International Journal of Research Publications
Volume 1 – Issue. 1, September 2017

Energy Consumption Analysis in Conventional Buildings: Case Study of Sweden

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Abstract:

The fast growing of energy in the world has become a high concern over some source problems in energy calculations of economy, where the buildings now described as one of the main energy consumers for about 33.35% worldwide. This paper aims to review and investigate on the Swedish conventional buildings for a quantitative research. To analyze the case study, latest energy analysis software (LEAP) used as an environmental simulation and assessment tool for the calculations. The first step is to lead toward studying the EU buildings in general with a case study focusing on Swedish conventional buildings for the design and method of calculation in energy performance and consumption. In the second step, analyzing the data for the energy consumption and comprehensive model for a conventional building (M-building) in Stockholm/Sweden. In the last step, a broad energy consumption that has been performed with the foundation of model for the evaluation of the power used as a part of the Swedish structures. Under the IPCC fifth assessments, the result shows that conventional buildings will expend more energy than other new sustainable buildings in Sweden for about 70% more. However, about 60 kWh of energy will be used for saving, which is approximately 2% for the management, transportations and other sectors/segments with a total of 263 kWh/m^2 as energy consumption.

Keywords: Energy Consumption, Conventional Buildings, Operating Energy, Building Materials

I. Introduction

The modern style of conventional buildings in Sweden has been found during the 1910s and 1920s with a low housing standard, poor energy calculations and not well thought strategies. Often the quality of these Swedish buildings and their construction and architecture designs were a minor importance to the designers for the distribution of such a big number of houses. However, million strategies were planned before by the government creativity projects opened during 1960s and 1970s, designed to form a million households in Sweden. These plans contain designs named such as minimalism design, hi-tech or technological design, expressionism architecture design and the design of neo-functionalism.

The design of conventional buildings in the Swedish environment has been a struggle continuously for managers and directors around the world in the matter of managing the demand of energy and calculates the energy consumption sufficiently. In general, energy consumption among buildings in the world became a challenge to study or investigate in the difficulty of reducing the consumption by creating sustainable structures and constructing more energy efficient buildings for decreasing. The northern Europe investigations has traced the development of the peoples of this region and looked forward to reach the standard of living in Europe over fifty years from the growing demand of electricity, potable irrigation and water; and found that the request of these peoples for energy will outstrip the energy consumption by its electricity measurements in north Europe countries. However, renewable energy sources outweigh the expected demand stages at the same time while the depleted traditional energy sources of oil, gas and coal will be more affected in the conventional buildings. The Swedish energy consumption analysis investigations of conventional buildings have presented all influences and approve the idea of buildings of high operation uses consume more energy than in the buildings with low operation for total energy use [5].

The conventional building design contains a couple of dimensions which could maximize the use of energy through its poor energy calculations, such as the use of electricity for heating, cooling and operational uses or by the use of non-isolated walls, ceilings and floors plus material selections. The European Council started to find a better way to construct the buildings for well use; therefore they established different objectives and plans for ensuring new zero-energy buildings for the EU countries at the end of 2020, with its newest instruction designs on the energy performance of buildings [1]. However, several studies and examinations by the EU council have been applied to the conventional thermal systems of energy storing to integrate the phase change material (PCM) for thermal characteristics of buildings. The phase change material is applied in different types of materials such as concrete, tiles mixture, gypsum, cement, plaster and others [2]. In the other way, the tangible impacts on energy consumption in conventional buildings can be shaped by certain elements in constructions (bricks). Thus, more alternatives material can be selected for reducing the consumption of energy [3-4]. The objective of this paper is to make a smart understanding view on the energy consumption in Swedish conventional buildings, and also explain their main designs and selections for the calculations of energy consumption by studying a real case in Stockholm/Sweden.

