Modelling Houses for the Future in Canada

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Abstract

Over 25 years ago, Natural Resources Canada initiated a project to replace HOT2000. They argued that with new "modern" computers, that the monthly bin-method employed by the software was no longer justified given advances in CPU speed and disk storage. The bin-method introduces basic limitations such that it cannot effectively model passive solar effects, controls for HVAC systems, thermal comfort, indoor air quality, etc. Unfortunately, they failed to deliver a successor, and HOT2000 remains the tool being used for almost all part-9 energy modelling across Canada. This paper presents results of an industry survey showing a desire by different stakeholders to have a new software tool that includes features that could help provide better design guidance for both climate mitigation (net-zero carbon, embodied carbon, renewable energy) and adaptation (thermal comfort, indoor air quality, backup power).

Introduction

Over 25 years ago, Natural Resources Canada (NRCan) initiated a project to replace HOT2000 (Haltrecht, et al. 1999), the modelling tool used almost exclusively to model the energy consumption of all small residential buildings in Canada. They argued that with new "modern" computers, that the monthly bin-method employed by the software was no longer justified given advances in CPU speed and disk storage. The bin-method introduces basic limitations such that it cannot effectively model passive solar effects, controls for HVAC systems, thermal comfort, indoor air quality, etc. Given the wide range of stakeholders using HOT2000, the objective was to use an existing sophisticated energy simulation engine with a simplified user interface, for an integrated software NRCan called HOT3000.

The screening of potential modelling engines considered many tools but shortlisted three: EnergyPlus, ESP-r, and TRNSYS. ESP-r was selected for a number of reasons, including that the team felt there was low technical risk in its selection given it was a stable program that had been in use for approximately 20 years at the time. However, the NRCan HOT3000 software development team failed to deliver a stable software that would link the simple user interface with the sophisticated ESP-r simulation engine. HOT3000 was shelved and NRCan has since focused on updating HOT2000. Yet, at its core, it still relies on the same energy analysis using the monthly-bin method and its associated limitations remain. With energy efficiency requirements continuously getting stronger, and with the impending introduction of GHG related requirements, with both energy and carbon going toward net-zero requirements, there is a need to revisit what type of software will be needed to support these efforts. It is particularly more important given that codes are moving towards more performance-based requirements that rely on energy modelling software to assist with design and to assess code compliance.

Past Evaluations of Modelling Requirements

There have been many studies that have reviewed building energy modelling software in order to assess modelling requirements for high performance and net-zero energy/carbon buildings (Athientis, et al., 2010, Attia 2011, Gong, et al. 2020, Maile, et al, 2007, Moore & Feiler 2007, Rocky Mountain Institute 2011). Subtask B: Design Process Tools of the IEA SHC Task 40 - *Net-Zero Energy Solar Buildings* (NZEB) aimed to identify and refine design approaches and tools to support industry adoption of innovative demand/supply technologies for net-zero energy solar buildings (SHC Task 40). The work included documenting processes and tools currently being used, assessing gaps and needs, and then informing simulation engine and detailed design tool developers of priorities for NZEBs. Some of the work carried out in SHC Task 40 was summarized by Athienitis, et al. (2010), which included a list of recommended features:

- Guidance towards better designs
- Facility for batch runs with optimization
- Direct calculation of primary energy and emissions
- Design day output
- Better user interface with more examples
- Better contextual help for each feature
- Sensitivity analysis for each input
- Explanation of limitations of each model
- Include modelling parameters such as: thermal admittance, time constants
- Faster feedback prioritized over greater accuracy
- Offer method for managing multiple designs
- Better post-processing (e.g., export to Excel)
- Include electricity demands of different plug loads
- Flags for inappropriate inputs
- Cost data/input and financial analysis
- Rules of thumb built in to provide guidance
- Simplified to facilitate wider use

In 2011, the Rocky Mountain Institute held a building innovation summit with key stakeholders of the energy modelling community to identify key barriers and implement a collaborative plan to address them (Rocky Mountain Institute, 2011). They identified that there was a current lack of confidence of energy modelling results by various stakeholders due to:

Lack of Quality: Energy modelling results may not reflect realistic building energy consumption and costs.

Lack of Reproducibility: Different practitioners do not produce the same energy modelling results, even when using the same tools and building characterization data.

Misguided Expectations: Customers do not have a clear understanding of what modelling can and should provide.

Difficulty in Assessing Skills: It is difficult for customers to assess the skill level of a practitioner.

