ENERGY EFFICIENT RESIDENTIAL BUILDINGS ASSESSMENT USING BUILDING INFORMATION MODELING

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Dedicated specially

To my beloved Father and Mother
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ABSTRACT

Energy efficiency is using less energy to provide the same level of performance, comfort, and convenience. Energy Efficient Home is a building that utilizes minimum energy needed to heat and cool the interior of a building with the added feature of making this space healthy and comfortable for human occupation, which includes air quality, moisture conditions, and lighting. The ideal energy efficient home maintains the best environment for living while reducing the cost of energy. These buildings have a number of advantages such as improved comfort, reliability, energy security, and environmental sustainability, which are the consequences of independency of fossil fuel consumption and less release of CO2 emissions. This thesis analyzes a Low Energy underground cooling ventilation to providing thermal comfort in Malaysia. In the analysis of the case study several factors are considered, including: orientation, window location and size, glazing type, wall and roof insulation levels and efficiencies of cooling systems. First, the case study was modeled based on the current situation and data gathered and cooling load calculated. Next, the optimal design features determined for selected case study in Malaysia. The optimization results indicate that changing orientation and materials such as windows and walls are required energy efficiency measures to design high energy performance homes throughout climatic zones in Malaysia. In particular, it was shown that implementing these measures can cost-effectively reduce the annual energy use by 32% compared to the current design practices of home in Melaka.
ABSTRAK

# TABLE OF CONTENT

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE</td>
<td></td>
<td>i</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td></td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td></td>
<td>v</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td></td>
<td>vi</td>
</tr>
<tr>
<td>TABLE CONTENT</td>
<td></td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td></td>
<td>xi</td>
</tr>
</tbody>
</table>

## 1 INTRODUCTION

1.1 Introduction 1
1.2 Background 3
1.3 Problem Statement 4
1.4 Aim and Objectives 5
1.5 Scope of Study 6

## 2 LITERATURE REVIEW

2.1 Definitions 7
2.2 Climate 9
2.3 Site Analysis and Orientation 10
2.4 Room configuration 16
2.5 Building envelope 17
2.6 Space Planning 18
2.7 Ventilation 18
2.8 Heating, cooling, lighting and appliances 21
2.9 Insulation
  2.9.1 Types of Insulation
  2.9.2 Insulation R-values
  2.9.3 Where to Insulate
2.10 Photovoltaic Systems
2.11 Solar Water Heating
2.12 Local Basic Information about Malaysia
  2.12.1 Average Household Size in Malaysia
  2.12.2 Energy Consumption in Malaysia
2.13 Simulation and Analyzing Softwares
  2.13.1 AutoCAD
  2.13.2 Revit Architecture
  2.13.3 Ecotect

3 RESEARCH METHODOLOGY
  3.1 Introduction
  3.2 Research Methodology
    3.2.1 Scope of Study
    3.2.2 Literature Review
    3.2.3 Data Collection
  3.3 Summary

4 CASE STUDY
  4.1 Introduction
  4.2 Case Study Identifications
  4.3 Simulation
  4.4 Summary

5 ANALYSIS AND DISCUSSION
  5.1 Orientation
  5.2 Materials
  5.3 Optimization
  5.6 Summary
<table>
<thead>
<tr>
<th>6</th>
<th>CONCLUSION AND RECOMMENDATION</th>
<th>71</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Introduction</td>
<td>71</td>
</tr>
<tr>
<td>6.2</td>
<td>Conclusion</td>
<td>71</td>
</tr>
<tr>
<td>6.3</td>
<td>Recommendation</td>
<td>73</td>
</tr>
</tbody>
</table>

