A la comunidad de software libre

Agradecimientos

Definitivamente este documento no hubiera sido posible sin Raúl Rechtman (mi asesor durante mi maestría y doctorado, y ahora un gran amigo) quién me puso tres reglas al iniciar a trabajar con él: Programar en C, escribir en LaTeXy graficar en Gnuplots.

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Resumen

En este documento encontraras los mejores consejos para que escribas tu tesis en LaTeXsin morir en el intento, sufrir es inevitable, pero la gloria de una tesis linda te espera del otro lado del camino. Este documento es el resultado de más de 20 años de uso y revisión de documentos.

Abstract

In this document i will try to give you my best advices for writting your thesis in LaTeX.

Capítulo 1

Introducción

1.1. General objective

To implement a methodology to evaluate if a building is zero energy for buildings in the design process or in buildings already built at CU-UNAM.

1.2. Specific objectives

- To provide a literature review about the concept of NZEB (Net-Zero Energy Building).
- To develop a model of a building in the design process at CU-UNAM to assess the meeting of the NZEB definitions.
- To develop a model of a building already built at CU-UNAM to assess the meeting of the NZEB definitions.
- To Implement the PMV and ePMV within the methodology.
- To propose and evaluate strategies for passive design, energy efficiency and renewable generation that allow meeting the NZEB definitions.
- To obtain a guide that can be taken as a reference in future building construction projects at CU-UNAM so that they can achieve NZEB status.

1.3. Energy Buildings: A Critical Look at the Definition

The aim of this document is to explore the concept of zero energy: what it means and why a clear and measurable definition is needed. This document defines a net zero-energy building (ZEB) as a construction with greatly reduced energy needs through efficiency gains such that the balance of the energy needs can be supplied by renewable technologies. A ZEB typically uses traditional energy sources such as the electric and natural gas utilities when on-site generation does not meet the loads. When the on-site generation is greater than the building's loads, excess electricity is exported to the utility grid. By using the grid to account for the energy balance, excess production can offset later energy use. Achieving a ZEB without the grid would be very difficult, as the current generation of storage technologies is limited. A zero energy building can be defined in several ways, depending on the boundary and the metric. Different definitions may be appropriate, depending on the project goals and the values of the design team and building owner. For example, building owners typically care about energy costs. Organizations such as DOE are concerned with national energy numbers, and are typically interested in primary or source energy. A building designer may be interested in site energy use for energy code requirements. Finally, those who are concerned about pollution from power plants and the burning of fossil fuels may be interested in reducing emissions. Four commonly used definitions are: net zero site energy, net zero source energy, net zero energy costs, and net zero energy emissions. A Net Zero Site Energy produces at least as much energy as it uses in a year, when accounted for at the site. A Net Zero Source Energy produces at least as much energy as it uses in a year, when accounted for at the source. Source energy refers to the primary energy used to generate and deliver the energy to the site. To calculate a building's total source energy, imported and exported energy is multiplied by the appropriate site-to-source conversion multipliers. In the Net Zero Energy Costs, the amount of money the utility pays the building owner for the energy the building exports to the grid is at least equal to the amount the owner pays the utility for the energy services and energy used over the year. Net Zero Energy Emissions produces at least as much emissions-free renewable energy as it uses from emissions-producing energy sources. The zero energy definition affects how buildings are designed to achieve the goal. It can emphasize energy efficiency, supply-side strategies, purchased energy sources, utility rate structures, or whether fuel-switching and conversion accounting can help meet the goal.

1.4. Extension of the PMV model to non-air-conditioned buildings in warm climates

The PMV model agrees well with high-quality field studies in buildings with HVAC systems, situated in cold, temperate and warm climates, studied during both summer and winter. In non-air-conditioned buildings in warm climates, occupants may sense the warmth as being less severe than the PMV predicts. The main factor that explains this phenomenon is the expectations of the occupants, which are people who have been living in hot environments. They are likely to judge a warm environment as less unacceptable than people who are used to air conditioning. This can be expressed by an expectation factor, *e*. This factor varies between 0.5 and 1, the latter being the appropriate value for buildings with air conditioning. For buildings without air conditioning, it is assumed that the expectation factor depends on the duration of warm weather during the year and whether there are other buildings in the region with air conditioning. Thus, if the weather is hot all year or most of the year and there are few or no other buildings with air conditioning, *e* may be 0.5, whereas it may be 0.7 if there are many other buildings with air-conditioning. A second factor contributing to this difference is the estimated activity. In many office field studies, metabolic rate is estimated with a questionnaire that identifies the percentage of time the person was sitting, standing, or walking. This approach fails to acknowledge the fact that people, when they feel hot, unconsciously tend to slow down their activity. They adapt to the hot environment by slowing down their metabolic rate. The lower rate in hot environments should be recognized by inserting a reduced metabolic rate when calculating PMV. Subsequent studies were conducted in various offices, where the recorded metabolic rates were reduced by 6.7 % for each PMV scale unit above neutrality. In conclusion, to calculate de ePMV the metabolic rate is reduced by 6.7 % for each PMV scale unit. With this reduced metabolic rate, PMV is recalculated. Finally, the PMV obtained is multiplied by the appropriate *e*. The extended PMV model agrees well with quality field studies in non-air-conditioned buildings of three continents.

