COMPLETION REPORT

ENERGY BENCHMARKING TOOL DEVELOPMENT

TAF NEW CONCEPT DEVELOPMENT PROGRAM

RWDI #1701187

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SUBMITTED TO

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EXECUTIVE SUMMARY

The following report summarizes the work-to-date on the energyCompass.design tool – an energy benchmarking and reporting tool for design-stage building development projects. EnergyCompass.design, or Compass for short, has recently completed a beta-testing period that engaged 16 users from 9 energy-focused architecture, engineering, and consulting firms. The tool will be further refined based on the response to this beta test, in anticipation of public launch in September, 2018.

Three specific outcomes of this project are of immediate benefit to the building industry:

1. A robust data extraction script that identifies the over 400 key building characteristics needed to complete the required submission forms for six existing programs and standards (LEED, HPNC, TGS, OBC SB-10, SBD, and 2030 Challenge), and correlates these characteristics to the location of each data point within the output files of three prominent energy modelling software (eQUEST, EnergyPlus, and IES-VE). While this extraction and form completion process could be done manually, the extraction script auto-populates all six program submission forms in seconds.

2. An end-user interface, online portal, and data storage architecture, which form an energy benchmarking tool that is freely and easily accessed by the entire design community in Ontario. By providing market-wide benchmarking analytics, Compass can enhance the quality of modelled energy performance, improve the energy literacy of the design and construction community, improve conservation program delivery, and ultimately reduce energy use and greenhouse gas emissions from every proposed building development in Ontario.

3. Three data visualization tools have been developed that allow Compass users to explore how their portfolio of work compares to the industry at large. The “Energy Breakdown” bar graph, “Bubble Chart,” and “Parallel Coordinates” visualizations each examine the data from different perspectives, allowing for a broad understanding of the data set, or targeted troubleshooting of specific projects.

1 INTRODUCTION

This report provides a completion report for the New Construction Energy Benchmarking Tool Development project: *GRANT #G-DEC 2016-1*. It is submitted to The Atmospheric Fund by the Ontario Association of Architects. For the technical development of the tool, the OAA has contracted RWDI engineers, one of the leading research engineering firms in Canada. This report has been prepared by RWDI.

1.1 Description of Project

In the current marketplace, regulations, voluntary standards and regulated incentive programs have been put in place to motivate newly constructed buildings to reduce their energy use and carbon footprint. Largely as a result of these programs, energy modelling has become a mainstream design exercise that is now completed on hundreds of projects annually in Ontario. To date, however, data contained within energy simulation files has not been leveraged either for broad analysis of performance trends or to benchmark like-buildings to improve energy performance.

Through the development of an Energy Benchmarking Tool, this project aims to automate the harvesting of information from completed energy models, and process the data in two ways to inform the building design industry in Ontario:

1. Completed program submission forms for six building standards and programs provided to the user; and
2. A data visualization platform available to the user to enable benchmarking of their building against the aggregated database of all harvested information.

The target market for the project is new construction design decision makers in Ontario including architects, engineers, builders, and municipal building authorities. The standardized program submission forms provided by the Tool will result in streamlined and consistent reporting, which will be of benefit to both the design community and the reporting agencies. The aggregated data set generated through this reporting will be a valuable benchmarking tool to inform the design processes through comparison of energy and emission characteristics to other projects and best practice targets. Further, it may be and a way for program administrators to track and analyze performance trends across all new buildings.

Three energy modelling applications have been identified as priorities for this project, based on their prevalence in the market: eQUEST, EnergyPlus, and Integrated Environmental Solutions – Virtual Environment (IES-VE).

2 PROJECT ACTIVITIES

2.1 Phase 1: TAF New Concept Development Program

The first phase of this project was funded by the TAF New Concept Development Program.

A concise and comprehensive summary of the reporting requirements for LEED, TGS, HPNC, OBC, SBD and 2030 Challenge was prepared in a single matrix – this matrix identified the building characteristics that would be extracted from each energy model. Having identified the program requirements and building characteristics for extraction, the next task involved locating each characteristic in the output files of all three selected energy modelling applications. Finally, using the output of these two tasks, the Energy Benchmarking Tool was developed using the Python programming language. The tool was developed and tested using multiple example modelling output files to which RWDI had access, for each modelling application.

Through this process, 300 building and energy characteristics were identified for extraction from each energy model, to enable completion of the submission forms for each standard/program. An additional 100 characteristics were selected for inclusion as useful metrics for the benchmarking process. These characteristics were selected based on RWDI's industry experience and the recommendation of the TAF staff.

Overall, the funding provided by TAF allowed RWDI to research the outputs generated by the energy modelling applications, the similarities and differences between these outputs, and how they can be utilized beyond the modelling process itself. The lessons learned during this initial phase of the project will be carried forward into the further development of the tool as part of the IESO funding that has been received.