REFERENCES | 74 |

APPENDICES | 76 |
| A | PRESENTATION | 76 |
### LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Types of Insulation and its material and usage in different part of building</td>
<td>24</td>
</tr>
<tr>
<td>2.2</td>
<td>Characteristics of common insulation materials</td>
<td>30</td>
</tr>
<tr>
<td>2.3</td>
<td>Malaysia by State, 1980-2010</td>
<td>37</td>
</tr>
<tr>
<td>4.1</td>
<td>Electricity Generated by PV panels in CoolTek Home (KWH)</td>
<td>56</td>
</tr>
<tr>
<td>5.1</td>
<td>Materials Used to Construct CoolTek Home</td>
<td>65</td>
</tr>
<tr>
<td>5.2</td>
<td>Cooling Load for Current Orientation and Materials of CoolTek Home</td>
<td>66</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE NO.</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Sun Path Movement in summer and winter</td>
<td>15</td>
</tr>
<tr>
<td>2.2</td>
<td>Difference between Solar Orientation and Magnetic Orientation</td>
<td>16</td>
</tr>
<tr>
<td>2.3</td>
<td>CoolTek Home Ventilation Procedure</td>
<td>20</td>
</tr>
<tr>
<td>2.4</td>
<td>Typical heat gain in summer and winter for an un-insulated home</td>
<td>23</td>
</tr>
<tr>
<td>2.5</td>
<td>Trends of Electricity Energy Consumption in Malaysia</td>
<td>38</td>
</tr>
<tr>
<td>2.6</td>
<td>Home Electricity Consumption by CETDM, 2006</td>
<td>39</td>
</tr>
<tr>
<td>2.7</td>
<td>Office buildings electricity consumption by CETDM, 2006</td>
<td>39</td>
</tr>
<tr>
<td>3.1</td>
<td>Flow Chart of Research Methodology</td>
<td>45</td>
</tr>
<tr>
<td>4.1</td>
<td>North envelope of CoolTek Home</td>
<td>49</td>
</tr>
<tr>
<td>4.2</td>
<td>CoolTek home Room Configuration</td>
<td>50</td>
</tr>
<tr>
<td>4.3</td>
<td>Site plan of the case study</td>
<td>51</td>
</tr>
<tr>
<td>4.4</td>
<td>North envelope of CoolTek Home</td>
<td>51</td>
</tr>
<tr>
<td>4.5</td>
<td>South envelope of CoolTek Home</td>
<td>51</td>
</tr>
<tr>
<td>4.6</td>
<td>West envelope of CoolTek Home</td>
<td>52</td>
</tr>
<tr>
<td>4.7</td>
<td>East envelope of CoolTek Home</td>
<td>52</td>
</tr>
<tr>
<td>4.8</td>
<td>Roof, Concrete Blocks for Walls and Frame Fixed Double-Glazed Windows</td>
<td>53</td>
</tr>
<tr>
<td>4.9</td>
<td>Ground Cooling System Ventilation under Construction</td>
<td>54</td>
</tr>
<tr>
<td>4.10</td>
<td>Ground Cooling System Ventilation of CoolTek Home</td>
<td>54</td>
</tr>
<tr>
<td>4.11</td>
<td>Solar Chimney in Cooltek Home</td>
<td>55</td>
</tr>
<tr>
<td>4.12</td>
<td>Installation PV Panels for CoolTek Home</td>
<td>56</td>
</tr>
<tr>
<td>4.13</td>
<td>2D Modeling of CoolTek Home in AutoCAD</td>
<td>57</td>
</tr>
<tr>
<td>4.14</td>
<td>Render of 3D Model of CoolTek Home in Revit</td>
<td>58</td>
</tr>
<tr>
<td>4.15</td>
<td>Different Zones of CoolTek home in Revit Simulation Model</td>
<td>58</td>
</tr>
<tr>
<td>Section</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>4.16</td>
<td>Materials Specification and Location of Site for CoolTek Home</td>
<td>59</td>
</tr>
<tr>
<td>4.17</td>
<td>3D Model Imported in Ecotect</td>
<td>59</td>
</tr>
<tr>
<td>4.18</td>
<td>Zone Management and Comfort Temperature Range for CoolTek Home</td>
<td>61</td>
</tr>
<tr>
<td>4.19</td>
<td>Zones Hourly Operational Schedules in Ecotect</td>
<td>61</td>
</tr>
<tr>
<td>5.1</td>
<td>Cooltek Home Current Orientation</td>
<td>62</td>
</tr>
<tr>
<td>5.2</td>
<td>Different orientation for CoolTek Home analyzed through Ecotect</td>
<td>63</td>
</tr>
<tr>
<td>5.3</td>
<td>Ecotect’s Solar Access Analysis</td>
<td>64</td>
</tr>
<tr>
<td>5.4</td>
<td>Cooling Load Diagram for All Months of the Year</td>
<td>65</td>
</tr>
<tr>
<td>5.5</td>
<td>Different materials allocated for windows in Ecotect for CoolTek Home calculate cooling load</td>
<td>67</td>
</tr>
<tr>
<td>5.6</td>
<td>Different materials allocated for walls in Ecotect for CoolTek Home calculate cooling load</td>
<td>68</td>
</tr>
<tr>
<td>5.7</td>
<td>Exchange of energy between different zones of CoolTek Home</td>
<td>69</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