1.5. Lessons Learned from Case Studies of Six High-Performance Building

The goal of this report is to combine and highlight the primary lessons learned from the case studies to help inform and direct future design studies and implementations to work towards ZEBs. NREL studied six buildings to understand the issues related to the design, construction, operation, and evaluation of the current generation of low energy commercial buildings. Each case study developed a list of lessons learned and recommendations relevant to that unique building These buildings and the lessons learned from them help inform a set of best practices, beneficial design elements, technologies, and techniques that should be encouraged in future buildings, as well as pitfalls to be avoided. The document captured a set of best practices that result from the lessons learned from these six buildings. Best practices are proven real-world technologies and processes that lead to high-performance buildings. The list is the result of the experience with the six case study buildings.

1.6. Criteria of sustainable construction - UNAM

This document consists in a guide that establishes technical, preventive, corrective and safety measures in the construction and remodeling of university buildings, with the aim of minimizing the negative effects that impact the environment, taking advantage of natural resources and elements in a sustainable manner. The objective of this document is to provide the UNAM dependencies with guidelines for proper management in the use, exploitation and saving of water and electricity from the project and during the construction and operation of the buildings.

Important elements to consider: This document contains important information about the buildings at CU-UNAM, such as lighting levels, dimensions of sanitary and education spaces, characteristics of the envelope and the standards involved.

1.7. Net-Zero Energy Buildings: the influence of definition on greenhouse gas emissions

This study compares the effectiveness of the four NZEB definitions to reduce operational emissions of a building. A simple geometry located in two different cities, that is, Toronto and Miami, with four different energy behaviors, which are simulated in OpenStudio, is used. It was found that, for both locations, the use of a NZEC balance leads to lower emissions, a reduction of 102-145 % for Toronto and 99-117 % for Miami. The NZEE definition, contrary to its designation, is the least effective in reducing GHG emissions, at 86 % for Toronto and 89-94 % for Miami.

Important elements to consider: The article shows the most important equations to develop each of the definitions.

1.8. A review of net zero energy buildings in hot and humid climates: Experience learned from 34 case study buildings

This paper provides a comprehensive review of NZEBs and their current development in hot and humid regions. Through investigating 34 NZEB cases around the world, this study summarized NZEB key design strategies, technology choices and energy performance. The study found that passive design and technologies such as daylighting and natural ventilation are often adopted for NZEBs in hot and humid climates, together with other energy efficient and renewable energy technologies. The Xingye building case demonstrated that natural ventilation could reduce the building's cooling energy from 2.5 kWh/m2 to less than 0.5 kWh/m2 per month — an 80 % cooling energy reduction in the shoulder seasons compared with the summer season. With daylighting, the Xingye building demonstrated that monthly lighting energy intensity can be controlled less than 0.5 kWh/m2.

1.9. Ten questions about zero energy buildings: A state of the art review.

This document has the aim of identifying, developing and understanding the main characteristics of zero energy buildings. For this, a review of the state of the art of the topic is carried out, where 97 articles considered to be of greater relevance were selected, in the period from 2006 to 2020. The methodology consisted of an analysis of these texts based on ten questions formulated to address the topic. The questions refer to definitions (P1), sustainability (P2), technologies involved (P3), emissions (P5), energy (P4) (P6) (P7), regulations (P8), climate change (P9) and future projections (P10). The work allows us to conclude that the ZEBs are integrated in a holistic way in the transformation towards a renewable and sustainable future in terms of energy solutions and have the potential to be implemented in different geographical and climatic positions.

Important elements to consider: Consumption for heating and cooling is usually the highest in buildings, so the reviewed literature proposes achieving savings in ZEB, between $\%25$ and $\%50$, respectively, limiting both at 30 $\frac{kWh}{m^2 * year}$.