The summit found that in order to allow users to design and operate better buildings, simulation engines and platforms should include the following features:

- Transparency
- Ability to model complex systems
- Increased credibility through validation
- Multiple levels of models:
    - Schematic Design, Design Development, Operations, etc.
- Scalability to large systems/buildings
- Flexible and extensible:
    - To model new technologies (i.e. easy to model any building using current technology, but also has capability to add new features in the future)
    - To adapt tools to new use cases, such as use in operation, which need other features that only time-domain simulation of a whole building system can provide.

Another assessment of existing building tools to determine what was required to better support net-zero energy building modelling was conducted by Attia (2011). This assessment found that tools needed to:

- Focus on carbon beside energy
- Allow for the simulation of passive design strategies
- Perform minimum efficiency, base-cases and code compliance calculations
- Address comfort in tools more explicitly
- Allow for the design and optimization of on-site renewable energy potential
- Incorporate the simulation of innovative system design solutions and technologies

Of the list of features identified by Athienitis, et al. (2010), the Rocky Mountain Institute (2011), and Attia (2011), HOT2000 provides relatively fast feedback, is fairly easy to use, has undergone some validation, and evaluates base case designs for code compliance calculations. However, the majority of the desired features are not available in HOT2000.

User Feedback Survey

In order to get some feedback from Canadian users of HOT2000 in terms of what they thought should be included in a potential next-generation tool, a survey was sent out to the broad user group including: energy advisors/modellers, academic researchers, municipal building officials, Building Code developers, consultants, crown and government employees. There was a total of 21 respondents, with representatives from all of the listed groups. The survey asked HOT2000 users to rate between 1 (unimportant) and 5 (critical) the need to include various technologies and features within HOT2000 (Table 1).

Table 1: Survey results on the criticality (1 to 5) of including features not currently in HOT2000.

Modelling Feature	**Rating**
Regionally specific GHG emission factors	4.7
More sophisticated cold-climate air-source heat pump models	4.6
Air-source hot water heat pumps	4.4
Exterior shading devices	4.4
Use of standard weather file formats	4.4
Heat pumps combi systems for DHW and space heating	4.2
Integrated ability to model future weather	4.2
Automated code compliance verification	4.1
Smaller time-steps (max 1 hr) in the modelling of control strategies, power management, passive solar, temperatures	4.0
Latent loads and energy recovery ventilation	4.0
Embodied carbon calculations	4.0
Solar PV with battery backup	3.9
Zoned HVAC approach to capture peak temperatures and heating/cooling loads	3.9
Natural ventilation for passive cooling	3.9
Ability to integrate with other tools	3.9
Impact of thermal mass on cooling load	3.8
Cost/energy/GHG optimization support	3.8
Backup electricity system	3.3
Model the impact of power outage	3.2
BIM capabilities	3.0

As Table 1 demonstrates, there is a desire to add new features and technologies within HOT2000, which matches the recommendations for the reviewed assessments of the required features for net-zero energy tools. Given that HOT2000 uses the bin method, it is difficult to add new technologies and tools within the software given that many of its energy models rely on empirical relationships. Adding new inputs and design elements to an empirical equation can be challenging.

Enhanced Communication Between Software Tools

A review of net-zero energy building case studies found that three to eight simulation tools are typically used in the design as no tool can model all of the systems used in the buildings to a sufficient level of detail (Athienitis, et al. 2010). This observation led the IEA SHC Task 40 to recommend two focus areas in the development of design tools: first, improve the interoperability between tools so that their unique features can be used to complement each other. The second was simply to increase the number of technologies included in design tools so that fewer tools needed to be used. As shown in Table 1, users of HOT2000 would like to see better integration of many technologies within software as well as having a better ability to integrate HOT2000 with other software tools using an Application Programming Interface (API), which is a software intermediary that allows two applications to talk to each other.

Hourly Modelling and Weather Data

Survey respondents rated the importance of using standard weather data file formats as an importance of 4.4/5 (Table 1). With its release of HOT2000 version 11.10, HOT2000 greatly expanded its weather data. For BC, the software expanded from 20 available weather locations to 62 locations. This was important as the province is moving towards mandatory Energy Step Code which relies solely on performance based modelling. Using inaccurate weather by choosing the closest available weather location can lead to performance requirements that are more or less stringent than they could have been if the actual location's climate data was used. Even with the expanded dataset, some Energy Advisors are having difficulty adequately modelling homes that aren't covered in the dataset. The effect of the mountainous terrain and changes in elevation leads to different climates even if locations are relatively close to each other. Should standardized weather file formats be used, a modeller could more easily locate or generate a weather file of the actual location. RETScreen, another energy modelling tool developed by NRCan recently announced that users will be able to use near real-time hourly weather data from almost anywhere on the planet (Energy Manager Canada, 2022) using NASA satellite data.

