APPLICATIONS OF SIMULATION AND CAD TOOLS IN THE ISRAELI “GREEN BUILDING” STANDARD FOR ACHIEVING LOW ENERGY ARCHITECTURE

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ABSTRACT
Current environmental assessment methods commonly use a simple ‘point hunting’ approach. As a result, developers and design teams try to obtain “cheap and easy points”. Consequently, they avoid choosing “Energy points”. Additionally, “Energy points” are achieved mainly by improving the mechanical, electrical and hot water systems, since they are easier points to handle than designing low energy buildings, especially at the advanced design stages. This is in contrast with the fact that buildings are designed to last 50 to 100 years and the mechanical systems only 15 to 20 years, at most. The new Israeli Green Building Standard attempts to overcome the deficiencies presented above by dividing the energy chapter into two parts; Building energy performance and Building services systems and by trying to make the “Building performance points” easier to handle at the early design stages. The present paper puts an emphasis on the building performance subchapter as well as on the simulation and CAD models that are applied to ensure bioclimatic and low energy building design.

INTRODUCTION
Green Architecture has recently gained momentum to become the trendy fashion and mainstream architectural practice. Hence, one would expect bioclimatic, passive and low energy architecture to expand with the Green Architecture movement. However, it did not happen. The Israel Green Building Standard 5281 was first issued on November 2005 (SI 5281, 2005). As other current environmental assessment methods like Leadership in Energy and Environmental Design (LEED, 2009), or BRE Environmental Assessment Method (BREAM, 2008), the Israeli Green Building Standard uses the ‘point hunting’ approach. According to the number of points achieved, the building is labelled as a “Green Building” (55-75 points) or “Outstanding Green Building” (75-100 points).

Only very few “Green Labelled buildings” were built in Israel or submitted to obtained certification based on the first version of SI 5281, or on LEED. I would like to present the Intel Building, the first building in Israel that achieved “LEED Gold” according to LEED for New Construction V2.2, as well as obtained “Outstanding Green Building” according to SI 5281 2005 (Figure 1).

Examining the green points obtained by the Intel building according to LEED, one finds that only five points out of the 17 points available in LEED V2.2 were granted to Energy Efficiency. Moreover, only 2 points (the minimum compulsory by LEED v2.2) were devoted to Optimize Energy Performance. Nevertheless, the building achieved “LEED GOLD” (Figure 2).

WHAT IS FAULTY WITH CURRENT ASSESSMENT TOOLS?
The Intel building example only emphasises the conclusions derived from examining LEED Green Labelled buildings in the USA (Shaviv, 2008), which are:

Figure 1 Intel Building: West and South elevations. The first” LEED GOLD Green Building” in Israel

Figure 2 Left: LEED v2.2 - total possible points, Right: Points achieved by the Intel Building to obtained LEED Gold Accreditation
1. Cheap and easy points: The current environmental assessment methods that use simple ‘point hunting’ approach encourage choosing “cheap and easy points”. In other words, to collect enough points in order to achieve the label of “Green Building”, the architect and the project manager, under the pressure of the developer, look for the “cheapest points”. Energy points are, in general, expensive ones. Hence, they are trying to avoid them.

2. No need to improve building energy performance: Energy efficiency, according to LEED, may be achieved only by improving the mechanical, electrical and hot water systems. There is no real need to improve the architectural design from bioclimatic, passive solar and low energy building design.

3. No need for Bioclimatic, Passive and Low Energy Buildings: The energy calculations in LEED for minimizing energy performance are based on appendix G of ASHRAE 90.1, which paradoxically cannot be implemented for buildings without mechanical systems. Therefore, if the building is an innovative Passive Solar and Bioclimatic one and doesn’t require any mechanical heating or cooling, it can’t be assessed and graded by ASHRAE and hence, fails to acquire any credit points for “minimizing energy performance” by LEED. In other words, the best architectural design is rejected! It may not even be recognized as “Green Building” as happened to the SF Federal Building designed by Architect Maine (Stamp, 2008) before it was re-evaluated.