1.10. A Guide to Zero Energy and Zero Energy Ready K–12 Schools

This document describes the steps to create a ZE school. These steps serve as a guide to ensure that a school achieves its ZE design goal and maintains its ZE status after it is occupied and operational. The topics covered in the steps are: Assessment of the needs of a building, integration of zero energy goals in the design, management of goals in the design and operation phases, performance evaluation, etc. Each step also includes an experience about the step. These brief anecdotes were provided by the participating school districts and offer a brief synopsis of the district's experience with that step.

1.11. Analysis of the environmental, energy and economic effects between a sustainable construction model and a conventional one in Querétaro

The document focuses on performing an analysis of the environmental, energy and economic effects resulting from the construction of buildings using a sustainability model compared to a conventional model, in order to obtain a cost indicator when using a sustainable construction model to a house and see if it is possible that it is not more than 15 % against using a traditional construction model. 3 traditional housing models and 3 sustainable housing models were proposed to make comparisons between them. The energy and thermal simulation of all the cases was carried out in EnergyPlus. Comparing the best-equipped sustainable housing model with the worst-equipped traditional housing model, the percentage increase in cost was 14.75$

Important elements to consider: Site-to-Source conversion factors, CO2 emission factors, Occupancy schedules and residential loads and take into account inflation and NPV in the calculation of savings.

1.12. Methodology for the validation of thermal simulations of a real building

This document shows a methodology to validate thermal simulations of a real building. Comparison metrics and tolerance ranges, both obtained from the literature, are also included. An IER building is used as a case study. Two cases are proposed, a base case where sun protection is used and another one where it is not used. The results include graphs for qualitative comparison of the measurement and the two simulated cases. A quantitative comparison was made using the most common metrics described in the literature review. In both comparisons, the result obtained for case 2 is better than for case 1, this suggests that the solar protections of the building are absorbing heat, due to the red color, and are transmitting heat by conduction and radiation to the interior of the building.

Important elements to consider: It is likely that for the ZEB thesis data will need to be collected from the building of interest, for which a correct validation will need to be carried out. This thesis can be a good guide in case I don't remember very well what the methodology was like.

1.13. Thermal comfort studies

The aim of this document is to explore the evaluation of thermal comfort that the use of passive strategies and low energy consumption provides to occupants in naturally ventilated buildings. In this work, a methodology is proposed for the validation of thermal simulations, whose results show that the building model obtained with the calibration process is applicable to different times of the year, occupancy and ventilation conditions, as well as obtaining accurate results of the thermal comfort assessment using night ventilation strategies and change in the absorptivity of the envelope. The thesis also proposes a methodology for the evaluation of thermal, acoustic and light comfort in the design stage of the new IER building, for which it is proposed to use the extended predicted mean vote method.

Important elements to consider: The validation methodology of the bachelor thesis is used. The document contains important information about the PMVe.

Capítulo 2

Escritura

2.1. Introducción

En este capítulo explicaremos cada parte del estilo usado para esta plantilla en la sección 2.2, como escribir secciones, subsecciones, referencias a capítulos o secciones, citas con bibtex, ecuaciones, listas y tablas.

2.2. tesisIER.cls

En latex se define el tipo de documento al iniciar en

```
\documentclass[]{article}
```

y si te fijas, estamos usando un archivo tesisIER.cls que está basado en la book.cls.

2.3. Estructura de archivos

2.4. Secciones y subsecciones

Esta es una sección.

2.4.1. Esta es una subsección

A manera personal no recomiendo usar más allá de subsections.

Item	Cantidad [-]	Precio [mxn]
bolsa croquetas	1	999.99
jabon platos	1	9.99

Tabla 2.1: Esta es mi lista de super de hoy.

Sub sub sección

A partir de este nivel, Latex automáticamente deja de numerar y tampoco aparecerán en el índice.

2.5. Ecuaciones

Un estilo para escribir ecuaciones, es considerarlas como texto, entonces, la ecuación de aceleración es

$$a = \frac{dv}{dt}, \tag{2.1}$$

donde a es la aceleración $[m/s^2]$, v es la velocidad $[m/s]$ y t el tiempo $[s]$. Nota que no hay un renglón vacio entre la ecuación y la continuación del texto, de esa manera no aparecerá una sangría donde no la quieres.

En la Ec. 2.1 estamos presentando la definición de la aceleración, y te recominedo usar etiquetas agregando algo que te de referencia a lo que es, una tabla (table:palabra), ecuación (eq:palabra), figura (fig:palabra) donde la palabra describe la ecuación, de esa manera, cuando el programa que usas autocomplete y tengas una lista interminable, te será más fácil identificar la etiqueta adecuada.