Given that HOT2000 uses proprietary weather data, users are reliant on NRCan for updates. Given that climate change is happening at an increasing rate, using climate data derived from historical averages is not representative of the climate that the building is expected to see in its lifetime. A number of organizations like the Pacific Climate Impacts Consortium (PCIC) have developed standard format weather files depicting future climate using a number of different scenarios (PCIC, 2022). Survey respondents rated the importance of being able to model future weather data as an importance of 4.2/5 (Table 1).

Using monthly weather data limits HOT2000's ability to predict indoor temperatures as it relates to thermal comfort and life safety. Using smaller time-steps was rated as 4/5 in the user survey (Table 1). The heat dome that occurred in BC in 2021 was the deadliest weather event in Canadian history. Proper design that considers future weather data and modelled indoor temperatures will be keys in helping mitigate the impacts of our changing climate. In its recently published *Guideline for management of overheating risk in residential buildings* (Laouadi, et al., 2021), NRC recommends the development of an extreme reference summer weather years (RSWY) that would evaluate overheating in an expected heat wave. The report also lists four minimum requirements of a software to be able to evaluate overheating in buildings. HOT2000 does not meet any of the four requirements:

1. Use local hourly weather data including temperature, relative humidity, solar radiation (diffuse and global), and wind speed and direction;
2. Split building into multiple thermal zones (rated 3.9/5 in Table 1);
3. Use air flow networks or other suitable method to model natural ventilation (rated 3.9/5 in Table 1);
4. Produce hourly results of the indoor environment to complete overheating analysis.

Embodied Carbon

Magwood, et al., (2021) examined how the embodied carbon of homes changed between Tier 3 to Tier 5 of the Canadian National Building Code using high carbon materials (HCM), mid-range carbon materials (MCM), best available materials (BAM) and best possible carbon materials (BPM). Figure 1 shows that there is a very large range of embodied carbon depending on material selection from storing 13 tonnes to emitting an equivalent of 129 tonnes. A more significant finding is that for HCM and MCM scenarios, the embodied carbon actually went up as efficiency increased. The average operational carbon emission reduction going from Tier 3 to Tier 5 per home across all housing typologies they studied in cities with clean grids was 0.08 t CO_2e/year. In areas with more carbon intensive electric grids, going from Tier 3 to 5 saw average savings of 6.5 tonnes/year, 80 times more impactful. If the building uses primarily high embodied carbon emission materials, it would take over 260 years of operational carbon savings to make up for the increase in embodied carbon needed to meet Tier 5 compared to Tier 3. It is just over 3 years in areas with a more carbon intensive grid. As all utilities move towards reducing their carbon intensity, not accounting for embodied carbon can result in an increase in total carbon emissions as building codes move towards higher performance efficiency.

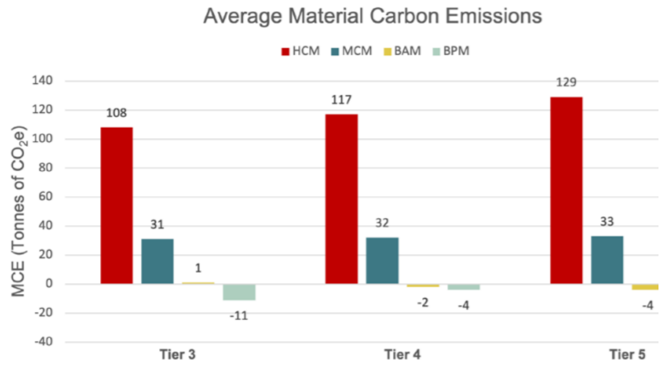

Figure 1: Average material carbon emissions (MCE) per material selection scenarios for each NBC energy efficiency Tier

In the HOT2000 user survey, the most desired feature for HOT2000 was regionally specific GHG emissions factors (Table 1). This is not surprising as regulators have started to shift the focus from operating energy as a proxy for carbon to considering actual carbon emissions when looking at climate mitigation. However, as the Magwood, et al., (2021) study highlights, including embodied carbon emissions in building codes will be needed to effectively mitigate the climate impacts of the built environment. Leading jurisdictions have already started to include embodied carbon in their building performance requirements, with many others assessing how it could be included, as many groups are lobbying for this action to better address climate change. Any new building energy modelling tool used for code compliance should have the capacity to calculate embodied carbon, or be easily integrated with industry leading embodied carbon calculation tools.

