CU Example Dissertation Thesis

by

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The final copy of this thesis has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.

Last, First Middle (Ph.D., Architectural Engineering)

CU Example Dissertation Thesis

Thesis directed by Prof. Gregor Henze, Ph.D, P.E.

Abstract

What is the purpose of this document

Contents

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Acronyms

CVRMSE	coefficient of variation of the root mean square error
DES	district energy system
GEB	Grid-Interactive Efficient Building
MMF	Metamodeling Framework
NMBE	normalized mean bias error

Chapter 1

Introduction

Example document showing the features of this LaTeX class. Citations are similar to any other LaTeX document and require a bibtex format of the bibliography to be saved in the project directory.

1.1 Figures

Figures have to be saved in a `figures` as defined in the main `main-cu-example.tex` file. Figure 1.1 shows the breakdown of commercial building energy consumption in the United States [1].

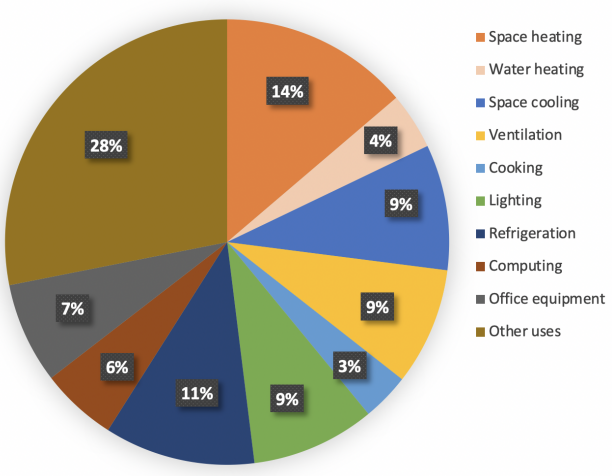

Figure 1.1: Commercial building energy use

If the figure has a citation in it, then make sure to use the "two level caption" so the citation does not appear in the table of contents. This can cause an issue when the references/citations are shown in the order of appearance. Note the use of square brackets as the first caption.

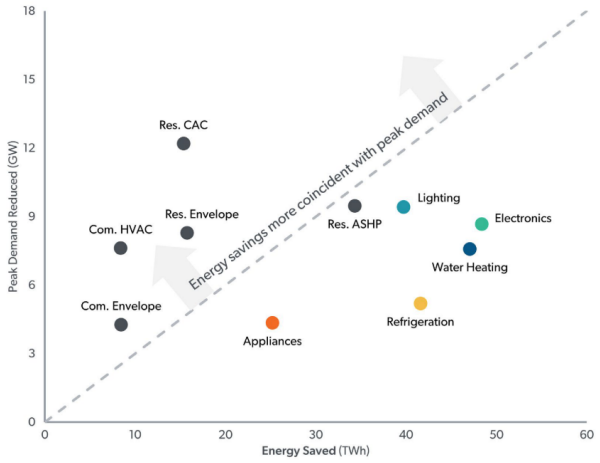

Figure 1.2: Peak demand reduction vs energy saved by building technology [2]

1.2 Tables

An example table with caption is shown in Table 1.1.

Table 1.1: Example table of objectives

Research Objective	Method of Achievement	Expected Outcome
Cell 1	Cell 2	Cell 2
Another cell	And another cell with some text wrapping if there is enough text needed for it to wrap based on the fixed width defined in the tabular definition	Last cell for this row

1.3 Equations

ASHRAE Guideline 14's [3] coefficient of variation of the root mean square error (CVRMSE) and normalized mean bias error (NMBE) calculations shown in Equations 1.1 and 1.2, respectively, as well as r^2 and various visual plots generated by the Metamodeling Framework (MMF).

$$CVRMSE = \frac{1}{\bar{y}}\sqrt{\frac{\sum (y_i - \hat{y}_i)^2}{n-1}} \tag{1.1}$$

where y_i is the actual data at timestep, i, $\hat{y}_i$ is the modeled (or estimate) of the data at timestep, i, $\bar{y}$ is the mean of the actual data, and n is the number of samples.

$$NMBE = \frac{\sum (y_i - \hat{y}_i)}{(n-1)\cdot \bar{y}} \tag{1.2}$$

where y_i is the actual data at timestep, i, $\hat{y}_i$ is the modeled (or estimate) of the data at timestep, i, $\bar{y}$ is the mean of the actual data, and n is the number of samples.