2.6. Tablas

Las tablas pueden causar dolores de cabeza, especialmente cuando son muy largas, y un editor de LaTeX se agradece para crearlas. Una tabla sencilla es la mostrada en 2.1.

La clave para escribir tablas como la mostrada en 2.1 es que desde tu editor de texto la puedas ver estructurada, así será más fácil ver los errores. Como puedes ver, LaTeX tambiíen decide donde poner las tablas, te recomiendo no forzar nada. No olvides agregar un renglón para las unidades.

Si tienes una tabla muy larga como la Tabla 2.2 , donde se decidió rotar una página para insertarla y que se pueda usar esta página en modo apaisado. No te recomiendo achicar la tabla, habemos quienes sufrimos mucho con la letra chiquita. Para rotar la página se utiliza el paquete landscape y se pone en un ambiente lo que se desea poner en la página o páginas rotadas.

Item	Cantidad [-]	Precio [mxn]	Descripción
bolsa croquetas	1	999.99	Esta es una descripción muy larga para hacer una prueba de una tabla larga
jabon platos	1	9.99	Esta es una descripción muy larga para hacer una prueba de una tabla larga

Tabla 2.2: Esta es una lista muy larga de ejemplo en una página rotada.

Puede ser que tengan una tabla tan larga, Tabla 2.3 que requieras más de una página, para esos casos usa el ambiente longtable que lo proporciona el paquete con el mismo nombre.

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Tabla 2.3: Esta es mi lista de super de hoy.

2.7. Bibtex y yo

Lo ideal es que uses bibtex para administrar tus citas, te recomiendo que revises el archivo bibliografia.bib y uses un editor de LaTeXpara poder agregar campos bibliográficos con un simple botonazo. Para citar correctamente hay que usar la tilde pegada a la última palabra **?**. De esa manera, la cita y la última palabra forman un bloque y el paquete hyphenation no las separa de ser necesario, además da una separación muy linda visualmente. Recuerda que puedes citar muchos autores al mismo tiempo y bibtex los va acomodar **????**. Todos los anteriores hicieron trabajos sobre levitación acústica, por si te da curiosidad saber quienes son.

2.7.1. Diferentes formas de citar

[**?**] encontró que la vida es difícil.

2.7.2. Compilando con bibtex y más

Recuerda correr pdflatex y luego bibtex y luego otra vez dos veces pdflatex para que los cambios en tu bibliografía se vean reflejados. Esto es necesario porque en la primer compilación de pdflatex se crea el archivo bbl y luego se actualiza en la segunda compilación.

Si quieres comenzar un nuevo párrafo, solo debes dejar una línea y el párrafo nuevo se distingue por la sangría, no uses doble diagonal para poner un espacio extra, esa es una mala práctica.

Por cierto, si notas que los margenes están desiguales, es por qué esta tesis está configurada para imprimirse por los dos lados, cuando las tesis tenían que ser impresas a fuerza, eso lo puedes desactivar en el preambulo de main.tex, actualmente está

```
\documentclass[10pt,twoside]{tesisIER}
```

y lo puedes arreglar usando:

```
\documentclass[10pt,oneside]{tesisIER}
```

para que no se vea con los margenes desiguales. Es importante seleccionar el twoside si imprimes por los dos lados de la hoja.

2.8. Editores de LaTeX

2.8.1. TexMaker

2.8.2. Emacs

2.8.3. Vim

2.8.4. LaTeXy Python, la vida es bella

2.9. Conclusiones

Capítulo 3

Figuras

3.1. Tipos de figuras y sus editores

3.1.1. Configuración de ambiente y posicionamiento

En la Figura 3.1 se muestra una captura de la página web del IER-UNAM. La figura se incluyó con el siguiente código

```
\begin{figure}
\centering
\includegraphics[scale=0.2]{ier_homepage}
\caption{
Captura tomada de la página web del IER-UNAM.
\label{fig:IER}}
\end{figure}
```

Una práctica muy común que veo es que usan

```
\begin{figure}[!ht]
```

que le está diciendo a latex forzar a poner la figura en la misma página que el texto y en la parte superior de la página. Te recomiendo no usar esto y darle oportunidad a latex de acomodar las figuras de acuerdo a su criterio, además conforme tengas más texto, las figuras irán cambiando su lugar y se verá mejor.

Figura 3.1: Captura tomada de la página web del IER-UNAM.

3.1.2. Figuras en pdf

3.1.3. Figuras en png/jpg

3.1.4. Figuras en epslatex

3.1.5. Figuras con gnuplot

3.1.6. Figuras en tex

3.1.7. Recomendaciones generales

Apéndice A

Overleaf

A.1. Introducción