4. Renewable energy and Passive solar systems: The use of renewable energy, like solar energy for hot water, PV, or even buying Green Power, is awarded twice by LEED: once, as it reduces the amount of the total purchased energy and again, as it contributes to the “On Site Renewable Energy” credit, or to the “Green Power” credit. However, Passive Solar Energy is not considered as “On Site Renewable Energy”. Consequently, there is no incentive in LEED for passive solar design.

In 2008 it was decided to periodically review the Israeli Green Building Standard at least once every five years, in order to adapt it to scientific and technological developments. This paper refers to the revision of this Green Building Standard, as was published on 11.7.2011.

The revision of the Green Building Standard includes eight parts, which are: Part 1: general requirements and parts 2 to 8: specific requirements for different building types including: Residential, office, education, hotels, healthcare, retail and public buildings. All types of buildings contain the same categories, but the sections and points allocated to each section and category are not always the same. In this paper all examples are brought from the SI 5281 Part 3: Requirements for Office Buildings (SI 5281-3). According to the number of points achieved, the building may be labelled as a green building on five “Green Grade” levels according to Table 1.

### Required points for rating “Green Grade” in each level

<table>
<thead>
<tr>
<th>Rating of Building</th>
<th>Total points</th>
</tr>
</thead>
<tbody>
<tr>
<td>“One star green building”</td>
<td>55 to 64</td>
</tr>
<tr>
<td>“Two stars green building”</td>
<td>65 to 74</td>
</tr>
<tr>
<td>“Three stars green building”</td>
<td>75 to 82</td>
</tr>
<tr>
<td>“Four stars green building”</td>
<td>83 to 89</td>
</tr>
<tr>
<td>“Five stars green building”</td>
<td>90 to 100</td>
</tr>
</tbody>
</table>

ENSURING LOW ENERGY BUILDINGS IN ‘POINT HUNTING’ TOOLS

The new revised Israeli Green Building standard uses the ‘point hunting’ approach as the former one. In order to avoid the above mentioned deficiencies, the author of this paper, who participated in the development of the revision of the Energy Chapter of the Israeli Green Building Standard, has put an emphasis on providing solutions to the four points presented above:

1. Cheap and easy points: To increase the attractiveness of the Energy points the “costly” sections should be more valuable. Hence, they should get a high score, as well as the entire Energy Category. The Energy Committee recommended that 45 points will be allocated to the Energy Chapter, while 20 points out of it are assigned to minimizing the energy performance of new buildings and 25 for retrofitting. However, the Environmental Weighting value (according to BREAM, 2008) of each category was determined by the “Office Expert Committee” and by the Technical committee. These bodies assigned only 37% of the total environmental weighting to Energy despite the recognition that energy is the most important factor in Israel. Thus, the value of each “Energy point” was modified accordingly and is only about 0.82.

In order to simplify the application of the energy sections, easy to use design tools and handy interface for CAD simulations were developed and introduced. These facilitate the architect, as well as the whole design team, at the early design stages, in designing an energy conscious building.

2. No need to improve building energy performance: To overcome this drawback, the Energy Chapter is divided into two subchapters: 1.1. Building energy performance and 1.2. Building services systems and a minimum awarded number of points from each subchapter is required, in order to reach a certain level of “Green Grade” (see Table 2). Moreover, the energy rating of the proposed building should reach a predefined minimum level, according to SI 5282 (SI 5282-2, 2011), which guarantees at least 28% “building energy performance” saving in new buildings and 20% in existing buildings, compared with the performance of a reference building.
Table 2

<table>
<thead>
<tr>
<th>Rating of Building</th>
<th>1.1 Building</th>
<th>1.2 Systems</th>
<th>At least Level According to SI 5282-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>One Star</td>
<td>8.5</td>
<td>6</td>
<td>C</td>
</tr>
<tr>
<td>Two Stars</td>
<td>11</td>
<td>8</td>
<td>B</td>
</tr>
<tr>
<td>Three Stars</td>
<td>13</td>
<td>10</td>
<td>A</td>
</tr>
<tr>
<td>Four Stars</td>
<td>15</td>
<td>12</td>
<td>A+</td>
</tr>
<tr>
<td>Five Stars</td>
<td>17</td>
<td>13</td>
<td>A+</td>
</tr>
</tbody>
</table>