1.1 Introduction

During the past two decades, energy consumption growth has closely paralleled with population growth and it leads to continuous increase in energy prices and additional release of CO2 and greenhouse gas emissions particularly in the building sector (Biaou, Bernier, Yan, 2006). In addition to this growing demand for energy, consumers are demanding increasingly flexible, convenient, and clean energy forms. The focus of a sustainable energy future has been towards the energy demand sector. The building sector particularly consumes around 40% of total consumed energy (Deng et al., 2011). As a result, reduced consumption in this sector has the potential for high impact.

Energy efficiency is using less energy to provide the same level of performance, comfort, and convenience. In building section, it is defined as the minimum utilization of energy needed to heat and cool the interior of a building with the added feature of making this space healthy and comfortable for human occupation. Therefore, it is a building that uses less energy and is more comfortable and healthier than before. This includes air quality, moisture conditions, and lighting. The ideal energy-efficient home retains the best environment for living while minimizing the cost of energy. (Dennis Crook, 2006)
Energy efficient buildings provide a technically practicable method to reducing energy consumption in buildings. It is designed to deliver maximum comfort to occupants by making the most of free natural heating, cooling and lighting and utilizing efficient design principles and building materials to reduce the need for appliances and its design principles is becoming more practical to adopt due to the increasing costs of traditional fossil fuels and their negative impact on the planet's climate and ecological balance. An energy efficient home costs no more to build than a conventional home, but is more comfortable and easier to maintain and has reduced unnecessary energy consumption, greenhouse gas emissions and demands for non-renewable resources. They simultaneously provide healthier living conditions and offer homeowners significant money savings over conventional homes. Many factors can comprise residential energy efficiency, and both new and existing homes can be improved with energy efficient strategies and products.

In energy efficient homes, efficiency boosting technology reduces the building loads. With the lower energy demand, solar and other renewable technologies have the potential to meet most of a buildings energy needs. Energy efficient homes include the following design features:

- Climate-specific design
- Energy-efficient constructions and building products/materials
- Energy-efficient appliances and lighting
- Renewable energy technologies

The energy efficient home design principle is becoming more practical to adopt due to the increasing costs of traditional fossil fuels and their negative impact on the planet's climate and ecological balance. These buildings have a number of advantages:

- Improved comfort: An energy-efficient building envelope reduces temperature fluctuations
- Reliability: It can be designed to continue functioning even during blackouts
• Energy security: A building that produces energy protects its owner from fluctuations in energy prices
• Environmental sustainability: It saves energy and reduces pollution

1.2 Background of Study

Construction of energy efficient homes is an important lever for reducing energy consumption. By increasing cost of energy between years 1970 to 1980 in most of the world, engineers thought about constricting buildings with low energy consumption (Safa, Rahimi, 2012). The first symptom of interest to decrease the energy consumption dates back to before World War II and it began with research on solar heating system in Massachusetts Institute of Technology (MIT). (U.S. department of energy, 2003)

