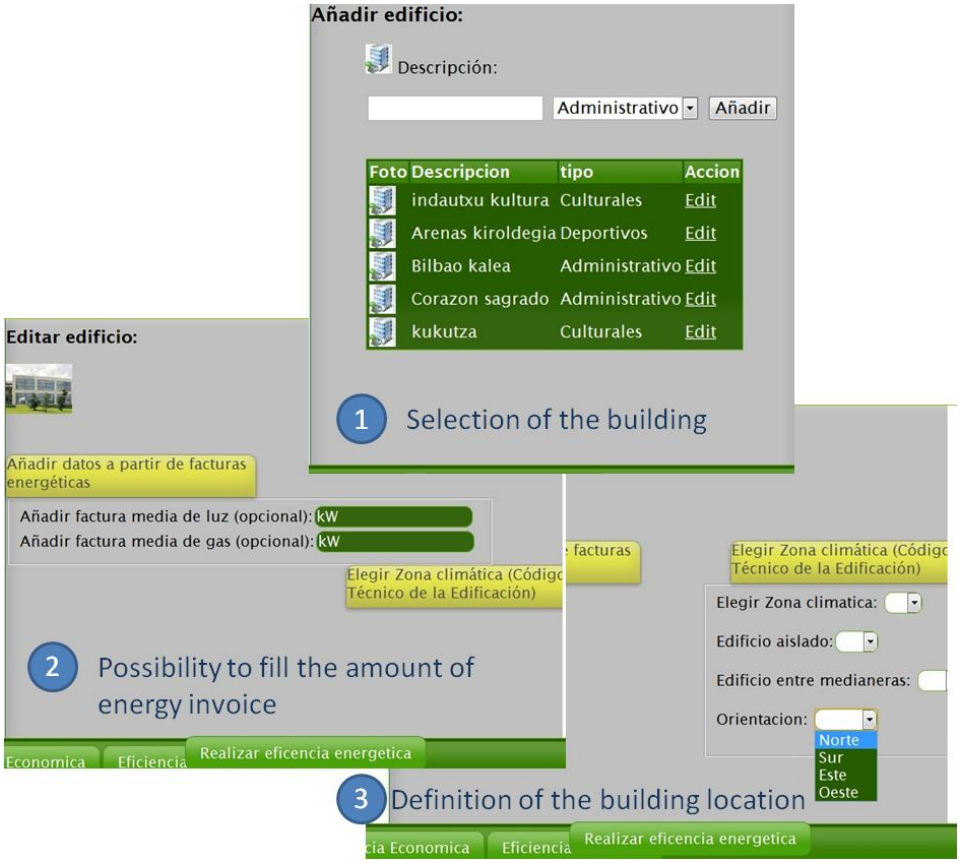

Figure 6 – User interface for the definition of the targeted building

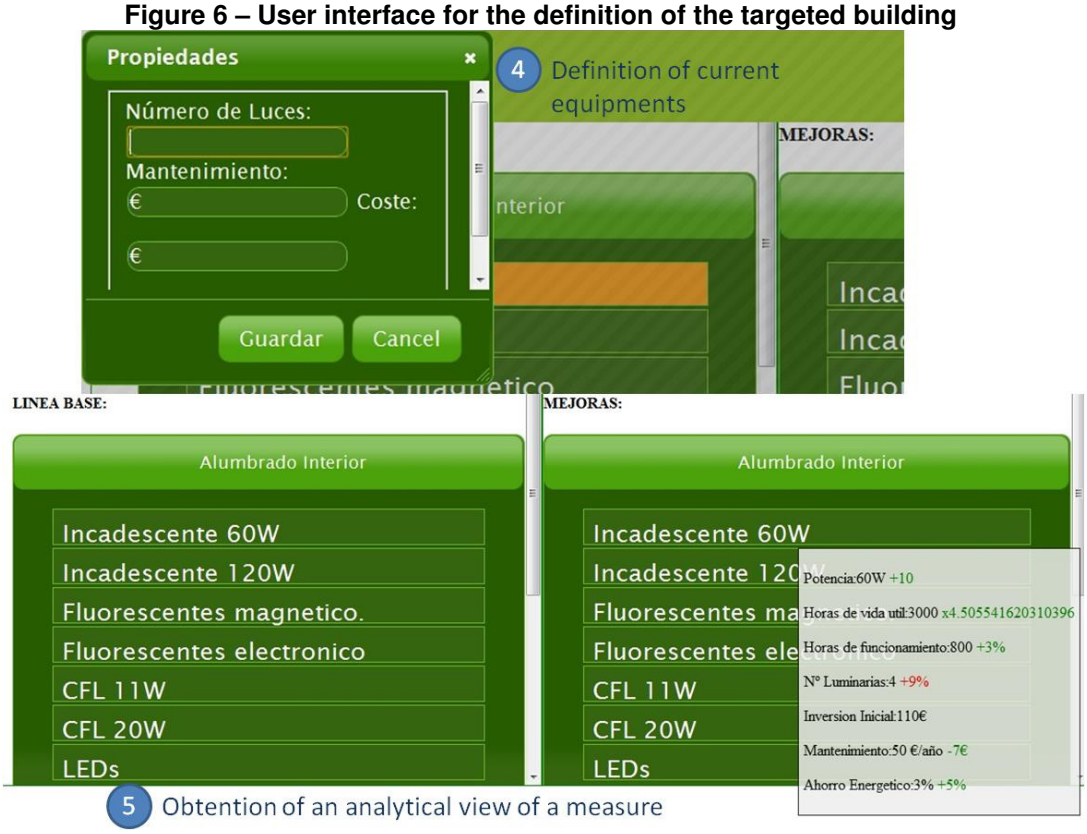

Figure 7 – User interface for the definition of current equipments and an analytical view of a light substitution measure

Figure 7 gives details on:

1) how to define current equipments: once a type of equipment selected in the first column (i.e. the column of the current situation), a window appears and the user will fill in the corresponding short questionnaire.
2) an analytical view of a light substitution measure: by clicking on another type of equipment in the second column (i.e. the column of the future situation), the user is choosing a substitution of the current equipment by a future one. A window will provide the relevant information of the application of this substitution measure; for each descriptor (i.e. maintenance), the first data in black is the value of the future equipment and when the second data is the gain, so it appears in green and when the second data shows a negative gain, e.g. an additional cost, the data is given in red.

Conclusion

This paper has presented the ENERVALUE project aiming at developing an ICT tool for Energy Efficiency in Buildings. As described in this paper, the main objectives are to provide implementation plan or corrective passive or active measures for the improvement of the energy performance of buildings in a cost-effective way and to reduce the carbon footprint of the studied building. ENERVALUE project will endeavor to develop a reliable, clear and useful tool providing quick results and applicable to different main building types of a city. Moreover, by offering two types of version: one for experts and a second one for non-expert users, ENERVALUE project also aims at raising social awareness by providing a tool helping users to become eco-efficient and better manage their carbon footprint.

ENERVALUE project is an on-going project and the ICT tool is still under development. Key challenges for this development are the capacity to manage a large amount of data and the data dependencies and the ability to provide valuable information in right quantity in order to efficiently help the decision maker as to the implementation of measures plan in the concerned building. The generated plan of corrective measures takes into account parameters related to environmental, energy and financial economic aspects. The first completed version of the tool is expected at the end of November 2012. The last phase of the project will then focus on the implementation of pilots and validation sessions.

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