3. No need for Bioclimatic, Passive and Low Energy Buildings: As the life expectancy of a building in Israel is about 50 to 100 years and that of the building services systems is only 15 to 20 years, the requirements for these two groups of the energy sub-categories should differ and we can’t treat them equally when assessing the energy consumption of the building. This is in contrast to Appendix G of ASHRAE. The Energy Consumption of the Building services systems, like the mechanical equipments, is under the control of an Israeli Standard that defines the minimum required efficiency (COP) for each system, while the energy consumption of the building is carried out according to the Israeli Standard SI 5282 “Energy rating of buildings” (SI 5282, 2011) that put an emphasis on the low energy building design, as will be explained in details in the next chapter.

4. Renewable energy and Passive solar systems: Solar systems, like solar water heating and PV, are not included in the subchapters “Building energy performance”, but under the subchapter “Building services systems”, as their life expectancy is much shorter than that of the building. On top of it, in Israel, solar systems for water heating are mandatory in residential buildings for over 30 years. For this reason, no points can be granted for it. Only in cases where it is not mandatory, solar water heating systems can be awarded points and then, according to the size and efficiency of the system. PV is not mandatory, but as it is highly subsidized by the government, consequently the decision was to consider it as a separate issue. Passive systems that are part of the building and not just added systems, are recognized as renewable energy systems and are awarded points under the building energy performance subchapter.

For each building type, the Energy Committee divided the points dedicated to Energy differently between the subchapters 1.1. Building energy performance and 1.2 Building services systems. Thus, the maximum available points for “Building performance” are 21 and for the “services systems” are 16. These numbers are not the same in all building types. For example, in residential buildings, the “Building performance” subchapter includes 29 points and the “services systems” subchapter has only 8 points (when the mechanical systems are not an integral part of the building). It also contains more sections than what exists in Office Buildings.

The author of this paper, who was in charge of the revision of the “building energy performance” subchapter, put an emphasis on the architectural aspects, i.e. implementation of bioclimatic and passive solar solutions as well as on minimizing the energy consumption of the building. The rest of the paper will be devoted to present this subchapter.

ENSURING LOW ENERGY BUILDING PERFORMANCE IN ‘POINT HUNTING’ TOOLS

The sections defined in the the subchapter “Building energy performance” for office buildings and the points allocated to them are:

- Bioclimatic Design – Passive heating and cooling (4pt)
- Bioclimatic Design – Sun and shade (7pt)
- Energy Efficiency according to SI 5282 (17pt for new buildings or 21pt for retrofitting and for improved Passive Buildings).

Bioclimatic Design - Passive heating and cooling

The intent of this section is to encourage energy efficient building design using passive heating and cooling techniques including natural ventilation. The first part of this section includes Bioclimatic analysis and the determination of design strategies that fit best the location of the project. The requirement is to present the climatic conditions; temperature and relative humidity on a Bioclimatic Chart, in order to understand the local climate and to determine the suitable passive and low energy strategies (Figure 3). The Bioclimatic analysis is a prerequisite, without awarding any points. It may be carried out manually, or by using computer programs like PASYS (Yezioro and Shaviv, 1996).

![Figure 3 Bioclimatic analysis using computer program PASYS](image-url)
The second part includes the physical application of passive systems for heating, cooling and ensuring natural ventilation in the building, according to the Bio-climatic design strategies that are appropriate for the building site. There is an emphasis on passive systems in which special effort was needed to bring the solar passive heating to spaces that cannot get direct sun, like Northern rooms, or lower rooms that are shaded by the surrounding, or when direct sun may cause too much brightness and glare. These include for example “Vented Wall” or “Sunspace” for space heating, or “Wind Chimney” and “Thermal Chimney” for cooling by natural ventilation. The vented wall or Sunspace, for example, may serve also as Thermal Chimney. Hence, they are considered as two systems (Figure 4).