II. Research Methods, Objectives and Definitions

2.1 General Research Design

In order to learn and explore the energy uses in Swedish conventional buildings, an extensive study on different methods and operations of how energy consumed were well covered in this paper. The study built on discovering the energy consumption of normal buildings in a real Swedish case study then examines all quantitative measurements and data by importing the model using energy analysis software specified for the Swedish and northern Europe environment called long range energy planning system (LEAP). In general, several papers and researches focused on new techniques by how to examine the quantitative data of such a normal/conventional building into a simulation tool. Where some of these techniques defined in a literature understanding which is pretty old for about 10-15 years ago.

Many factors and elements can influence the energy measurements in conventional buildings worldwide, which can be critical and lead to apply an appropriate way for a suitable description for the energy analysis. Examining the results of the failure in the energy use in the Sweden and in world in general, limited researches were prepared to catch a proper explanation to this question through the value of energy performance. Therefore, it was built on considering energy uses alternatives in a related study, and then examines the data and all information by using comprehensive instrument of energy deviations LEAP as a simulation tool [6].

This simulation will give an extensive possibility in accounting, regeneration and the effects of different elements sufficiently accomplished in the purpose of power use, which are furthermore flexible and easy to add in LEAP software assembling all materials and consequences for model. However, the model here is also integrates the range in an exact measures containing costs representatives in area, for example, transportation positioning, income and number of houses [7]. Thus, the feasibility studies here can analyze the inefficiency of energy use for different segments; good outcomes were originated for discovering the best way where these segments could switch between each other. Designers here found the knowledge of ruling diverse types of measures to study the use of energy in conventional buildings conferring to their various approaches. Conversely, material selection can show a wide investigate path for the energy consumption, which could be achieved by using different measurement factors such as R-value study, shading coefficient incorporation, lights and fuel analysis [8]. Therefore, this paper will cover the energy consumption investigation through assembling real information of conventional building model in Stockholm/ Sweden from the vision of energy use explained in table 1.

Table 1. Energy use amounts assumptions

	Ultimate energy		**Valuable energy**	
Heat	100		85	
Limitations	**Fuel**	**Energy efficiency**	**Valuable energy**	**Activity in house**
Power	50	100%	50	59%
Gas	50	70%	35	41%

2.2 Energy Description of Swedish Buildings

The number of buildings in European Union countries is about 198 million in the previous and earlier researches, of which around 15% focused in Sweden. However, the annual report for rates of constructing these houses stated as a proportion of the size of the current EU store varieties as a 0.3% inside Swedish borders and up to 3.5% in the other EU countries [9]. Most of these conventional buildings have been constructed under poor or without any energy plans plus inefficient technologies, where the factor of material selection played as a significant influence on the building type comparing with the sustainable and energy efficient buildings. Therefore, in 1974, the Swedish government has established a new plan for the energy and power save by presenting a huge support in financial form for the matter of sustainable construction by its energy efficiency options and their green implementations for power and heat saving.

In general, the construction methods of conventional structures denote to the old-style and traditional techniques of building where the production design awareness are delivered from one age group of buildings to others. However, the energy consumption in these buildings have a big impact on the financial balance, taking in the mind several factors and elements that might include some additional significant on traditional constructions.

The old strategies throughout all building stages such as construction phase and pre-construction phase for these conventional buildings could show a tangible effect over its quality of finishing, site condition, labor intensive and time. Material selection such as concrete, cement, bricks, plastering, masonry, windows, doors and others have been carefully chosen also with poor plans for the future energy performance calculations or any additional requirements. The problem for more than 80% of Swedish conventional buildings can be handled and explained by the view of its occupants, which contain a high energy request though unplanned building energy analysis. However, power distribution for energy consumption in Sweden can be classified per segment as shown in Figure 1. Associated with other EU buildings, Sweden has a developed and high proportion of energy use & consumption in the business and in other facilities segments, while it has a minor and poor proportion in transportation and housing segment [10].

