Energy 10 Performance on Building Energy Efficiency in Jordan

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ABSTRACT

This paper examines building energy efficiency parameter in order to improve efficient of construction projects as well as looking into making the building more energy efficient. Buildings considered one of the largest consumers of energy. In the developing countries huge number of new buildings is constructed yearly. One of the major barriers for better building energy efficiency is the lack of aiding tools during the primary design stage. A major barrier during design process of building has been the difficulty in finding the available suitable programs. ENERGY-10 overcomes this hurdle by automating many of the time-consuming tasks, shortening the time required from hours or days to minutes. Buildings descriptions are created automatically based on defaults.

Keywords: Energy Efficiency, Building Energy, Residential Sector, Energy 10, Software Programs.

1. INTRODUCTION

Jordan is small country of about 5.6 million people, falls in the heart of the Middle East. It is among the low-income countries of the region with an average GDP per capita of about US$ 2550 in 2006, compared to US$ 10,000–18,000 for neighboring oil exporting Arab Gulf States [1, 2]. Jordan suffers from an ever-present lack of sufficient supplies of natural resources including water, minerals, crude oil and natural gas. Being a non-oil producing country, there has been an increasing anxiety about energy consumption and its harmful impact on the national economy as well as local environment. At present, Jordan depends profoundly on imported crude oil and natural gas from neighboring Arab countries as main sources of energy which causes a drain of scarce hard currency.

The annual energy bill has been hurriedly escalating over the past few years and exceeded US$ 3 billion in year 2006 due to high rates of population and economic growth combined with the successive increase in the oil price.

The residential sector in Jordan has been affected more than any other sector by the economic and technological changes witnessed in the country. For example, in the 1960s and 1970s, kerosene was the major fuel used for cooking and water heating in urban areas in Jordan. Electricity was not widespread, and most dwellings did not have electrical appliances such as refrigerators and television sets. Gas cookers and gas heaters also were not exists, particularly among low-income families. Currently, liquefied petroleum gas (LPG) is the main fuel used for cooking and water heating. Electricity is available for almost all households, which used many different electrical appliances [3]. The residential sector is divided into two main sub-sectors: rural and urban, where urban forms almost 80% of the total population at present. In 1994, the average family sizes were 6.65 for urban and 7.49 members for rural, while in 2004 these dropped to about 5 for urban and 6 for rural. More than 80% of the population lives in dwellings that range from 50 to 200 meter square. The distribution of the income in Jordan, however, is very disproportionate. The wealthiest 10% of households earn more than 50% of the total national household income, while the poorest 48% earn only about 10% of the total household income, and live below what is accepted to be the poverty level: the average monthly income per family is approximately US$ 300–400 [4]. Lack of adequate housing and access to basic services are also indicators of poverty: at present more than a quarter of the population live in miserable conditions, e.g. permanent Palestinian refugee camps or marginal houses, far below basic acceptable levels. About 61% only of all households have access to a sewage network [5].

Improving the end-use energy efficiency is one of the most effective ways to reduce energy consumption in the residential sector and associated pollutant emissions. In most developing countries, such as Jordan, substantial energy losses exist in a large number of houses. Reduction of such losses would improve energy efficiency significantly, which means less reliance on energy imports, and less CO₂ emissions. Lately, several papers have shown that implementing few options, such as use of more efficient lighting, refrigerators, thermal insulation of buildings, efficient space and water heating, demand-side
management and fuel substitution. Therefore, residential sector could reduce energy consumption and CO₂ emissions [6–9]. In spite of the existence of several studies attempting to analyze current and future energy requirements for the residential sector in Jordan [10, 11], there is a need for empirical models to analyze and explain the main driving forces behind fuel and electricity consumptions changes. For the residential sector, since energy planning is not possible without a deep knowledge and analysis of past and present consumption. This paper describes the program’s features, simulation engines and the capability to use the program.

1.1 Energy efficiency building and construction sectors

In Jordan energy requirement will remains very intensive. Commercial and residential buildings alone account for about 13% of total energy consumption, and 48% of electricity consumption. This means Jordan has a strong need and great potential to apply energy efficient strategies in lowering energy consumption in buildings [12]. Constructing energy efficient buildings in the future helps Jordan safeguarded its depleting energy resources and through energy efficient buildings increase construction costs up to 15% higher than conventional designs. Saving energy use in buildings need cooperation, everyone from architects, engineer interior designer and researcher play creation of energy efficient buildings.