2.2 Phase 2: IESO Conservation Fund

Parallel to the work described above, RWDI partnered with the OAA and the Toronto 2030 District to apply to the Independent Electricity Systems Operator (IESO) Conservation Fund. The IESO application proposed an expansion of the Energy Benchmarking Tool project to include a robust online user interface, beta-testing with industry partners from the design and regulatory sectors, and 2-years of user engagement to support the market launch of the tool.

The application was successful, and the project was awarded its full funding request. Building upon the foundational work that was accomplished during Phase 1, the next phase for the Energy Benchmarking Tool Development project – now known as energyCompass.design, or Compass for short – can be summarized as follows:

1. Completed the development of the tool, including finalizing the automated data extraction scripts and preliminary output reports, designing a user interface, and developing data security and stewardship protocols;
2. Initial industry engagement through internal alpha- and external beta-testing and tool technical refinement;

The beta test period, which ran from May 8 to June 15, 2018, engaged architecture, engineering, and consulting firms, targeting teams with a primary focus on energy modelling and consulting. In total, 16 individuals from 9 firms participated. Each firm was asked to upload a minimum of 3 projects to Compass, and to share their experience through the completion of a survey and/or exit interview. The beta test period exceeded participation expectations, seeing 65 energy models uploaded to the tool.

Based on feedback received, the tool's greatest strength is its ease of use and ability to automatically extract variables, in seconds, from complex files that could otherwise only be interpreted by highly skilled professionals. At the close of the beta test period, 100% of the participants who completed the feedback survey reported that they would continue to use the tool into the future. The survey also provided feedback direction for where to focus further development efforts in preparation of the public launch.

2.3 Next Steps

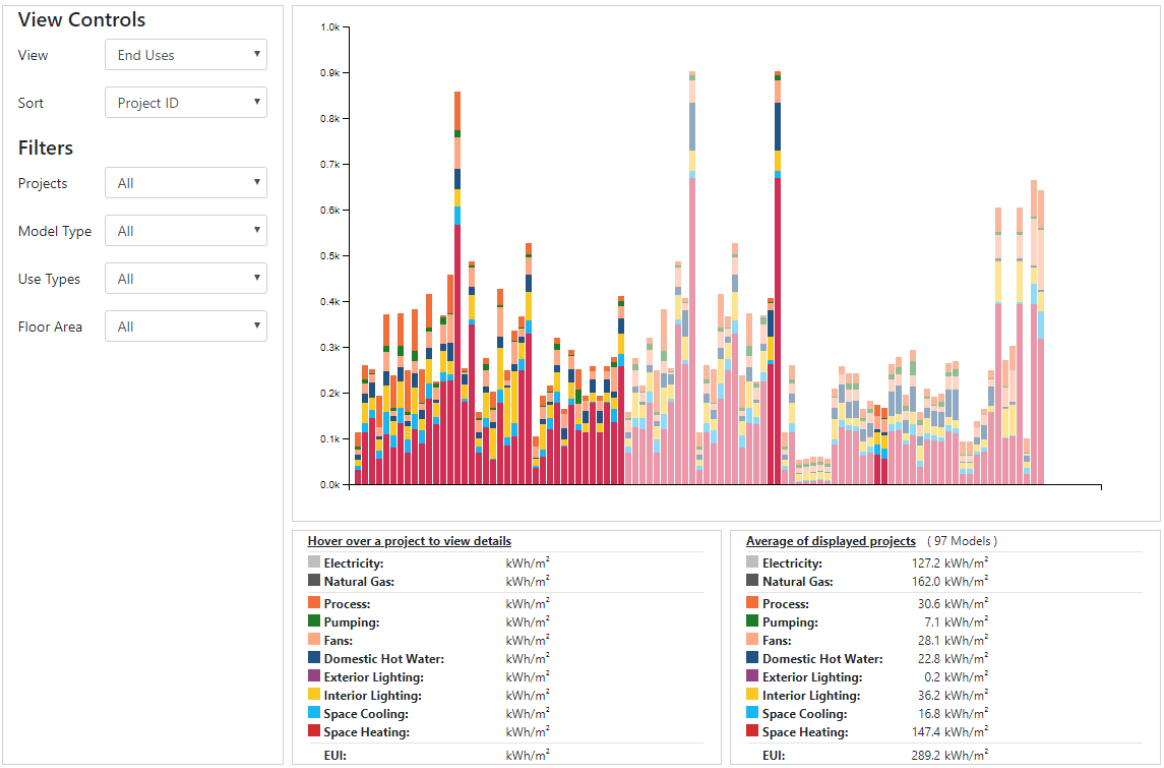
With the completion of the beta-test period, RWDI will continue to develop the Compass tool in preparation for the public launch in September, 2018. After launching, 24-month full rollout to industry will be undertaken, including province-wide education and engagement sessions. There will also be ongoing technical refinement and support for any updates to the standards/programs or software, in order to maintain the relevance of the Energy Benchmarking Tool for users.