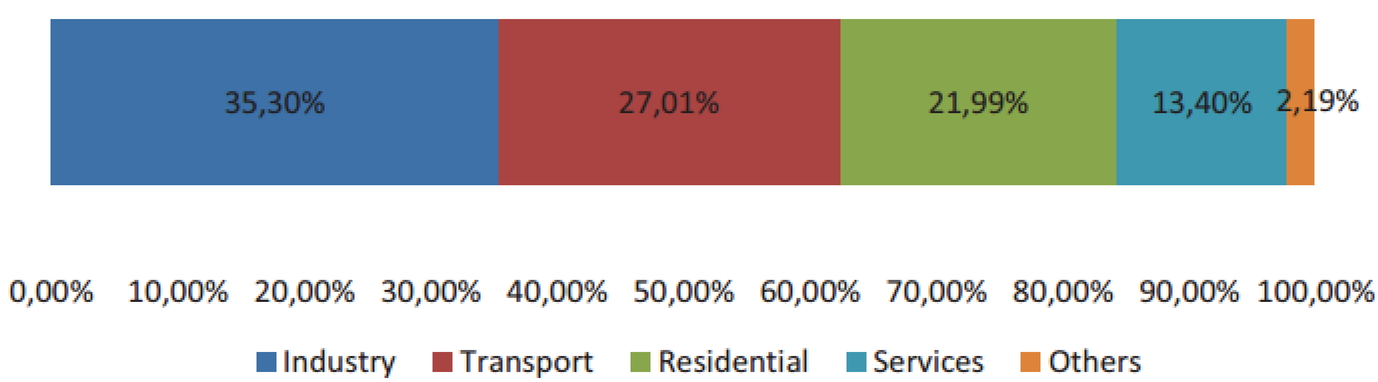

Figure 1: Swedish energy use per segment. Source: Eurostat 2011

2.3 Designs & Implementations

The building segment is measured throughout the years as a main consumer of energy for around 33.35% of the overall energy consumption worldwide, moreover in the recent years the buildings considered in place of a significant and great cause of CO2 emissions [6]. The design of these conventional buildings is related to the construction of (in-situ or RC cast-in-place) for the Swedish code by using different types of normal reinforced concrete. Also, all plans are particularly not operated very well for energy performance analysis combining several intensive processes between contractors. The type of RC is selected through some codes and regulation for conventional construction by Swedish government before the innovation of new construction energy plans in 1974. The concrete type can be obtained by replacing the fly and volcanic ash for parallel assets plus gypsum, aggregate, lime and other components which practice as binders for the design of traditional structures.

Planning & scheduling in conventional buildings formed for extreme reuse, heavy-duty and more expensive in cost, but it can save for some strategies on the overall construction cost with suitable transport charges too. However, the setting and undressing the project for these buildings can be classified as:

- Replication of the purposes for growth of crew competence as the work developments.
- Consumption of steel fix or different piece pinch influences that partially protected and cool to collect or pull to pieces for pre-cast features.
- Improve additional structure elements that sort all processes of control, assembly, and undressing.

The utilization of warming and high temp water in Swedish private premises was of 17.7 TWh in 2009. Although, the most regularly vitality source utilized was locale warming and trailed by power. Power was generated for the most fragment utilized as a part of littler structures, while locale warming was operated as a part of the 54% of the structures speaking to the 72% of the entire zone. However, the particular yearly power use for warming in administrations structures per square meter in 2004 was 119 ± 2 kWh/m^2 for every year discussed by SCB Statistiska Central byrån (Statistics in English) [10]. This yearly normal shifts significantly relying upon the time of development of the building. For structures worked after 1980 the warming use was of around 97 to 98 kWh/m^2 every year, while those worked previously 1980 operated from 120 to 133 kWh/m^2 every year. As per another investigation did in 2011 the normal of 123 studied structures in 2009 was 106 kWh/m^2. The outline in the course of the most recent years is to substitute oil items and power as causes of energy and power for warming backgrounds.