More HVAC Technology Options

As discussed, the bin-method introduces basic limitations in things that cannot be modelled (e.g. air temperature), and makes it more difficult and expensive to add new HVAC technologies to HOT2000. The difficulty arises in that the models used to calculate energy consumption were empirically derived and adding new parameters could require the development of a new set of empirical relationships. At the time HOT2000 was developed, the emphasis was on getting a more accurate heating load. The cooling model did not account for any thermal mass effects and limited latent heat considerations. Adding these features now would require an overhaul of HOT2000's cooling load calculations. Given that there is no easily accessible, publicly available, documentation on the modelling that is implemented within HOT2000, there is little opportunity for the research community or for industry to develop or suggest modifications to the existing empirical models.

As previous surveys have shown, the need for a software to be able to easily add new technologies is essential for net-zero energy modelling tools. With governments at all levels advocating for a rapid deployment of heat pump technologies, HOT2000 has been very slow in keeping up with the technology. Some of the ongoing limitations:

- It only recently developed a temporary workaround for energy advisors to better represent cold-climate air-source heat pumps.
- It uses a fixed COP when modelling air-to-water heat pumps for space heating.
- It does not have a heat pump model for domestic hot water (DHW) that has a condenser outside of the home.
- It does not have the ability to model combi-systems for space and DHW systems that use heat pumps.
- It does not have the ability to model heat-pump systems coupled with ventilation systems.
- It does not have the ability to effectively model variable capacity systems.

These limitations have been a frustration to energy advisors and other industry stakeholders trying to promote the use of heat pumps. This was reflected in the survey with all of the questions related to heat pump modelling options rating at 4 or higher in the industry survey. Why would a builder invest in a more expensive but more efficient system if they cannot use the savings to improve their building's rated performance level?

Electrical Loads, Solar and Batteries

As electrification is emerging as a key component of addressing the GHG impacts of the building stock, there is a need for tools to help better model the electrical loads within buildings. For existing homes, switching from natural gas heating and hot water systems to electric based systems can lead to costly upgrades of the home's electrical system to increase electrical capacity. Even with newer homes, using all electric systems coupled with electric vehicle chargers can lead to large overall electrical capacity requirements, which can lead to increased cost. However, there a number of emerging smart energy management control technologies that will allow more loads being connected to an electrical panel than the overall rating would typically allow, provided that a system is in place to ensure that large loads are not being turned on at the same time (Kumar, S., 2020). An example is a switch that allows electricity to either run an electric clothes dryer, or charge an electric vehicle.

If a software tool allowed for the more accurate modelling of electrical loads, different smart energy management control systems could be assessed by designers. If a design tool was sophisticated enough, it could better optimize the design making use of the dynamic interaction between different building systems. For example, Gong, et al. (2020)

found that including electric hot water tanks as a form of energy storage when solar PV systems are generating surplus electricity could help utilities manage the peaks and valleys associated with solar energy more cost effectively with a smaller battery system than if only solar and batteries were considered. Similarly, better modelling of electrical loads could help assess different control strategies to reduce electrical utility costs when time of day pricing and/or demand charges are in place. In order to model this hourly or sub-hourly time-steps are needed, thus it would be impossible to include in HOT2000 in its present form.

Accuracy

One study looked at the actual energy consumption of 19 net-zero energy homes in a community in Hawaii that were designed with the help of BEOpt (Norton, et al., 2013). Over the first year of occupancy, the homes were on average within 1% of the net-zero energy goals. However, they ranged from producing 2.5 times more than consumption, to consuming 20% more than production. The study authors suspect that the bulk of the differences came from miscellaneous plug loads and occupant behaviour. To increase the accuracy of modelled results requires more sophisticated ways to incorporate occupant behaviour effects on energy consumption. For example, one study that monitored temperature setpoints on a large set of homes over a 7-year period found that they varied by up to 5°C (Kneifel, et al., 2015). This can be a significant difference in energy consumption as modelling was showing that a 1°C could lead to a 7% change in energy consumption. However, when comparing net-zero energy designs to code minimum performance, the modelling accuracy of high performance homes was found to be less impacted by thermostat setpoints, weather, and air leakage.