The passive systems to be applied in the project and the building area served by each system should be documented and presented by schematic drawings. The points are determined according to the floor area of the building devoted to the primary functions that are served by the passive systems for heating or for cooling.

The contribution of the passive systems for heating and cooling to minimize the energy consumption of the building, as well as direct solar gain and cross ventilation are calculated by using computer simulation programs like EnergyPlus (EnergyPlus, 2011). However, to encourage the architect to design a passive building a prescription approach is presented in Appendix A of the SI 5281. This Appendix presents the passive systems as well as specifies the percentage of the required system area in relation to the floor area it serves (Figure 5). The user can also use CAD tools like PASYS (Yezioro and Shaviv) to learn at the early design stage about the best passive systems suitable for the specific project and their recommended size.

The prescription approach was developed by using the LCR method (Balcomb, 1983) that was derived after running many simulations. This method was adapted to the Israeli climate and building technology (Shaviv, 1995). Thus, the architect has a simple and easy to use design tool that allows him to know, at the early design stage, the required size of each passive system, according to the floor area it should serve.

<table>
<thead>
<tr>
<th>Climate Zone Single Glazing</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Climate Zone Double Glazing</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS6olL1</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>SS6olL2</td>
<td>16</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>SS6glm1</td>
<td>17</td>
<td>18</td>
<td>20</td>
<td>SS6glm2</td>
<td>15</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>SS6om1</td>
<td>17</td>
<td>19</td>
<td>20</td>
<td>SS6om2</td>
<td>16</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>SS6olL1</td>
<td>19</td>
<td>21</td>
<td>23</td>
<td>SS6olL2</td>
<td>18</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>SS6glm1</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>SS6glm2</td>
<td>16</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>SS6glL1</td>
<td>21</td>
<td>24</td>
<td>26</td>
<td>SS6glL2</td>
<td>18</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>SS6omL1</td>
<td>16</td>
<td>17</td>
<td>19</td>
<td>SS6omL2</td>
<td>15</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>SS6olL1</td>
<td>19</td>
<td>21</td>
<td>23</td>
<td>SS6olL2</td>
<td>18</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>SS6glm1</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>SS6glm2</td>
<td>16</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>SS6glL1</td>
<td>21</td>
<td>24</td>
<td>26</td>
<td>SS6glL2</td>
<td>18</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>SS6omL1</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>SS6omL2</td>
<td>14</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>SS6olL1</td>
<td>17</td>
<td>18</td>
<td>20</td>
<td>SS6olL2</td>
<td>16</td>
<td>17</td>
<td>18</td>
</tr>
</tbody>
</table>

Figure 4 Vented Sunspace for space heating which also serves as Wind Chimney or Thermal Chimney for cooling and natural ventilation (Shaviv, 1984)
From Appendix A of SI 5281

Figure 5 Up: Different Configurations of Sunspace Systems (Balcomb et al., 1983.)
Down: The required % of system area relative to the floor area it serves.
From Appendix A of SI 5281
Bioclimatic Design – Sun and shade

The building density in Israel is one of the highest in the world. The green code should ensure suitable environmental conditions to the surrounding buildings, sidewalks and open spaces, as well as the proposed project in regards to the sun and winds. (Winds analysis was first included in this chapter but was moved later to the chapter “Health and Wellbeing”). Therefore, the intent of this section is to maintain the solar rights of the proposed project and of the buildings and open areas in its close environment, and in addition to carefully shade the open spaces and sidewalks in summer, without depriving winter insolation.

Analyzing the shadow cast by the surrounding buildings and objects and the shadow cast by the proposed building on its close environment is a prerequisite, which does not carry any bonus points. This analysis can be carried out manually, according to a prescription/description approach (Capeluto et al., 2005) or by using computer aided design programs like SHADING (Yezioro and Shaviv, 1994) or SUSTARC (Capeluto and Shaviv, 1999) (Figures 6-8).