III. Analyzing the Case Study (M-building)

M-building located at lund university constructed by Akademiska Hus company, therefore this organization is possessed by the Swedish government and is considered as one of the biggest property organizations in Sweden with more than 3.2 million square meters. The fundamental business of Akademiska Hus is renting their properties to instructive and inquires about establishments. With a 64% of the piece of the share is the primary supplier of buildings to schools and colleges. Instructing and research center premises are the biggest extent of floor space with 82% of the overall surface [10]. The ordered M-building was constructed to be one of the main configurations buildings at Lund University for six surface partitions as an educational structure. However, the study in this paper is established by energy consumption scenario for energy calculations and managing made on the Swedish code for planning and scheduling system. The objective of this case study is to investigate and examine the energy consumption analysis for conventional type of buildings, also to find its overall use of energy by the main construction sectors and climate changes in the environment of Stockholm, Sweden.

Table 2. Building features.

M-building by Akademiska Hus	
Construction features	Piles heaps for foundation, reinforced concrete plus factory-made components and covering the façade with plastic
Design of roof	Traditional and old style rooftop design by spending concrete and steel bars supports for the reinforcement
Design of windows	Single glass openings by huge standard glassy with 15 W/m2K of warmth loss
Ventilation classification	Powered aeration system and poor interior air class
Heating classification	Partially heating with great number of heaters in classrooms
Cooling classification	Quarter and partially cooling arrangement

According to the latest energy consumption investigations, M-building consumes power for around 135 kWh/m^2 for heating purpose, 32 kWh/m^2 for cooling and 115 kWh/m^2 for operation power and electricity. The study of this building life cycle is moreover applied in the simulation to resolve the constructions ordinary and financial process during the entire period of its life observed by LCA studies [11]. However, the vitality and water supply consumption at this building were found as 650 MSEK (Million Swedish Kroner) in 2010, where this number was just 69% of the overall working expense of the organization operations. This is a normal of 203 SEK (Swedish Krona)/m^2 every year. For a better understanding, Figure 2 demonstrates the circulation for every last utilize in M-building. The primary piece of the energy charges is observed because of poor power deployment, which of about 390 MSEK with warming expenses was 217 MSEK while cooling costs were 20 MSEK [10].