In the quest for a sustainable energy future, focus has been shifting towards the energy demand sector. One of the key demand contributors is energy use in buildings. The extended lifetime of buildings, ranging from 50 to 100 years, has a large impact on energy use patterns. Therefore, it is difficult to change building energy use patterns quickly. One method for minimizing building energy use is through the promotion of energy efficient buildings. (Kadam, 2001). An energy efficient building has the below strategies:

• Reduces domestic electricity consumption through energy efficient appliances and lighting;
• Reduces household water heating requirements through water efficient appliances;
• Reduces space heating and cooling energy using an energy efficient building envelope; and
• Uses appropriate site-based renewable energy systems to supply heat and electricity.
To construct such buildings and to reach the goals, on one hand, energy consumption of buildings should decrease; on the other hand, generation of renewable energies should be substituted with fossil energy consumption. Today, by decreasing the supply of fossil fuels, rising cost of energy and emerge of new technologies, it is a necessity to move from conventional buildings toward energy efficient buildings. In addition, because of the decreasing costs of solar systems of about 80% during two past decades, tendency to use these systems increased. According to statistics announced, in energy efficient buildings, consumption of energy compare to conventional buildings is so much lower and this amount in US is 75%, in UK 77% and in Ireland is 85%. (Safa, Rahimi, 2012)

The parameters that influence energy use in buildings are as follows: site analysis, home orientation, room configuration, building envelope, space planning, ventilation, insulation, heating, cooling, lighting and appliances, water heating, and waste management. The most important factors that have the most influence are orientation, ventilation, insulation and weather condition.

1.3 Problem Statement

Even though there are several studies that have been undertaken towards energy efficient buildings all around the world only few concepts are available for residential energy efficient buildings in Malaysia. More attention and research needs to be conducted to promote the usage of renewable energies in housing industry and come up with appropriate designed concepts for energy efficient homes based on conditions in Malaysia.

Energy is essential to our daily lives. It heats our homes, fuels our transport and supplies our electricity. At the moment, most of the energy we use comes from fossil fuels such as oil, gas, coal and peat. Unfortunately there is a limited supply of
fossil fuels in the world and we are using them up at a very fast rate. In addition, developing energy efficient homes can reduce independency to fossil fuels and release of CO2 emissions in countries similar to Malaysia that do not have a vast source of energy. Additionally, Malaysia is located near the equator which has enough sunny days and is capable of generating huge amounts of clean energy. Unfortunately, this advantage of region do not utilized proper and these capacities ignored somehow.

The other problem that constructing energy efficient homes face with is that very few architects and constructors have the necessary skills or experience to build them and it should be rectified by conducting more research and training more designers and engineers. Also, with government support, these projects can move forward towards the construction of energy efficient homes.

1.4 Aims and Objectives

Successfully meeting the goals, which is using less energy to provide the same level of performance, comfort, and convenience is the ultimate destination for energy efficient buildings. The main aim of the study is to analyze a successful energy efficient home (CoolTek Home) in the weather conditions of Malaysia in order to come up with the optimal principles for energy efficient homes in the country. The objectives of this study are as following:

- To identify and gather required data and information about CoolTek Home.
- To simulate CoolTek Home by using suitable software.
- To analyze the energy consumption of CoolTek Home.
1.5 **Scope of the Study**

The scope of this study is focused on the following:

- **Case Study**: The CoolTek Home is located in Tiara Melaka Golf & Country Club, Ayer Keroh. It has a typical site plan with area about 200 m², constructed by energy efficiency materials and using PV panels to generate a portion of energy required and also utilizing underground cooling ventilation to decrease the cooling load.

- **Software**: Revit and Ecotect are popular softwares for simulating buildings and analyzing energy from different aspects.
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