Points are awarded according to the achieved predefined amount of solar exposure of the proposed project and the nearby environment including: (a) the solar systems (PV and water heating solar collectors), (b) the building elevations, and (c) the open spaces of the proposed designed project. Moreover, the building should comply with the requirements of keeping the solar rights of the neighbouring buildings and open spaces (Appendix B of SI 5281, 2011). The last requirement is mandatory for buildings taller than 90m or taller and longer than 45m.

An additional point is awarded when 20% of the main open area of the project is designed for achieving summer shading, while keeping the winter required insolation. This may be achieved by fixed shading devices or evergreen trees, in areas that are anyhow shaded during winter by the surrounding buildings, or by dynamic shading devices, including deciduous trees, in areas that are not shaded during winter by building masses. These areas can be also shaded by a fixed shading, like horizontal shading devices, that protects the open space from the summer high sun, but allows the winter low sun to reach this area.

![Figure 6: Solar rights design - the performance approach: Requirements for exposed hours](image)

![Figure 7: Solar rights design using computer program SustArc. Up: Description approach. Down: performance approach](image)

![Figure 8: Solar rights design using computer program SustArc. Up: Description approach. Down: performance approach](image)
Energy Efficiency according to SI 5282-2

Achieving points for minimizing the energy required for heating, cooling and lighting, is based on the Israeli Standard SI 5282-2 for office buildings (SI 5282-2, 2011). This Standard offers prescription/description methods, as well as performance one, to evaluate the building energy consumption.

The energy performance method defines a reference building that complies with the mandatory Israeli Standard SI 1045 that prescribes the required insulation and shading of the building envelope (SI 1045, 2011). The energy rating includes 5 grades. The % of the required energy saving for achieving grades D and C is the same in all four climatic zones of Israel. However, to be awarded grades B, A or A+ the requirements for saving are different, as it was impossible to achieve 50% energy savings in the hot climatic zones. The hotter the climate is, the less saving could be achieved relative to the standard building practice today. Yet, energy rating of A+ provides a new building with 17 green points in all climatic zones and 21 for retrofitting, while energy rating of C in new buildings, or D for existing buildings, wins 5 points only in all climatic zones. Achieving the same level of energy efficiency in existing buildings is more difficult. Hence each energy rating grade gets a higher score in renovation (see table 3).

In order to improve the building energy performance according to the performance approach, one should run a heavy simulation models like EnergyPlus that requires high expertise to run it. Therefore, the tendency is to use such models only at the very advanced design stages, when it is almost impossible to change the geometry of the building or to perform other major changes. We know that a good energy conscious building design should start with correct decisions at the early design stages, like the building mass and orientation. Hence, it is important to be able to evaluate the building performance at the early design stages. To solve this problem, an easy to use interface was written as part of the SI 5282 standard. This interface includes the requirements of how to use the performance approach and how to define the reference building, which the interface builds automatically. It also creates automatically the building database required to run EnergyPlus. The interface is presented in (Yezioro et al., 2011).

### Table 3

Energy rating of buildings in SI 5282 and SI 5281

<table>
<thead>
<tr>
<th>Compliance Level in SI 5282-2</th>
<th>Energy Saving (%)</th>
<th>Credit points In SI 5281-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Building</td>
<td>Existing Building</td>
<td></td>
</tr>
<tr>
<td>A, D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level D</td>
<td>20%&lt;</td>
<td>-</td>
</tr>
<tr>
<td>Level C</td>
<td>28%&lt;</td>
<td>5</td>
</tr>
<tr>
<td>Level B</td>
<td>34%&lt; 36%&lt;</td>
<td>9</td>
</tr>
<tr>
<td>Level A</td>
<td>44%&lt; 40%&lt;</td>
<td>13</td>
</tr>
<tr>
<td>Level A+</td>
<td>46%&lt; 52%&lt;</td>
<td>17</td>
</tr>
</tbody>
</table>

Figure 9 "Energy Efficiency according to SI 5282-2 for Office Buildings: The Descriptive approach." The dark bar is a semi-optimal solution. The “Energy Grade” is defined on the sensitivity analysis. There are 48 graphs like this one, for 4 climatic zones, 8 orientations and 2 office depth: 5.00 & 8.20 m
Another simple way to start a good energy conscious building design is to follow the requirements of the prescriptive, or the descriptive approach (Figure 9), derived from summarizing the results obtained from running a large number of cases (Shaviv et al., 2005) using the simulation model ENERGY (Shaviv & Shaviv, 1978, Shaviv, 1999).