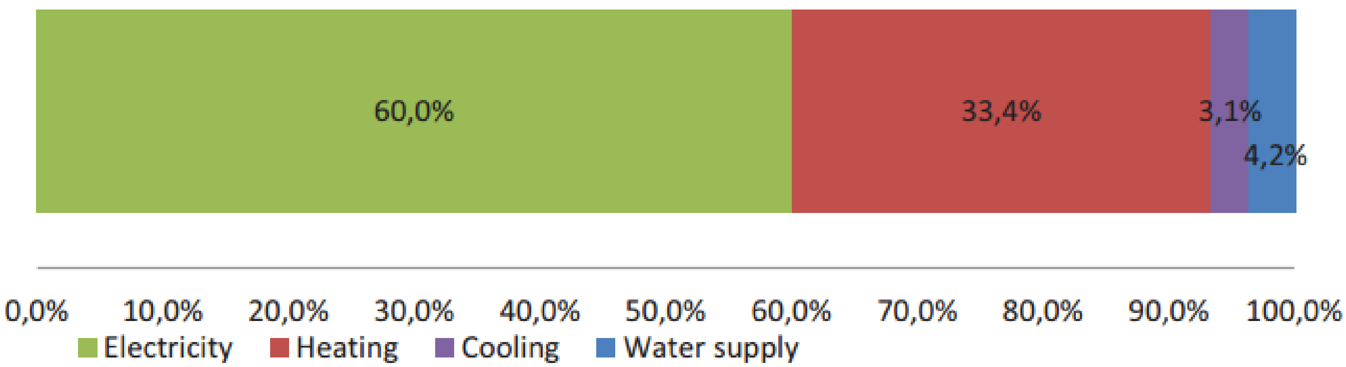

Figure 2: Active cost and water source cost supply. Source AH, 2010b

This consideration permits a huge understating for evaluation between sustainable building and conventional/normal building in Swedish environment. In the default outline, vitality operation and worked control is figured as the aftereffect of the activity stages and a yearly power induce (control work use per the unit development activity). Conversely, the general activities here can be portrayed similarly by the aftereffects of the individual activities landed close to a whole branch of the request tree, where it could observe huge changes between these conventional buildings and other green buildings through its economic evaluations in industry [13].

IV. LEAP as Simulation Tool

The energy consumption scenario in this study is applied in a self- steady action of the power outline force in a LEAP simulation tool to develop and analysis energy in the case of conventional building. Using LEAP as an instrument will extend the approach agents which additionally can make and evaluate elective circumstances by taking a gander at their energy essential factors, their social costs plus points of interest and their environmental effects [12]. The software here is considered as an effective simulation tool examines all energy stages and detailed calculations refer to Long Range Energy Alternatives Planning (LEAP) for the energy strategy study for Swedish buildings. However, the energy consumption scenario for the case study of M-building will be analyzed by three effective situations (Baseline, Mitigation and applied Energy Consumption), where these situations will distinguish all building changes and discover all energy request and demand for future via current operations. Furthermore, the model here with its three advanced situations is sufficient to gauge and measure the vitality operation by a correlation examination in Sweden. In any case, the reenactment will make a critical impact while running the examination in LEAP by various methodologies and procedures for feasible improvements.

There are two essential assortments add to this simulation system that and actualized in this investigation: the first was in the examination of overall energy request of contextual investigations while the second will decide about energy powers at the device level and how could be possible as the measure of fuel worked per unit of activity under the IPCC fifth assessment (AR5, 2013, With Climate Feedbacks). Moreover, the simulation here was completed through calculating and estimating all the industrial, profitable and transportation difficulties in Sweden. IPCC fifth assessment in LEAP will show significant differences for better expressive the influence of conventional construction in energy requests and adjustments as shown in Figure 3. The analysis of energy consumption scenario in this research is shaped and applied to examine also the time setting designs through attracting electricity as a additional fuel for case study building at two floors levels.