ENERGY-10 is a PC-based building energy simulation program for smaller buildings that focuses on integrating the energy-saving strategies of day lighting, passive solar heating, low-energy cooling, and energy-efficient equipment during the early stages of the architectural design process [13]. Developed specifically as a design tool, the program facilitates quick evaluations. Its simulation engines perform whole-building energy analyses for 8760 hours per year, integrating day lighting and dynamic thermal calculations. Figure.1: shows how ENERGY-10 can be effectively integrated into the design process, identifying key activities at each stage. [14]. When a calculation is initiated, ENERGY-10 first uses the simulator to determine the HVAC system capacities required to meet loads on winter and summer design days. The simulation then steps through the year iterating to find an energy balance at each hour accounting for heat storage in each material layer. A key feature of the simulator is that it iterates to find a consistent solution for the building load and the HVAC system at each time step.

2. FEATURES OF ENERGY - 10

2.1 Auto Build

In the pre-design phase, two complete building descriptions are generated automatically. These are a Reference Case and a Low-Energy Case. The Reference Case is a basic shoe-box building that satisfies the building requirements. The Low-Energy Case is the same building but modified to incorporate a set of energy-efficient strategies (EESs) reselected by the user. These two simulated buildings gave the designer two important pieces of information [15]:

1- They show the energy use pattern of a typical building of the right size, in the right climate, having the appropriate internal-gains for a building of the desired type. The balance between heating, cooling, and other energy uses is determined.

2- The simulations identify the potential for energy and cost savings from a particular set of strategies.

Only five inputs (location, size, use, HVAC, and number of stories) are needed to initiate the Auto Build process as shown in Figure 2. With this information, the program creates a provisional shoe-box building description. The user can fine-tune the dimensions or other features or simply accept the program's suggestions. Using a default library, the program then proceeds to generate a complete building description which includes hundreds of design parameters.
The general principle used in ENERGY-10 is that everything is defaulted, but can be changed. For example, when the user selects the building, the program selects hourly profiles of internal heat generation caused by lights, personal use, hot water, and other, that matched measure data and yield national average end-use energy consumption values appropriate for the desired type of building. [17], 2400 sf House in Minneapolis / Auto Build Shoebox, figure 3 shows that.

The APPLY operations were actually used to generate the Low-Energy Case in the previous example, starting with the default Reference Case. Eight of the possible strategies were applied, excluding day lighting, because it is already included in the default lighting schedule for residential buildings, and economizer cycle.

2.3 Rank

This feature is similar to APPLY except that the EESs are applied individually. When the user selects a set of EESs and then clicks on RANK, the program applies the first EES, performs a simulation, saves the results, removes the EES, applies the next EESs and so forth until all the EESs have been applied and simulated. The program then rank-orders the results according to the desired criteria (lowest annual energy, lowest annual operating cost, lowest life-cycle cost, etc.) and displays the result, which might appear as shown below[18].

2.4 Graphic Output

Twenty graphic outputs are available in fixed formats, generally comparing the current design with a reference building. Bar graphs, such as the above example, compare overall loads, costs, and cost breakdown by end use. Line graphs, such as the example below, show monthly loads, average-daily monthly profiles, day lighting effectiveness, and actual hourly results for any period [18]. Bar-graph comparisons of a selected sequence of design schemes can be displayed (using KEEP, another time-saving feature of ENERGY-10). All graphical results can be printed directly or exported as metafiles for inclusion in a report. These graphs can be used to educate the client and to demonstrate the value of good building design as shown in Figure 4 and Figure 5. Other features include a library of materials, constructions, and schedules that can be added to or modified on the fly.
Figure 4: example of hourly simulation results

Figure 5: example of cost breakdown graph

Energy-10 as a Tool for Getting New Technologies into the Market Place: Because APPLY makes it so easy for the user to do an evaluation, ENERGY-10 serves as an ideal mechanism to encourage the adoption of technologies into buildings. With a couple clicks, the user can globally changes the building description to represent the addition of the technology, in two to three minutes later he or she is inspecting the results. Technology which might’s have not even been considered, because of ignorance or the difficulty of doing an evaluation can be investigated quickly. Technology that is not in the mainstream but is particularly suitable for inclusion in the APPLY and RANK list include the following [19]:

- Evaporative cooling
- Ventilation air preheat using transpired collectors
- Photovoltaic (PV)
- Desiccant cooling
- Solar water heating
- Natural cooling
- Air tightening / exhaust-air heat recovery

A major advantage of using ENERGY-10 is that the analysis is fully integrated, all of the interactive effects are accounted for in the simulations. For example, the cooling load reductions that are a result of dimming lights in a daylight building are taken into account. In a building-integrated photovoltaic application, all the electrical loads handled by the PV system are known, including HVAC loads and artificial lighting loads, accounting for dimming of the lights in response to daylight.

CONCLUSIONS

Energy-10 was written to fill an identified need and has been well received by designers and energy consultants. It is fast easy to use and accurate. It allows the user to quickly identify cost-effective strategies based on detailed hourly simulation analysis that accounts for interactive effects.

REFERENCES