The prediction of absolute energy values of an energy simulation is rarely accurate due to the various assumptions used in modelling (Maile, et al., 2007). The biggest cause of differences comes from not capturing the dynamic occupant usage of buildings. Energy modelling typically relies on standard occupant assumptions set by building codes, which typically do not reflect the actual usage of buildings. Maile, et al. (2007) suggest that a statistical distribution of occupancy and other internal loads could enable more realistic models and improve overall modelling accuracy. Another suggested approach in addressing the issue is to add uncertainty analysis into building simulation tools (Rocky Mountain Institute, 2011). Instead of one predicted annual energy consumption result, the tool could give a range of values accounting for modelling uncertainty.

Although occupant behaviour is important to capture, there are some differences that can be attributed to the energy models themselves. Purdy and Beausoleil-Morrison (2001) found that the single zone modelling assumption in HOT2000 could lead to a 7.5% difference in heat load calculation.

A sensitivity analysis found that a number of parameters can have more significant influence on accuracy: The simulation of the ground contact, the thermal bridging through the opaque envelope, the modelling of infiltration into the house, the external temperature, and the ground reflected solar radiation had larger impacts than other inputs (Purdy and Beausoleil-Morrison 2001). The challenge comes in finding the right mix of pragmatic assumptions and in-built defaults that will not impact accuracy to a great extent in order to help limit the amount of data entry. A home energy model in EnergyPlus, which represents a more accurate physical representation of the home, can have over 2000 inputs required compared to the 100-200 inputs required in the more traditional home energy rating tools (Moore & Feiler, 2007). More inputs can improve accuracy, however, it also increases the risk of modeller errors.

Simplifications in the way HVAC systems and plant are modelled have a large impact on ease-of-use and performance (Rocky Mountain Institute, 2011). Some tools (e.g. IDA/ICE and Modelica), make a single tool that is usable for different types of applications and users (e.g. architects and. engineers) using a graphical interface with built in default values that can be modified depending on the application and type of user.

When it comes to modelling existing buildings, Kneifel & Webb (2016) found that predictive regression models using post-occupancy data can accurately predict energy consumption and production based on a few common weather-based factors. The regression model they developed was more accurate at estimating actual yearly performance (within 243 kWh) of a net-zero energy home in Gaithersburg, MD compared to EnergyPlus (910 kWh) and TRNSYS (1,095 kWh) models. One reason for this is that the regression model was calibrated with in-situ energy outputs from the home, whereas the physics-based energy models were calibrated using in-situ performance of individual subsystems. This finding points to the possibility that a different modelling tool could potentially be developed for new and existing buildings. Alternatively, a tool based on physics-based energy models could be used for existing buildings, but to employ predictive regression models using energy consumption data in order to have a quality assurance check of the modelled data. A warning could be issued should the physics-based modelling results differ too significantly from the predictive regression model results.

Automated Quality Assurance

As reported, one element that reduces the confidence in energy modelling tools is the lack of reproducibility where different practitioners do not produce the same energy modelling results, even when using the same tools and building characterization data (Rocky Mountain Institute, 2011). Even though a software tool has the potential to be accurate, input errors can lead to discrepancies. As a new energy consultant fresh out of university, one of the first tasks assigned to the author of this paper was to verify energy models of commercial buildings modelled using EE4 against building construction plans to assess eligibility for a government grant. All models assessed had some errors ranging from missing and/or incorrectly inputted walls or windows, to issues with schedules or mechanical equipment inputs. Similarly, over the years the author has had to review HOT2000 models, and more often than not, modelling errors were found. Many had issues with either the size or orientation of windows. As an example, one had a typo that made the patio door 10 times wider than actual, leading to significantly more modelled energy use than anticipated, whereas another had a typo that made the ceiling 10 times smaller than actual, leading to a more minor impact on overall energy.

NRCan performs a limited amount of quality assurance on HOT2000 files that are submitted through its EnerGuide Rating System. HOT2000 also provides error messages when users input values that are outside the allowable range. However, there would be some value in providing users with other warnings should a design input fall outside the expected range for a given size house. As performance-based codes get adopted, energy modelling results will dictate whether a building gets its building permit or not. Most Building Code officials do not have the capacity to carefully review all the inputs in the files. Outputs could be formatted to better assist in compliance verification. As an example, the output could provide a window count by orientation and a window to wall ratio (WWR). Window counts by orientation was the metric most frequently used by the author of this paper to detect errors in HOT2000 files. With experience, a reviewer could see whether the reported WWR was in the right ballpark by looking at the building elevations. Without any checks and balances, the are no real incentives to make sure that energy modellers don't accidentally or intentionally forget to include a window or other building component enabling them to meet code requirements. Most of the HOT2000 survey responders rated including automated QA of modelling files as critical (average importance rating of 4.6/5).