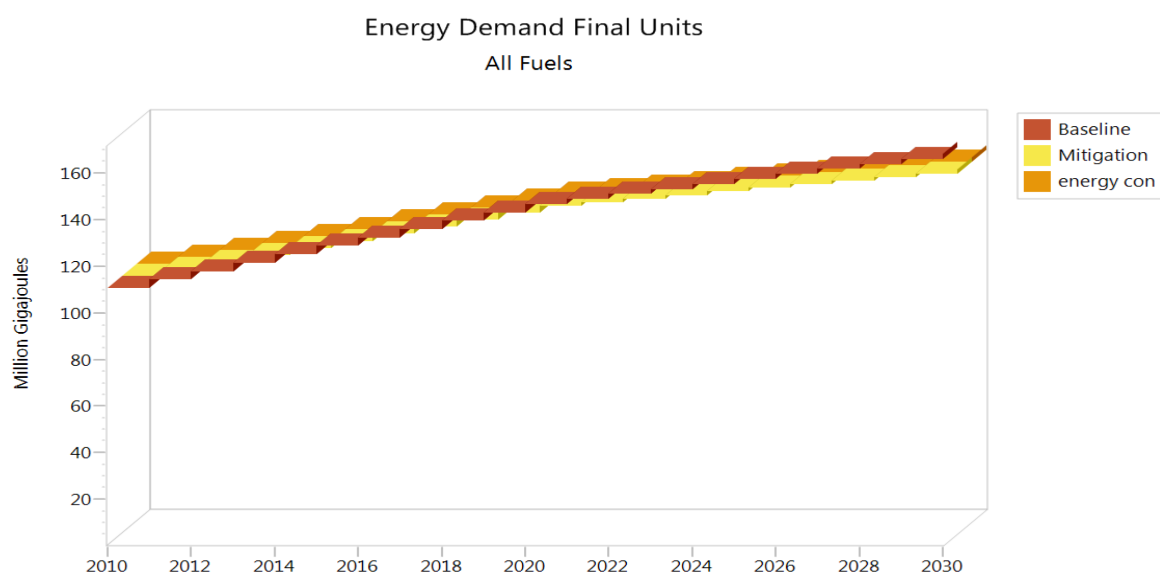

Figure 3. Energy request for final unit based on different situation.

At the main level, LEAP's worked in computations hold the majority of the outflows, costs and operational power estimations. At the second level, by entering information deliveries that are operated to distinguish time portion approximations and furthermore to produce a broad decent diversity of modern multi-variable, subsequently enabling econometric and reenactment strategies to be dug in classified the improvement traces in Sweden.

V. Conclusions & Recommendation

Energy operations and its consumption investigations turned into a critical region for the examination plans and for implementing diverse applications of the energy analysis in all types of buildings around the world for purpose of measuring and decreasing the energy use. Thus, arranging energy consumption study needs great reproduction abilities keeping in mind the end goal to comprehend and break down the building practices which will prompt outline enhanced and developed models for regeneration which reflect its distinctive implementations. This paper highlighted the main idea of energy consumption uses and the main studies for real case studies of conventional building (M-building) in Sweden under the view of LEAP software as a simulation tools for measuring energy consumption and replications. The study shows that by apply the three situations in the consumption scenario (Baseline, Mitigation and applied Energy Consumption); a time frame calculation will be clearly identified through its diverse key assumptions (demands, transportation and resources) and also to produce a wide range of logical adjustable analysis for these conventional buildings. Also, the simulation in this study has taken a place in the evaluation analysis process, LEAP which has found that the conventional buildings with a less or no efficient implementations could highly request more energy for heating and cooling between 60 Kwh/m^2 and 160 Kwh/m^2 yearly, while the Swedish sustainable buildings request less energy between 40 Kwh/m^2 and 100 Kwh/m^2 yearly. This simulation and evaluation was made in the average outdoor temperature for four different weather conditions (7.7 ℃, 4.8℃, 1.8℃ and -1.7℃) according to Stockholm Annual Weather Averages [14].

On the other hand, about 1.98% of overall clean energy in the conventional construction will be spent in different segments such as services segment and transportations with overall energy consumption equivalents to 263 kWh/m^2 which can be also used in the power generation segment. The study was built and arranged for energy utilization investigations which are accomplished through the use of LEAP as reproduction program instrument in bright of three distinct situations for concentrate the productivity in conventional structures. Moreover, the effected energy request of the conventional building(M-building) and its demand needs will be more smooth and further organized by these diverse planning and scheduling approaches that found in the energy consumption scenario with its three situations, which have also an excessive effect on industry of construction. Additionally, LEAP has found that M-building spends and consume more energy than other new buildings in the Swedish environment, about 127 kWh/m^2 in winter for warming and heating, 28 kWh/m^2 in hot temperature for cooling and about 108 kWh/m^2 in power generation of electricity used for operations.

Finally, this energy consumption study shows great changes in the calculations of energy for the M-building case study from the operation and applications forecasts. Therefore, this research can support and approve that the Swedish conventional buildings with their traditional applications in design and in the calculations of energy efficiency can be less attractive to use by comparing it with the sustainable and green buildings for modern EU development through considering latest plans for the construction buildings. Concluding that, the results of operations in conventional buildings will generate a smooth level for modifications in the traditional manufacturing industry and also will lead the architecture and construction designs towards sustainable/green developments for better energy demand and much safer/improved uses of energy.

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