The Israeli standard SI 5282 emphasizes the building architecture and its details including: the building geometry, compactness and proportions, windows size and orientation, window shading and glazing type, envelope insulation and thermal mass, as well as night ventilation for passive cooling and comfort ventilation. The reference building in SI 5282 is defined with fixed geometry and depth that allows daylighting. For this reason, the geometry of the proposed building affects the results. The calculations of the energy consumption for heating, cooling and daylighting for a proposed building, as well as for the reference one, are performed according to the electricity consumption of the same predefined air-condition unit, even if the proposed building will not have any mechanical systems. Thus, only the building energy performance is considered under SI 5282. This is in contrast to ASHRAE 90.1 (ASHRAE, 2007) that requires that the proposed building should have mechanical systems as written: “the provisions of this standard do not apply to: … buildings that do not use either electricity or fossil fuel”. Furthermore, there is a minimum requirement for the capacity of the HVAC systems: “provided that the enclosed spaces are: 1. heated by a heating system whose output capacity is greater than or equal to 3.4 Btu/h·ft² or 2. Cooled by a cooling system whose sensible output capacity is greater than or equal to 5 Btu/h·ft².” As the emphasis in ASHRAE 90.1 is put on improving the mechanical systems, and not on the architectural design, the reference building in appendix G is defined according to the geometry of the proposed building, and thus the influence of the building’s geometry is eliminated.

CONCLUSIONS

This paper revealed the disturbing phenomena that exist in ‘point hunting “Green Buildings” assessment methods rating schemes, like LEED, and presented how they were solved in the Israeli new “green building” standard IS 5281. The disturbing phenomena discussed in the paper are:

1. Attempt to get only cheap and easy points. As “Energy points” are not cheap and easy ones, they are avoided.
2. Attempt to improve only the systems of the building and not the building itself, as this is easier and cheaper.
3. Optimizing the energy consumption of the building according to Appendix G of ASHRAE takes into consideration mainly the performance of the systems and not of the architectural design of the building. Hence, improving the geometry of the building is neglected.
4. Renewable energy systems are rewarded twice but passive solar systems are not considered renewable energy and are not awarded. The Israeli Green Building Standard is also a ‘point hunting’ one. Therefore, based on the above-mentioned observations, and in order to guarantee that Green Buildings will be designed as “Low Energy Buildings” the Energy Committee for the Israeli Green Building Standard used the following criteria:

   a. The Energy Chapter should get sufficiently more points than other green categories in order to increase the weight of energy saving.
   b. The Energy Chapter should be devided into two parts: “building performance” and “services systems” and a minimum required points from each subchapter should be obligatory in order to achieve each “Green Grade” level. This separation is also important because the building is designed to outlive the services systems by a large margin.
   c. Low energy building design requirements should be imposed for achieving a minimum required predefined Energy Rating of the building for each “Green Grade” level according to SI 5282-2.
   d. Bioclimatic analysis should be a prerequisite without awarded points for it.
   e. “Passive and Low Energy Building Design” should be awarded and treated separately from the hot water systems (that is mandatory in Israel) and from the mechanical systems (AC and others, like elevators). However, it is not sufficient to impose requirements in order to achieve “Low Energy Green Buildings”. One should remember that the “Green Building” standard is a voluntary one; hence, we should make it easy to use. Therefore, all the sections in the ‘Building Performance” subchapter include (on top of a performance approach that required expert professional stuff to run the heavy simulation models) prescription or description methods, which were derived by running many simulations in advance. It also refers to simple CAD tools that can be used in the early design stages. Even the heavy energy simulation model EnergyPlus may be run by using a simple CAD tool EnergyUI, as a user interface.

REFERENCES


LEED, 2009 for New Construction & Major Renovations.