Existing Tools

There are various existing software tools that can be used to evaluate the energy performance of housing. Some tools help combine the best features of existing software programs. The are a couple tools that help integrate the 3D modelling aspects of Sketch-up with the energy modelling capabilities of EnergyPlus. Sketch-up has a product called Sefaira that uses EnergyPlus and Radiance to provide guidance on energy, carbon, thermal comfort and daylighting at the conceptual and schematic design stage (Sketchup, 2022). Similarly, the Open Studio SketchUp Plug-in allows users to model a building developed in SketchUp 3D using EnergyPlus and Radiance (OpenStudio, 2022).

Other tools developed their own interface to work with EnergyPlus. DesignBuilder, TRACE® 3D Plus and BeOpt have their own graphical user interface to model buildings using EnergyPlus. Similarly, eQuest was developed to interface with DOE-2, EnergyPlus' predecessor. Other popular tools use other engines, such as IES-VE that uses APACHE.

When the HOT2000 user respondents for this research paper were asked "Is there an existing modelling tool, maybe used in another country, that includes most (or some) of the features that you would like to see?", the following tools were mentioned:

- EkoTrope (2 mentions)
- BeOpt (2 mentions)
- SketchUp (1 mention)
- A variation of PHPP (2 mentions)
- OpenStudio (1 mention)
- Properate (1 mention)
- eQuest (1 mention)

One particular comment was very pertinent to the development of a next generation tool. Whatever tool is developed, it would need to be readily adopted by the thousands of Energy Advisors that are currently trained on and using HOT2000. If the tool is too complex, requiring too many inputs, it may be difficult for some EAs to transition to a new tool.

Survey respondents were specifically asked if "Should the tool rely on an existing simulation engine (e.g. EnergyPlus) with the focus being on developing a new graphical user interface?". Most didn't have an opinion, one way or another. One was against it commenting to "No. Let existing tools exist. Develop something simpler." Six said it would be a good idea, with two specifying that EnergyPlus would be a good tool to choose.

Conclusion

Canada's residential construction industry plays a critical role in Canada's economy. In 2020, it represented 1.24 million jobs, $81.1 Billion in wages, and provided for $138.1 billion in economic investment (CHBA, 2021). Of the jobs, 58% were in the renovation and repair sector. If the federal, provincial and municipal governments are to come close to meeting their GHG reduction targets (2030 and 2050), most houses in Canada will need to undergo a deep energy retrofit. One of the key tools at the heart of this multi-billion-dollar industry, helping make critical design decisions is HOT2000, a software tool that NRCan said needed replacement 25 years ago based on the advent of "modern" computing powers.

By 2030, the federal government is aiming for net-zero performance levels for new buildings. In order to address the growing need to consider both climate change mitigation and adaptation, design tools will need to address embodied carbon, adapt to an ever-changing climate dataset and emerging technologies. At some point, the industry will need to move beyond HOT2000 to effectively achieve these objectives. Upgrading a simulation program to better meet customer needs requires committing significant staffing resources and financial investment making it important to take a long-term view in charting a path forward (Rocky Mountain Institute, 2011).

This paper aimed to move the conversation of the need for a new tool beyond the water cooler conversations. The survey presented in this paper was limited as it only had 21 respondents, though respondents included experts from various different stakeholder groups. Should NRCan decide to move to develop a next generation tool, they should conduct a much more thorough survey of their various stakeholders and user groups than was conducted in this paper, in order to better understand their current and future needs. The good news is that many others have done assessments of the requirements of net-zero energy simulation tools and there are many similarities in their findings.

It is possible that the government decides to move away from software development and let industry develop software tools. The fact that the government developed a free tool that is tied to most government programs provides little incentive for the private sector to develop a potentially better tool since they could never compete with a free tool (Rocky Mountain Institute, 2011). On the other hand, if the government wants to keeps its monopoly on housing energy modelling software used in Canada in order to better track and influence change, they need to accept the responsibility of making sure the tool is able to meet the housing industry's current and future needs.

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