1.4 Acronyms

This document also demonstrates the use of a glossary to provide acronym definitions. The definitions are stores in the `acronyms.tex` file. For example, a district energy system (DES) will be fully defined the first time, then after DES will be an acronym. This is a nice feature because if text moves then LaTeX will handle when to spell out the acronym first. The glossary also allows for pluralization, for example Grid-Interactive Efficient Buildings (GEBs) will be defined as plural, but later uses can still be singular. A GEB is already defined. Lastly, if the acronym glossary contains more items than defined in the document, it will only show the ones that are used.

Note that this functionality is not visible in the PDF that is produced attached to the GitHub action. To run this functionality, your LaTeX environment needs to build the glossary first. In TexStudio this is done by adding `txs:///makeglossaries` to your build setting. On Overleaf, this works out of the box.

1.5 Lists and Enumerations

Example of nested enumeration and lists (also known as itemize in LaTeX speak).

(1) First item

- Example of just a bullet item
- Another item
- Last item!

(2) Second numbered item

(a) Keep the list going,

(b) With more items,

(c) But now I'm done.

1.6 Code Snippets

An example of code snippets is shown in Python Code 1.1 below. The code can be used to generate the updated Modelica source code in Code 1.2.

```
        mofile.rename_component_argument(
                "Buildings.ThermalZones.ReducedOrder.EquivalentAirTemperature.
                    VDI6007",
                "eqAirTempVDI",
                "hConvWallOut",
                "hConWallOut"
        )

        mofile.add_connect(
                'port_a', f'{thermal_zone_name}.intGainsConv',
                annotations=['Line(points={{0,100},{96,100},{96,20},{92,20}},
                    color={191,0,0})']
        )

        mofile.add_connect(
                f'{thermal_zone_name}.TAir', 'TAir',
                annotations=[
```

```
                    'Line(points={{93,32},{98,32},{98,48},{110,48}}, color
                        ={0,0,127})'
            ]
        )
```

Code 1.1: Python snippets of Modelica Builder commands

```
        Buildings.ThermalZones.ReducedOrder.EquivalentAirTemperature.VDI6007
            eqAirTempVDI(
                aExt=0.5,
                wfGro=0,
                hConWallOut=20.0,
                hRad=5.0,
                n=1,
                wfWall={1.0},
                wfWin={0},
                TGro=285.15) "Computes equivalent air temperature for roof"
                annotation (Placement(transformation(extent={{30,34},{50,54}})));

        // ...

        connect(personsConv.port, thermalZoneFourElements.intGainsConv)
                annotation (
                        Line(points={{68,-52},{96,-52},{96,20},{92,20}}, color
                            ={191,0,0}));

        connect(thermalZoneFourElements.TAir, TAir)
                annotation(
                        Line(points={{93,32},{98,32},{98,48},{110,48}}, color
                            ={0,0,127}));
```

Code 1.2: Updated Modelica code after Modelica Builder

Chapter 2

Literature Review

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Chapter 3

Methodology

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Chapter 4

Results and Discussion

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Chapter 5

Conclusions and Future Work

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Bibliography

[1] U.S. Energy Information Administration, "Monthly Energy Review," Tech. Rep. December, US DOE Energy Information Administration, 2020.

[2] A. Satchwell, M. A. Piette, A. Khandekar, J. Granderson, N. M. Frick, R. Hledik, A. Faruqui, L. Lam, S. Ross, J. Cohen, K. Wang, D. Urigwe, D. Delurey, M. Neukomm, and D. Nemtzow, "A National Roadmap for Grid-Interactive Efficient Buildings," tech. rep., Department of Energy Office of Energy Efficiency and Reneweable Energy's Building Technologies Office, Washington, DC, 2021.

[3] D. R. Landsberg, J. A. Shonder, K. A. Barker, J. S. Haberl, S. A. Judson, D. A. Jump, W. E. Koran, R. L. Hall, D. T. Reindl, J. R. Anderson, C. S. Barnaby, J. A. Clark, J. F. Dunlap, J. W. Earley, S. J. Emmerich, and P. T. Graef, "ASHRAE Guideline 14-2014: Measurement of Energy, Demand, and Water Savings," tech. rep., ASHRAE, Atlanta, GA, 2014.

Appendix A

Other Interesting Results

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