3 SAMPLE TREND ANALYSIS

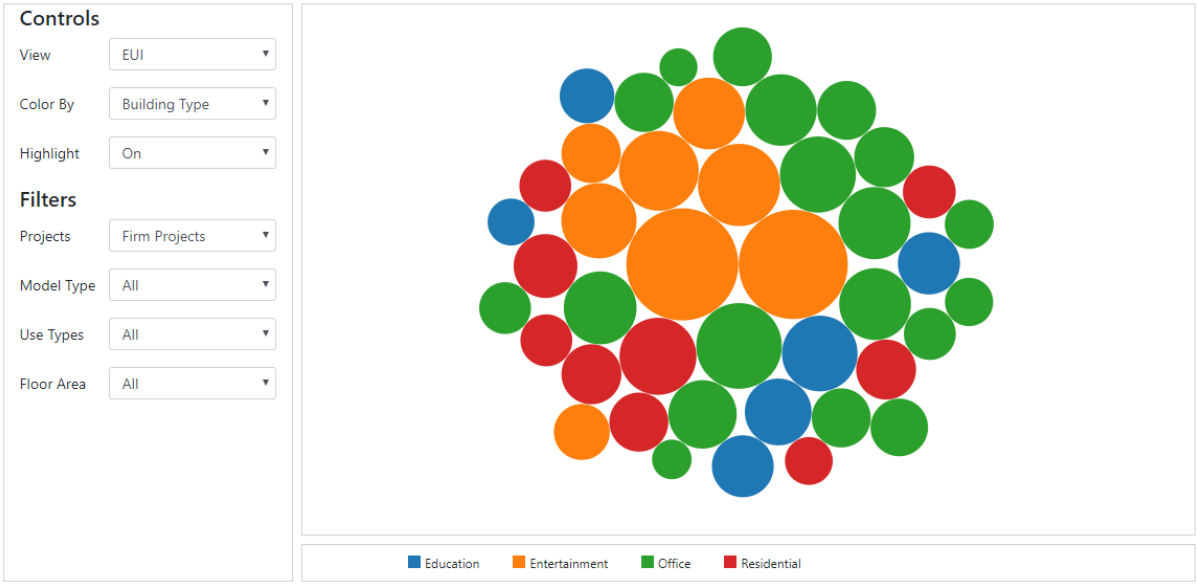
The first version of the Compass tool includes three visualizations: a "Energy Breakdown" bar graph, a "Bubble Chart" and a "Parallel Coordinates" plot. At this time, the data set is limited to those projects that have been uploaded during the alpha- and beta-testing periods. As such, conclusive trends and design recommendations are not yet possible. Nevertheless, this section of the report provides an example of how each of these visualizations could be used by the design and construction community to drive energy analysis and design conversations.

In the energy breakdown bar graph, a user can compare the energy use of projects within the Compass database. This simple yet powerful tool provides a useful high-level overview of a project's anticipated performance, and can be used for initial quality control reviews. For example, users can quickly query if the end-use profile of their project aligns with the general trend of a like-portfolio of projects, using the visualization filters. This can provide greater confidence of a predicted result's accuracy or, in cases where there is not alignment, a strong point of focus to begin troubleshooting.

The below output shows the models uploaded during the alpha and beta test periods. Projects that were uploaded by the user and other members of their firm, in this case RWDI, are shown using opaque colours, and the full details are displayed. Projects uploaded by others outside of the user's firm are given a transparent shading, and only limited information is displayed.



The second visual, a bubble chart, is best used to zoom out and identify high-level summaries and trends across a portfolio of data. Users can once again explore their firm's portfolio in isolation, or in the context of the larger Compass data set. For example, the screen capture of this visualization below shows RWDI's portfolio of projects in isolation: each bubble represents an individual project, the size indicates the relative energy use intensity (EUI), and the colour indicates the use type. The orange dots appear consistently larger, suggesting that achieving a low EUI for an entertainment use type is perhaps more challenging than for other sectors.



Perhaps the visualization with the most potential power as a design aid is the parallel coordinates plot. In this visualization, individual projects are each represented by a line running horizontally, and users can filter the data based on any of the variables included in vertical bars. In the image below, projects with an EUI of less than 200 kWh/m^2 have been highlighted. Users can then look at trends in a portfolio of projects that achieved this design objective, exploring what design characteristics may be most important. While this visualization provides great future potential, the current data set is too small to begin to draw conclusions about the trends that are beginning to emerge.